2008

Understanding Sustainability: Two-Week Unit for Life, Physical, and Earth Sciences Grades 6-8

Facing the Future, Western Washington University

Understanding Sustainability

Two-Week Unit for
Life, Physical, and Earth Sciences
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Facing the Future

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Developed by Facing the Future

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Facing the Future is a nonprofit, nonpartisan organization providing resources and community action opportunities on global issues and sustainability for teachers, students, and the public. For more information and to order copies of this guide, visit our website or contact us at:

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Introduction

The purpose of this unit is to teach important sustainability concepts and their interconnections, including natural resources, human population growth, and resource consumption. Students will also investigate their local environment and design and implement an action plan to reduce their Ecological Footprint.

Class: Physical Science, Life Science, Earth Science

Grade Level: 6-8

Unit Length: 2 weeks

Issues Covered/Key Concepts:

- Ecological Footprint
- Energy resources
- Fisheries
- Interconnections
- Population growth
- Carrying capacity
- Renewable and nonrenewable resources
- Sustainability
- Systems
- Water resources
- Technology

Student Skills Developed:

- Critical thinking
- Collaboration
- Outreach to school community

National Science Education Standards Addressed (Grades 5-8):

A - Science as Inquiry
- Abilities Necessary to Do Science Inquiry
- Understandings about Scientific Inquiry

B - Physical Science
- Transfer of Energy

C - Life Science
- Structure and Function in Living Systems
- Populations and Ecosystems

D - Earth and Space Science
- Structure of the Earth System

E - Science and Technology
- Abilities of Technological Design
- Understandings about Science and Technology

F - Science in Personal and Social Perspectives
- Populations, Resources, and Environments
- Risks and Benefits
- Science and Technology in Society

G - History and Nature of Science
- Nature of Science

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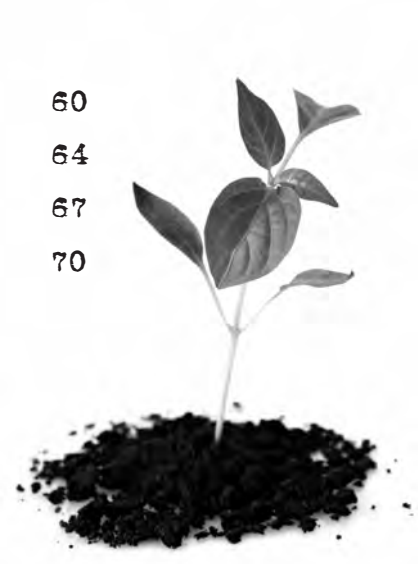


	Day 1	Day 2	Day 3	Day 4	Day 5
	Fishing for the Future activity and reflection 	**Watch Where You Step** activity and reflection 	**Systems Are Dynamic** activity and reflection **Who You Callin' Bigfoot?** activity	**School Sustainability Audit** surveys 	**School Sustainability Audit** news articles 
	Student Reading **1** **Ecological Footprint**	**Writing Connection**	Student Reading **2** **Sustainability**	Student Reading **3** **Energy and Sustainability**	

DAY 1: Introduction to Sustainability (50 minutes)
- Do Fishing for the Future activity and reflection
- Homework: Read Ecological Footprint

DAY 2: Ecological Footprint (50 minutes)
- Do Watch Where You Step activity and reflection
- Homework: Complete Watch Where You Step Writing Connection

DAY 3: Systems and Interconnections (50 minutes)
- Do Systems Are Dynamic activity and reflection
- Do Who You Callin' Bigfoot? activity (students begin Individual Footprint project)
- Homework: Read Sustainability

DAY 4: School Sustainability Audit—Surveys (50 minutes)
- Complete School Sustainability Audit surveys
- Homework: Read Energy and Sustainability

DAY 5: School Sustainability Audit—Summary and Analysis (50 minutes)
- Write School Sustainability Audit news articles and present group results
- Homework: Continue work on Individual Footprint project

	Day 6	Day 7	Day 8	Day 9	Day 10
	Is It Sustainable? activity and reflection 	**Toil For Oil** activity and reflection 	**Every Drop Counts!** activity and reflection 	**Deep Space 3000** activity and reflection 	**Individual Footprint Presentation** 
	Work on **Individual Footprint Presentation**	**Technology Connection**	Student Reading **4 Sustainable Solutions-We Can Do It!**	Work on **Individual Footprint Presentation**	

DAY 6: Examining Sustainability (50 minutes)
- Do Is It Sustainable? activity and reflection
- Homework: Work on Individual Footprint Presentation

Day 7: Nonrenewable Resource—Petroleum (50 minutes)
- Do Toil for Oil activity and reflection
- Homework: Complete Toil for Oil Technology Connection

DAY 8: Renewable Resource—Water (50 minutes)
- Do Every Drop Counts! activity and reflection
- Homework: Read Sustainable Solutions-We Can Do It!

DAY 9: Sustainable Solutions (50 minutes)
- Do Deep Space 3000 activity and reflection
- Homework: Work on Individual Footprint Presentation

DAY 10: Personal Solutions—Individual Footprint Presentations (50 minutes)
- Students present results of one-week individual footprint reduction
- (Optional) Turn in Individual Footprint Worksheets

Fishing

Through a fishing simulation, students model several consecutive seasons of a fishery and explore how technology, population growth, and sustainable practices impact fish catch and fisheries management. As the students progress through the fishing seasons, they will likely overfish their oceans and will have to migrate to other oceans to meet their basic needs.

Fishing for the Future is adapted with permission from "Fishing with Jim" by Jim Hartmann and Ben Smith

For The Future

Key Issues/Concepts

- Resource management
- Tragedy of the Commons
- Sustainability

Integrated Subject Areas

- Social Studies (Geography, Economics, Global Studies)
- Math

Inquiry/Critical Thinking Questions

- What happens when a commonly owned resource is overused?
- What are the impacts of overfishing or exploiting a natural resource?
- How can we establish and maintain the sustainable use of a resource?

Objectives

Students will:

- Experience the "Tragedy of the Commons" as it relates to fishing resources
- Consider social, environmental, and economic impacts of overfishing
- Identify sustainable fishing practices
- Determine and explain purchasing/consumption choices

National Science Education Standards Addressed

C - Life Science
- Populations and Ecosystems

E - Science and Technology
- Understandings about Science and Technology

F - Science in Personal and Social Perspectives
- Populations, Resources, and Environments

Vocabulary

- **Tragedy of the Commons**—Occurs when resources shared by everyone (or held in common)—such as the air we breathe, the water we drink, and the fish we eat—are used at a rate that exceeds the sustainable limit of these resources. Ultimately, as population grows and consumption increases, the "commons" collapse.
- **Sustainability**—Meeting present needs without compromising the ability of future generations to meet their own needs.

Materials/Preparation

- Plain, small candy-covered chocolate candies, one 16-ounce bag for up to 20 students (two 16-ounce bags for more than 20 students)
- Small plastic bowls, 1 per 4-5 students
- Put about 20 candies in 1 bowl per 4-5 students
- Spoons, 1 per 4-5 students
- Straws, 1 per student
- Watch, for timing activity
- Handout: Fishing Log, 1 per student

Activity

Introduction

1. Ask students if they have heard of "sustainability." Use the definition given in the vocabulary section to explain the meaning of sustainability.
2. Ask why sustainability might be an important goal for a society and what might be some of the challenges in realizing this goal. Tell students that today they are going to go fishing and explore some of these sustainability issues.

Steps

1. Explain the game rules:

    a. Each student will be a "fisher" whose livelihood depends on catching fish.
    b. The candies represent ocean fish such as cod, salmon, tuna, etc.
    c. Each fisher must catch at least 2 fish in each round to survive (i.e., get enough fish to either eat or sell).
    d. When the fishing begins, students must hold their hands behind their backs and use the "fishing rod" (straw) to suck "fish" (candies) from the "ocean" (bowl) and deposit them into their "boat" (i.e., on the table in front of them).
    e. The fish remaining in the ocean after each fishing season represent the breeding population, thus, 1 new fish will be added for every fish left in the ocean (bowl).

2. Divide the class into groups of 4 or 5 students and have each group choose an ocean name, such as North Atlantic, North Pacific, Arctic, Mediterranean, etc.
3. Give each group 1 serving bowl and give each student 1 straw and 1 copy of the handout Fishing Log.
4. Put 1 bowl with the candies by each group.
5. Say, "Start fishing," and give the students about 20 seconds for the first "season" of fishing.
6. Have each fisher count his or her catch and record the data in their Fishing Log.
7. Fishers who did not catch the 2-fish minimum must sit out the following round.
8. Add 1 new fish (candy from the bag) for every fish left in the ocean (bowl).
9. Allow fishers to use their hands on the straws during the second session to represent "new technology."
10. After the second fishing season, give 1 fisher from each group a spoon representing more new fishing technology such as trawl nets, sonar equipment, etc. Continue the game for round 3.
11. Ask the students what happened when ocean group [name] ran out of fish. How are the fishers going to survive now (e.g., one option is to move to another ocean)? Allow students to "invade" other ocean groups when their ocean is depleted, but do not tell them that they can do this beforehand. Fishers may either go as a group to another ocean or they may disperse to other oceans by themselves.
12. Repeat fishing, recording, and replenishing fish stocks until either sustainable fishing levels are achieved or until all (or most) groups fish out their ocean.
13. (Optional) Repeat the activity after the class has experienced the "Tragedy of the Commons" and discussed sustainable practices to see if they can harvest in a sustainable manner. Tell students that their goal is to fish in such a way that the fish populations either remain at their current size or increase in size.
14. Conclude with the following reflection questions.

Assessment

Reflection

1. How did you feel when you realized that you had depleted your fish stock?
2. How did you feel when other fishers joined your ocean group?
3. How does this activity relate to real ocean and fishery issues?
4. What are some ways to have a sustainable fishery? What rules could be developed (e.g., limit the types of equipment allowed, limit the amount and type of fish, institute shorter seasons)?
5. What happens to a resource when you have infinite population growth, rapidly developing technology, and a finite resource?
6. Are there any commonly owned resources in our region or community? If so, what are some similar issues that arise, and how can they best be managed? (For example, air is a commonly used resource—how do we deal with air pollution? Forestry or animal grazing rights sometimes prompt similar discussion points. You might also talk about city parks, national parks, and other public lands, and their competing uses and needs.)

Lesson Extension

Have students choose 1 of the major world fisheries, such as salmon, cod, or tuna, and develop a sustainable fishing plan, paying attention to international laws and treaties.

Action Project

Students can research which fish are harvested in a sustainable manner and which are being depleted. Have them do an advertising campaign in their school promoting the consumption of sustainable fish and avoiding the consumption of threatened fish. This might include researching the kind of fish served in your school cafeteria and then recommending a sustainable seafood purchasing program to cafeteria staff and school principal. For recommendations about which seafood to buy or avoid, check out the Monterey Bay Aquarium's website "Seafood Watch" at **www.montereybayaquarium.org/cr/seafoodwatch.asp**.

Additional Resources

Book

State of the World, Worldwatch Institute, New York, **www.worldwatch.org**.

Websites

www.redefiningprogress.org—One of the key organizations working on Ecological Footprint analysis has now developed a Fishprint analysis to assess sustainability of fisheries.

www.fao.org/fi—The United Nations Food and Agriculture Organization (FAO) Fisheries Information Center has a wealth of information on fisheries practices and statistics.

Fishing Log

Ocean Name _____

Fishers _____

Record your group's catch and the amount of fish left in ocean after each season:

Season	Catch	Fish Left in the Ocean
1		
2		

Briefly describe the status/health of your fishery: _____

Season	Catch	Fish Left in the Ocean
3		
4		

Briefly describe the status or health of your fishery now: _____

How could you have made your fishing practices sustainable? _____

2

Watch Where You Step

Students identify the components of an Ecological Footprint by creating a web diagram of all the resources they use in their everyday lives and the mark or "footprint" this consumption leaves on the environment. The activity emphasizes the interconnectedness of lifestyle, population, and environmental impacts, and focuses on solutions to reduce Ecological Footprints.

Key Issues/Concepts

- Ecological Footprint
- Population
- Consumption

Integrated Subject Areas

- Social Studies (Geography, Economics, Global Studies)

Inquiry/ Critical Thinking Questions

- What are the environmental, economic, and social impacts of a typical U.S. diet and lifestyle?
- What would be the consequences if the rest of the world adopted a U.S. lifestyle?
- What can we do to reduce impacts associated with resource consumption?

Objectives

Students will:

- Identify the resources, processes, and impacts embodied in everyday activities
- Describe the interconnectedness of population, lifestyle, economics, and environmental issues
- Discuss, create, and implement ways to reduce Ecological Footprints

National Science Education Standards Addressed

F - Science in Personal and Social Perspectives

- Populations, Resources, and Environments

Materials/Preparation

- Butcher paper, 1 sheet per group of 3-4 students
- Colored marking pens, 2–3 pens per group of 3-4 students
- Overhead: Definition and Components of an Ecological Footprint
- (Optional) Handout: Hamburger, Fries, and a Cola

Activity

Introduction

1. Introduce the concept of Ecological Footprint using the overhead, Definition and Components of an Ecological Footprint. Tell students that in order to understand this concept, they will create a web diagram illustrating everything associated with 1 component of their Ecological Footprint.
2. Bring in an everyday item in its original packaging (e.g., a juice box, CD, cookies, drink cup, small appliance, toy) and have the class brainstorm about the Ecological Footprint created by producing, distributing, and disposing of the item. Discuss alternatives to using the item and/or how the item could be produced in a more sustainable manner.

Steps

1. Give the following directions before grouping students and assigning their Footprint component: In groups, brainstorm and map all of the resources, processes, and impacts associated with 1 component of your Ecological Footprint, such as a meal, mode of transport, favorite object, or item of clothing. For example, for "My Favorite Meal," you would first agree on a meal you like, write and/or draw it in the center of the paper, and then write and/or draw the resources and processes it took to produce it.

   Note: There is no single "right" way to do this activity. A simple web diagram could include lines or arrows connecting all of the inputs and impacts to the various components of an item. Students may be able to think of many possible inputs and outputs related to their chosen item. This activity could also be expanded to include student research on the materials required to produce a given item.

2. Do a short verbal example together with the class. Ask them what it takes to create a hamburger (cow, bun, lettuce, etc.). There are a few steps in between the cow and the burger itself—what are they (e.g., grass, butcher, meat grinder)? In between the cow, we have the slaughterhouse, the transportation of the beef to the restaurant, the energy to heat the stove to cook the burger, and so on. Now, think about all the steps required to make your item, including the resources needed to produce, process, deliver, serve, and dispose of it (e.g., farmland, water, farm machinery, fertilizer, pesticides, petroleum fuels, electrical energy, transportation, refrigeration, markets, and restaurants). What impacts result from each of those processes and technologies (e.g., soil erosion, pesticide runoff, air pollution, freeway crowding, and urban sprawl)? Use the optional handout, Hamburger, Fries, and a Cola, as an example of what goes into producing this common U.S. meal.
3. Arrange students in groups of 3-4.
4. Assign each group 1 of the following scenarios that illustrate 1 component of an Ecological Footprint, and have them begin their web diagrams (if you have a large class, you can assign items to more than one group):

   - My Favorite Food
   - How I Traveled Here Today (a mode of transportation)
   - My Favorite Object (a toy, sports equipment, etc.)
   - My Favorite Piece of Clothing

5. If students need help organizing their thoughts, you may want to create a chart on the board like the example on this page to get them started.

Item/ Component	What Is It Made Of?	What Resources Are Needed?	Is Transportation Required?	What Are Possible Impacts?

6. Allow about 20 minutes for this portion of the activity. Encourage students to be creative and think of everything that is related to the object. Remind them to include items such as transportation of a product, the marketing of popular brand items, health issues, and waste disposal.
7. After completing their diagrams, have students brainstorm and list, on the back of their butcher paper, 10 things that they can do personally to reduce their Ecological Footprint (in relation to the item they mapped).
8. Have each group present their diagrams and report their findings and solutions to the class. As students present their Footprint reduction solutions, be sure to emphasize that they do not need to give up everything they like, but rather should focus on ways to reduce their impacts. For example, they do not need to say that people should never drive cars; rather, they could say that people could ride a bike to school when possible, or once a week.
9. Bring the class back together for reflection questions.

Assessment

Reflection

1. Discuss the average size of an Ecological Footprint of a person living in the United States (about 24 acres) as compared to someone living in India (about 2 acres).
2. What impacts might result if twice as many people lived in our community and enjoyed the same meals, transportation, clothing, etc.?
3. What impacts might result if everyone in the world were to enjoy the same lifestyle as U.S. citizens? How would that impact you economically, environmentally, socially, and politically? How might that impact your access to education, employment, and recreation?
4. What would be the consequences of 12 billion people having the same lifestyle as U.S. citizens? Would that be sustainable? How might your life change in response?
5. How else could you maintain a comfortable and fulfilling lifestyle, but lower the associated environmental impacts?

Writing Connection

Have students write a letter to someone about the Ecological Footprint concept. By writing a letter, students demonstrate that they understand what an Ecological Footprint is, why the concept is an important one, and how one's Footprint might be reduced. Alternatively, if a student feels it is not important to reduce one's Footprint, he/she may explain why he/she feels that way. Give students the following instructions: Write a letter to a friend, cousin, parent, or someone else that you know. In your letter, you must:

- Briefly explain what an Ecological Footprint is. What have you learned about it?
- Suggest ways that you and the recipient of your letter might reduce your Ecological Footprints. Be realistic. What are some things you might really try?
- Try to convince the other person that it is worth trying these suggestions. Explain why you think it is important to reduce the size of your Ecological Footprint. Alternatively, if you believe that it is not important to do so, then explain why not. Try calculating your own Ecological Footprint at **www.myfootprint.org** before writing your letter.

Action Project

If your school has a cafeteria, have the students evaluate the food prepared there and present a proposal to the school administration and their peers with alternatives to high resource consumption and wasteful practices.

Additional Resources

Film

The Ecological Footprint: Accounting for a Small Planet, Global Footprint Network, Bullfrog Films, 2005, 30 minutes, **www.bullfrogfilms.com/catalog/efoot.html**. In this documentary film, Mathis Wackernagel introduces the Ecological Footprint and paints a picture of our current global situation.

Book

Stuff: The Secret Lives of Everyday Things, John C. Ryan and Alan Thein Durning, Northwest Environment Watch (now the Sightline Institute), 1997. Stuff reveals the resources required to produce things that a typical middle-class North American consumes daily. **www.sightline.org/publications/books/stuff/stuff**

Websites

www.redefiningprogress.org—Redefining Progress works with a broad array of partners to shift the economy and public policy towards sustainability.

www.footprintnetwork.org—The Global Footprint Network supports a sustainable economy by advancing the Ecological Footprint, a measurement and management tool that makes the reality of planetary limits relevant to decision-makers around the world.

Definition and Components of an Ecological Footprint

Ecological Footprint:

The area of the earth's productive surface (land and sea) that it takes to produce the goods and services necessary to support a person's lifestyle.

Components of an Ecological Footprint:

- **Oxygen** (trees for absorbing carbon dioxide)
- **Food** (e.g., meat, dairy, fish, fruits and veggies)
- **Water** (e.g., drinking, cooking, washing)
- **Fiber** (e.g., clothes, wood, upholstery)
- **Energy** (e.g., fuel for cars, heat for cooking)
- **Infrastructure** (e.g., highways, hospitals, water facilities)
- **Waste Disposal** (garbage dumps, landfills)
- **Recreation** (e.g., soccer fields, parks)

Hamburger, Fries, and a Cola

What Did It Take to Produce This American Meal?

The meat came from cattle grazed initially on public or private land, and later fed grain. About 10 percent of all public lands in the western United States have been turned to desert by overgrazing, and about two-thirds of those public lands are significantly degraded. Streamside lands where cattle graze have been especially damaged.

It took approximately 2 pounds of grain to produce that quarter pound of meat, and that grain production caused five times its weight in topsoil loss due to erosion from unsustainable farming methods. Producing that grain also took substantial amounts of pesticides and fertilizers (half of all fertilizer in the United States is applied to feed corn for animals), some of which ran off into surface water or seeped into groundwater supplies. By the time the steer was finished in the feedlot, it took 600 gallons of water to build that hamburger patty. Once slaughtered and processed, the meat was frozen, shipped by truck, kept cold, and then cooked on a grill using natural gas.

The 5-ounce order of fries came from one 10-ounce potato grown in Idaho on half a square foot of soil. It took 7.5 gallons of water to raise that potato, plus quantities of fertilizer and pesticides, some of which ran off into the Columbia or Snake Rivers. Because of that, and dams that generate power and divert water for irrigation, the Snake River sockeye salmon is virtually extinct. A number of other species are also in decline because of these production practices.

The potato was dug with a diesel-powered harvester and then trucked to a processing plant where it was dehydrated, sliced, and frozen. The freezing was done by a cooling unit containing hydro fluorocarbons (HFCs), some of which escaped into the atmosphere and likely contributed to global climate change. The frozen fries were then trucked to a distribution center, then on to a fast-food restaurant where they were stored in a freezer and then fried in corn oil heated by electricity generated by hydropower.

The meal was served in a fast-food restaurant built on land that was originally forest, then farmland, and then converted to commercial/industrial uses as the city expanded. The ketchup in aluminum-foil packets came from Pittsburgh and was made from Florida tomatoes. The salt came from Louisiana.

The cola came from a Seattle processing plant. It is made of 90 percent water from the Cedar River. The high-fructose corn syrup came from Iowa, as did the carbon dioxide used to produce the fizz, which is produced by fermenting corn. The caffeine came from a processing plant that makes decaffeinated coffee. The cola can was made from one-third recycled aluminum and two-thirds bauxite ore strip-mined in Australia. It came to Washington State on a Korean freighter, and was processed into aluminum using an amount of energy equivalent to a quart of gasoline. The energy came from some of the same dams mentioned earlier that have contributed to a 97 percent decrease in the salmon runs of the Columbia Basin.

The typical mouthful of food consumed in the United States traveled 1,200 miles for us to eat it. Along the way, it required packaging, energy, roads, bridges, and warehouses, and contributed to atmospheric pollution, adverse health effects, and traffic congestion.

Adapted from *Stuff—The Secret Lives of Everyday Things*, by John C. Ryan and Alan Thein Durning, Northwest Environment Watch (now the Sightline Institute), 1997.

3

Systems

Students experience the dynamic, interconnected, and self-organizing nature of systems through an exercise in which they move around an open space trying to keep an equal distance between themselves and 2 other

Systems Are Dynamic

Variations of this activity have been used for many years in a variety of educational settings to provide direct experience with the dynamic nature of systems.

Are Dynamic

Key Issues/ Concepts

- Systems dynamics
- Interconnectedness
- Self-organizing systems

Integrated Subject Areas

- Social Studies (Geography, Economics, Global Studies)

Inquiry/Critical Thinking Questions

- What is the inherent nature of a system?
- How can understanding the nature of systems help us find solutions to large, complex problems?

Objectives

Students will:

- Experience and discuss the dynamic, interconnected, and self-organizing nature of systems
- Consider how understanding the nature of systems can help us find sustainable solutions

National Science Education Standards Addressed

A - Science as Inquiry
- Abilities Necessary to Do Science Inquiry

C - Life Science
- Populations and Ecosystems

F - Science in Personal and Social Perspectives
- Risks and Benefits

Materials/Preparation

- No materials needed, but you will need a large open space to conduct the activity

Activity

Introduction

1. Ask students to define a "system." What are some of the defining features of a system? (For example, a system has many parts that work together; if you change 1 part it affects other parts; if you remove or add something it can change the whole system; a system is made of interconnected parts; a system can be something in nature, or it can be mechanical or human.) Ask for examples of systems that they encounter, use, or are a part of. Some examples are a computer, an ecosystem, and a human body.
2. Explain to the students that they are going to do an exercise to help them understand the dynamic, or continually changing, nature of systems.

Steps

1. Have the students stand randomly in a large open space either indoors or outside.
2. Give the following 2 instructions:

    - Mentally select 2 other people in the group, without indicating whom you have chosen.
    - Move so as to keep an equal distance between you and each of these 2 people at all times. This does not mean simply remaining at the midpoint between them.

3. To pursue this objective, students will begin to circulate, each movement triggering many others in an active, interdependent fashion. Movement may speed up for a while, then may abate, accelerate, and again slow down toward equilibrium, but it rarely reaches stasis.

    - **Lesson Variation**: Have 2 students stay outside the room during instructions, then call them in at a certain point during the activity and ask them to try to detect what is happening. When the process halts and they learn (or have discovered) the principle guiding people's movements, ask the observers if they could organize this complex process from the outside. This highlights the principle that relations within systems are so complex that they can only self-regulate. You can also invite the observers to walk quietly through the game while it is in progress. The observers and the players will notice that this pass-through does not affect or disrupt the game, since the players are moving solely in relation to each other. This models how humans can pass through a system (such as a forest or a swamp) and not disrupt its defining relations.

4. Let the movement continue for 3 or 4 minutes; then, as activity lessens, have students pause where they are and begin the reflection questions.
5. After students answer the reflection questions, begin the activity, Who You Callin' Bigfoot?

Assessment

Reflection

1. Have the students describe what happened during the activity. Begin by asking, "What did you experience?" Their reflection may bring out some key features of self-regulating systems, such as the interdependence of all parts and the continuous process of seeking and

maintaining balance. Students may realize that they thought the point of the game was to achieve stasis, whereas in fact the game demonstrated that self-regulating systems require constant internal activity.

2. Where was your attention focused when you were doing this activity? Were you focused on the big picture or the small details? Were you focused on your own actions or the actions of others? Why is this perception important?
3. What other systems can you think of that are interconnected, dynamic, and self-regulating (e.g., the human body, an automobile, a natural habitat)?
4. Why and how is it helpful to understand these aspects of a system? How can this understanding of systems help us to figure out solutions to large and complicated global issues?
5. How far-reaching are the effects of one small, intentional change within a system? What might the implications of this be for making positive changes to a system?
6. How can we think of the world as a system? What are its component parts, and how are they related?

Lesson Extension

Systems thinking can be used to visualize interconnections. Have students create a "cluster" graphic organizer following these guidelines: Choose a global issue and write that in the center of the paper. Write as many connecting issues as you can think of around the issue. Write as many other issues you can think of that affect or are affected by these issues and connect them with lines. Write a short summary explaining the cluster.

Action Project

Have students identify a local system (e.g., your school or classroom, watershed, park, forest) and the changes that could be introduced to that system to make a positive difference.

Additional Resources

Film

Finding Balance: Forests and Family Planning in Madagascar, Population Action International, 2004, 9 minutes, **www.populationaction.org**. This short documentary explores the connections between women's health and environmental sustainability.

Book

The Web of Life: A New Scientific Understanding of Living Systems, Fritjof Capra, Anchor, 1997. Capra sets forth a new scientific language to describe the interrelationships and interdependence of psychological, biological, physical, social, and cultural phenomena.

Websites

www.pegasuscom.com—Pegasus Communications' website provides systems thinking resources to help individuals, teams, and organizations understand and address the challenges and complexities of a changing world.

www.sustainabilityinstitute.org—The Sustainability Institute focuses on understanding the root causes of unsustainable behavior in complex systems and, through projects and training, helps people to shift their mindsets and restructure systems in sustainable ways.

Who You

Students determine ways to increase the sustainability of their lifestyles. Each student changes 1 aspect of his or her daily life for 1 week to reduce his or her Ecological Footprint. Students present their results to the class at the end of the project.

Callin' Bigfoot?

Key Issues/Concepts

- Personal solutions
- Sustainability
- Ecological Footprint

Inquiry/Critical Thinking Questions

- In what way(s) can we reduce our Ecological Footprint?
- What personal actions can be taken to promote sustainability?

Objectives

Students will:

- Pledge to create a more sustainable world by implementing a change over 1 week
- Record daily progress toward reducing their Ecological Footprint
- Share the results of their individual Footprint reduction with peers

National Science Education Standards Addressed

A - Science as Inquiry
- Abilities Necessary to Do Science Inquiry
- Understandings about Scientific Inquiry

F - Science in Personal and Social Perspectives
- Populations, Resources, and Environments

G - History and Nature of Science
- Nature of Science

Materials/Preparation

- Handout: Individual Footprint Worksheet, 1 for each student
- Handout: Facing the Future pledge, 1 for each student

Activity

Steps

1. Introduce the week-long assignment to students by telling them the following information: Each of you will reduce 1 component of your Ecological Footprint during the next week. (For example, you may reduce the amount of water used when brushing your teeth or walk to school rather than riding in a car.) This should be a measurable, or quantifiable, change that you will record over the next 7 days. You will present the results of your Footprint reduction to the class.
2. Give students 5 minutes to brainstorm ways that they may reduce their individual Ecological Footprints. This brainstorm session could be done individually, in pairs, or as a class discussion in which students can share ideas freely.
3. Have each student fill out the Facing the Future pledge. The completed pledges should be hung around the classroom so that all students may be reminded of their goals and may examine their peers' ideas.

4. Give each student an Individual Footprint Worksheet. The first 2 questions should be answered today, either in class or for homework. Each day for the next 7 days, students will record their progress on the worksheet.
5. Show students the assessment rubric for this activity (see below) so that they know what you expect them to include in their presentation.
6. Upon completion of the week-long project, students will present their individual projects in order to communicate the ways in which they reduced their Ecological Footprint and to reflect on the success and importance of their efforts. Students should include information that clearly explains the action taken to reduce their Ecological Footprint, how they performed the project, and their successes and limitations. It may help to tell students to present the information in such a way that another person could learn how to duplicate the project and what potential successes and/or pitfalls the project may include.
7. In addition to the short oral presentations, each student will create a poster to visually communicate the project, including outcomes and sustainability implications. Give the following information to students:

    - Each poster will illustrate or describe 1 way to reduce your individual Ecological Footprint. Information about your individual project will be included on the poster.
    - The poster should be clear and eye-catching. These posters will be displayed in a public place in your school. Your objective is to explain how you reduced your Ecological Footprint.

8. On the day set aside for student presentations, allow each student 1-2 minutes to orally present his or her project.
9. (Optional) After students give their presentations, ask them to hand in their completed Individual Footprint Worksheets.
10. Display the posters at school where students, staff, and parents can see them.

Assessment Component	3 Exceeds Expectations	2 Meets Expectations	1 Needs Improvement	0 Little or No Effort Made
Explanation of Student Project	Student action and methods explained clearly enough that others could repeat the project.	Student action and methods explained fairly clearly, but not enough detail provided for others to repeat the project.	An attempt to describe the project details is made but incomplete and unclear.	Student demonstrates no personal action taken.
Discussion of Results	Thorough reflection of the project is given, including impacts/importance, student success, and difficulties encountered.	Some reflection is provided on impacts of project, student success, and difficulties encountered.	Very limited discussion of importance of project. Little or no discussion of student's successes or difficulties.	No discussion of project results provided.
Presentation	Project is clearly presented and well thought out.	Presentation is mostly clear and contains good ideas that may not be well-developed.	Presentation provides little information, is unclear, or is not on topic.	Explanation is incomplete or incomprehensible.
Poster	Poster is eye-catching, relevant, and clearly illustrates the student's project.	Information is easy to understand, but poster may be disorganized or sloppy.	Poster gives very little insight into student project.	No poster.

Facing the Future

I'm taking the Facing the Future pledge!

I, _____,
pledge to take action to help create a sustainable world by:

_____

_____

_____

_____

_____

Signature _____ Date _____

Individual Footprint Worksheet

Name _____

I. Answer these questions before starting your project on Day 1:

1. What is one way you can reduce your impact on Earth's resources (i.e., your Ecological Footprint)?

2. What is your daily goal, and how will you measure your progress?

II. Record your efforts on each day below:

Day 1

Day 2

Day 3

Day 4

Day 5

Day 6

Day 7

III. Answer these questions after your seven-day Footprint project:

1. Were you successful in your goal? Explain why or why not.

2. Was this change difficult for you? How could others do it?

3. Some people feel that by reducing your Ecological Footprint, you are gaining something rather than giving up something. How has your quality of life improved by shrinking your Footprint?

4. How has this project infulenced you? Will you continute the action to reduce your Footprint? What other things might you do to increase sustainability?

School

On Day 1, students perform a sustainability audit of their school in 4 groups (Energy, Water, Waste, and Transportation). On Day 2, each group writes a news article and presents their audit results and recommendations to the class.

Sustainability Audit

Key Issues/Concepts

- Sustainability
- Ecological Footprint

Integrated Subject Areas

- Math
- Social Studies (Geography and Economics)

Inquiry/Critical Thinking Questions

- How sustainable are everyday activities at our school and at home?
- What are some ways that we can promote a more sustainable lifestyle?

Objectives

Students will:

- Assess the components of their school's Ecological Footprint
- Determine the degree to which the school's practices are sustainable
- Make recommendations for improving the overall sustainability of the school
- Communicate their knowledge and ideas to others by writing an informative news article

National Science Education Standards Addressed

A - Science as Inquiry
- Abilities Necessary to Do Science Inquiry
- Understandings about Scientific Inquiry

B - Physical Science
- Transfer of Energy

F - Science in Personal and Social Perspectives
- Populations, Resources, and Environments

G - History and Nature of Science
- Nature of Science

Materials/Preparation

- Survey worksheets, 1 per group
- Disposable gloves and scale (for School Waste Survey group)
- Access to computers (for article activity)
- Teacher will need to contact key personnel (e.g., janitorial and administrative staff) to ensure their availability during the audit activity. A representative from the school district's maintenance department could also be invited to participate. Give appropriate personnel the surveys ahead of time so that they will know the questions being asked of them.
- Notify other teachers and administrators prior to doing this activity so that roving student groups are expected.

Activity—Day 1

Introduction

1. Review the concept of the Ecological Footprint by asking students to explain how an Ecological Footprint is related to sustainability.
2. Tell students that they are going to do a sustainability audit of their school by completing surveys of 4 components of the school: energy, water, transportation, and waste. You may want to point out that these 4 areas are not the only components of sustainability, but that these will give students a great deal of information about their school's Ecological Footprint.

Steps

1. Divide the class into groups of 3-4 students each. Because there are only 4 different surveys, some groups may be collecting similar data. Assign project leaders to be in charge of delegating responsibilities to group members.
2. Give each group 1 survey worksheet.
3. Allow students 1 class period to survey appropriate school personnel and students. Make sure that each group has the supplies they need before leaving the classroom to collect data. Encourage students to find out as much information as possible, while acknowledging that they may be unable to find all answers.
4. Have each student group turn in their completed surveys at the end of the class period for use during Day 2.

Activity—Day 2

Introduction

1. Tell students that writing news articles will allow them to share information about the school's Ecological Footprint with other teachers, staff, and students.
2. Show them the assessment rubric for this activity so that they know all of the things that must be included in their article and group presentation (see next page).

Steps

1. Instruct students to write or type articles for the school newspaper or website. If you want students to type articles, you may want to reserve computers for this activity. Give students about 30 minutes to organize their thoughts and write their articles. The following are specific instructions to help students create thoughtful, informative articles:

    - Each article will describe the concept of the Ecological Footprint. The results of your group's survey will be included in the article to inform others about that particular component of your school's Ecological Footprint. You must also include at least 3 recommendations for minimizing the contribution of this component to the school's overall Ecological Footprint.
    - The article should be clear and interesting. It will be submitted for publication in your school newspaper or website. Your objectives are to educate others and raise awareness of the concept of the Ecological Footprint and ways to reduce your Footprint.

2. When projects have been completed, have each group present their survey results and recommendations to the class. Allow 2-3 minutes for each presentation.
3. Have students submit completed articles to either the school newspaper or website.

Lesson Extensions

- Sustainability audit results and recommendations for improving sustainability can be shared in other ways with the community. For example, results and recommendations may be presented to the school board at a school board meeting or to community leaders at a city council meeting.
- Have students vote on which recommendation is the most important yet manageable change. They can then draft a petition for other students, staff, and community members to sign. The signed petition may be presented to school administrators or the school board to implement school-wide change.

Action Project

Students and their families can evaluate energy use in their homes and devise ways to conserve energy resources. They may want to create their own audits or use questions from the school surveys. Energy information and conservation ideas can be obtained from the Energy Information Administration (**www.eia.doe.gov**) and the Alliance to Save Energy (**www.ase.org**).

Additional Resources

Film

Kilowatt Ours, Jeff Barrie, Southern Energy Conservation Initiative, 2004, 64 minutes, **www.kilowattours.org**. This film connects energy consumption to environmental and human health impacts, while providing simple ideas for reducing personal energy use.

Book

Radical Simplicity: Small Footprints on a Finite Earth, Jim Merkel, New Society Publishers, 2003.

Website

www.myfootprint.org—Students may calculate their own Ecological Footprints and compare them with people around the world.

Assessment Component	3 Exceeds Expectations	2 Meets Expectations	1 Needs Improvement	0 Little or No Effort Made
Explanation of Ecological Footprint	Concept is explained accurately, clearly, and completely. Students demonstrate full knowledge of this concept.	Basic comprehension is shown. Key components of an Ecological Footprint are included, but explanation may be incomplete or unclear.	An attempt to describe the Ecological Footprint concept is made but it is incomplete and/or unclear.	Group demonstrates no understanding of Ecological Footprint.
School Survey Results	At least 8 facts found during the audit are included. Enough information is given for readers to understand results.	At least 5 facts found during the audit are included. Results are easy to interpret.	1-5 facts found during the audit are given. Facts may not be clearly illustrated.	No survey facts have been included.
Solutions and Recommendations	Students offer 3 or more realistic and relevant recommendations for action.	Students offer 2 realistic and relevant recommendations for action.	Either only 1 recommendation is given, or recommendations are not reasonable.	No recommendations are given.
Poster	Article is understandable and interesting. Oral presentation is clear and informative.	Article is mostly understandable and interesting. Oral presentation may or may not be clear.	Article is either missing many elements or is sloppy, or oral presentation is unclear and disorganized.	Article and/or oral presentation is missing.

School Energy Survey

Group Members: _____

In this activity, your group will investigate and survey various people around the school to answer questions and make recommendations about your school's energy usage.

1. List 6 energy-using operations and appliances on the school grounds (classroom lights, generators, etc.). Be sure to include energy use inside and outside of buildings.

   _____ _____

   _____ _____

   _____ _____

2. Name the fuels/energy sources used in the school for the following purposes and categorize these sources as renewable or nonrenewable resources.

   Heating? _____ Renewable? _____

   Cooling? _____ Renewable? _____

   Hot water? _____ Renewable? _____

3. Does your school use compact fluorescent light bulbs or incandescent light bulbs? (Compact fluorescent bulbs last up to 10 times longer and use 75% less energy than incandescent bulbs.)

   _____

   _____

4. At what temperature is the thermostat set during:

   Summer? _____ Winter? _____

5. Write your own question about energy use at your school and record your answer.

   _____

   _____

   _____

   _____

6. Give at least 4 recommendations for reducing campus energy use:

   _____

   _____

   _____

   _____

Adapted from: http://www.eia.doe.gov/kids/classactivities/SchoolBuildingSurveyIntermediate.pdf

School Water Survey

Group Members: _____

In this activity, your group will investigate and survey various people around the school to answer questions and make recommendations about your school's water usage.

1. Estimate the number of faucets on your campus. (Hint: Count the faucets on 1 floor or in 1 building and multiply by the number of floors or buildings in the entire school.) _____

   How many of these are leaky? _____

2. Estimate the number of water fountains on your campus:

_____

3. Estimate the number of toilets in your school: _____

   How many of these are low-flow toilets? _____

4. How many showerheads are in the gym? _____

   How many of these are low-flow/water saving showerheads? _____

5. If the school grounds are watered, how is the watering done (overhead sprinklers, drip irrigation, etc.)? Is the water absorbed by plants and soil, or does excess water run off onto streets and sidewalks?

_____

_____

6. What types of plants grow on your school grounds? Indicate whether plants on your campus are drought-tolerant, or whether they require lots of water.

_____

_____

_____

7. Write your own question about water use at your school and record your answer.

_____

_____

_____

8. Give at least 4 recommendations for reducing campus water use:

_____

_____

_____

_____

Adapted from: http://www.eia.doe.gov/kids/classactivities/SchoolBuildingSurveyIntermediate.pdf

School Waste Survey

Group Members: _____

In this activity, your group will investigate and survey various people around the school to answer questions and make recommendations about your school's waste output.

1. Estimate the number of trash cans in your school. (Hint: Count the bins on 1 floor or in 1 building and multiply by the number of floors or buildings in the entire school.) _____

2. Estimate the number of pounds of trash that your school produces every day: _____
(Hint: Weigh 1 bag of trash and multiply by total estimated number of trash cans.)

3. How many recycling bins are on your campus? _____

4. What materials are recycled at your school?

_____

_____

5. What types of waste management (landfill, recycling, composting facilities) does your community have?

_____

6. Investigate a trash can (you'll want to wear protective gloves). What percent of items could be recycled that are being thrown away instead? (Hint: Divide the number of recyclable items by the total number of items or divide the weight of recyclable materials by the total weight of trash, then multiply by 100.)

_____

7. Write your own question about waste at your school and record your answer.

_____

_____

_____

8. Give at least 4 recommendations for reducing campus waste:

_____

_____

_____

_____

_____

Adapted from: http://www.eia.doe.gov/kids/classactivities/SchoolBuildingSurveyIntermediate.pdf

School Transportation Survey

Group Members: _____

In this activity, your group will investigate and survey various people around the school to answer questions and make recommendations about your school's transportation usage.

1. How do students usually get to school every morning? Survey one class, if possible. Turn raw data into percentages. (Hint: Divide number in each category by total number of people surveyed, then multiply by 100.)

   _____ % bike _____ % walk _____ % bus _____ % car

2. How do the teachers/staff usually get to school every morning? (Survey 3 teachers/staff.)

   Staff 1: _____ Staff 2: _____ Staff 3: _____

3. How many school buses serve your school? _____

4. Do city buses serve your school? _____

   What type of fuel do they use (petroleum-based gasoline, ethanol, biodiesel, natural gas, electricity)? _____

5. How many bike rack spaces are there at your school? _____

6. Write your own question about transportation at your school and record your answer.

_____

_____

_____

_____

7. Give at least 4 recommendations for reducing transportation-related energy use (and consequences such as air pollution and global warming) on campus:

_____

_____

_____

_____

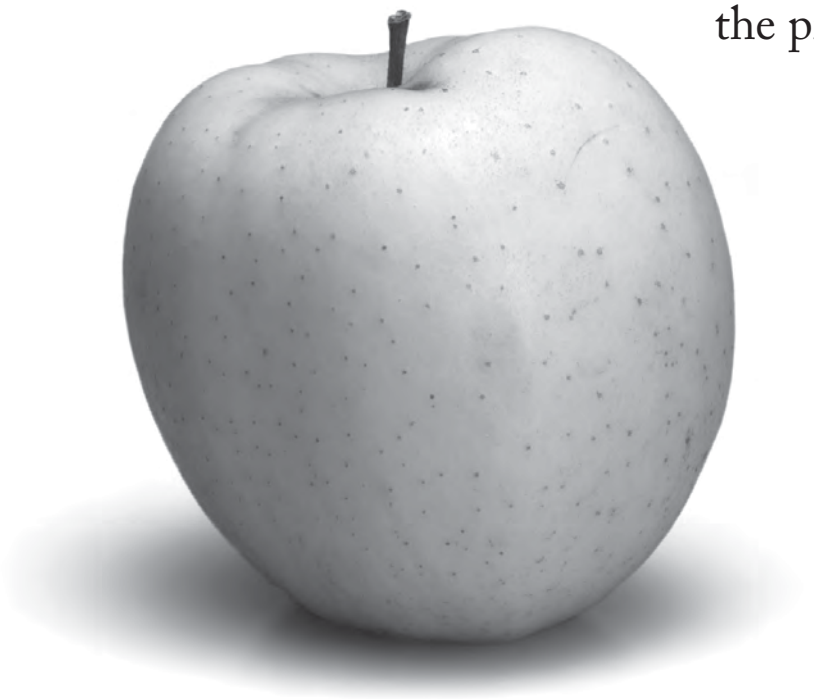
_____

_____

Adapted from: http://www.eia.doe.gov/kids/classactivities/SchoolBuildingSurveyIntermediate.pdf

Is It

Students define and discuss sustainability and its 3 key components: the economy, the environment, and society. Students brainstorm, analyze, and write about the sustainability of a variety of actions taken by individuals, businesses, and governments, using a Venn diagram to help organize the process.



Sustainable?

Key Issues/Concepts

- Sustainability
- Three components of sustainability: economy, environment, and society

Integrated Subject Areas

- Social Studies (Geography, Economics, Global Studies, Civics/Government)

Inquiry/Critical Thinking Questions

- What does "sustainability" mean and how does it apply to human activity?
- How is the sustainability of an individual, business, or government activity determined?
- How can we balance the needs of people, protect the environment, and have a vibrant and equitable economy?
- How can an activity be made more sustainable?

Objectives

Students will:

- Define sustainability and its 3 key components: the economy, the environment, and society
- Identify and describe a range of activities undertaken by individuals, businesses, and governments (e.g., foods they eat, transportation they use, products they buy, services provided, laws passed)
- Determine the sustainability of these activities based on a set of criteria that includes impacts on the economy, the environment, and society
- Present their findings using a Venn diagram
- Analyze if and how an unsustainable activity can be altered to adhere to the 3 components of sustainability

National Science Education Standards Addressed

C - Life Science
- Populations and Ecosystems

E - Science and Technology
- Abilities of Technological Design
- Understandings about Science and Technology

F - Science in Personal and Social Perspectives
- Populations, Resources, and Environments
- Science and Technology in Society

Vocabulary

- **Economy**— A system that includes the production, distribution, and consumption of goods and services.
- **Environment**—The physical surroundings, including living and nonliving factors, in which an organism lives.
- **Society**—A community, nation, or other grouping of humans who have common interests, institutions, or culture.
- **Sustainability**—Meeting our own needs without limiting the ability of future generations to meet their needs.

Materials/Preparation

- Overhead: Components of Sustainability
- 3 different colored sticky notes, 2"x2", enough for each student to have 1 sticky note of each color
- Draw a Venn diagram (like the one in the Components of Sustainability overhead) on a large sheet of butcher paper (or project the overhead onto a whiteboard)

Activity

Introduction

1. Review the definition of sustainability with students.
2. Have them brainstorm some human needs and then discuss the potential conflicts that inevitably arise between needs (e.g., having affordable clothing versus livable wages for workers, or having clean air versus using a car as transportation).

Steps

1. Define the 3 components of sustainability using the overhead, Components of Sustainability. Explain that in determining whether an action or product/good/service is sustainable, many people who study sustainability take into account 3 key elements: the environment, the economy, and society/equity. In order to determine whether or not something is sustainable, the activity being evaluated would be assessed in relation to each of these principles, or "standards of sustainability." This assessment reveals how the action or item impacts the economy, the environment, and society, in either negative, positive, or neutral ways. You may need to define "economy," "environment," and "society."
2. Using the Venn diagram (on the butcher paper or projected on the whiteboard), explain that its purpose is to demonstrate that issues overlap and share common traits.
3. Explain that they will list and analyze the sustainability of several different activities, products, and actions from the following categories: individual activities (e.g., eating breakfast, driving to school, attending school, playing guitar), business products and services (e.g., clothes, housing, computers, restaurants), or government actions (e.g., passing laws and regulations such as speed limits and burn bans, provision of services such as utilities and trash).
4. Before breaking them into groups, choose 1 activity (such as riding the bus to school) and walk through an analysis of the activity with the whole class, asking if it is sustainable using the 3 "components of sustainability" (economy, environment, and society) as a guide. Questions to ask about the activity include:

Environment

- Does the activity use a minimal amount of resources? Are the resources renewable?
- Can the activity be done without damaging plants or animals?
- Does it improve air, water, and soil quality, rather than leading to pollution or erosion?
- Does it use resources at a rate that allows the resource to be renewed or regenerated?
- Is the waste created by the activity recycled or recyclable?
- Does the activity generate a limited amount of waste?
- Does this activity contribute to the conservation of natural resources?

Society

- Does the activity contribute to people's quality of life?
- Does it positively affect culture(s)?
- Are individuals and communities involved in making decisions about the activity, and is the decision-making process fair and democratic?

- Is it an equitable activity (i.e., does it offer more options and opportunities to certain groups of people than others)?

Economy

- Does the activity have a positive economic impact?
- Does it create meaningful and satisfying work for individuals?
- Does it contribute to a community's economic development?
- Do all people receive equal economic benefits from the activity, rather than some people benefiting at the expense of others?

Sustainability

- Can the activity be done without causing damage in the 3 areas (economy, environment, and society)?
- Can this activity be done so that people in the future will have the same opportunities to do this activity as people today?

5. Arrange students in groups of 3 and assign each group 1 category: individual activities, business products and services, or government actions.
6. Have them create a brainstorm list of activities that fall within their assigned category.
7. From their brainstorm list, have students choose 2 activities from their list and transfer these to individual color-coded sticky notes (use different colored sticky notes for each category, such as blue for individual activities, yellow for business activities, and green for government activities).
8. Have students place their sticky notes on the Venn diagram in the area they think the activity best fits, depending on whether the activity is economically, environmentally, and/or socially sustainable. If an activity is both environmentally and economically sustainable, place the sticky note in the area of overlap between the environment and economy circles. If an activity is not sustainable in any of the 3 categories, place the sticky note outside the Venn diagram.
9. Have each group explain to the class how they decided on the placement, giving concrete examples and evidence to support their decision. Encourage each member of the group to participate in the discussion, and answer questions from the class.
10. Conclude with the following reflection questions.

Assessment

Reflection

1. If someone asked you what sustainability meant, how would you respond?
2. Explain whether it is easy or hard to decide whether an activity is sustainable.
3. In determining sustainability, is 1 aspect more important than the others? For example, do you think concerns about environment are more important than concerns about society or the economy?
4. Can everything we do be measured against the standards of sustainability? What are some examples of activities that would be especially difficult to measure and especially easy to measure?
5. Choose an unsustainable activity from the Venn diagram and explain how it could be made more sustainable.

Action Project

Visit **www.facingthefuture.org**, click on **Take Action**, then **Fast Facts & Quick Actions** for sustainability information and action opportunities.

Additional Resources

Film

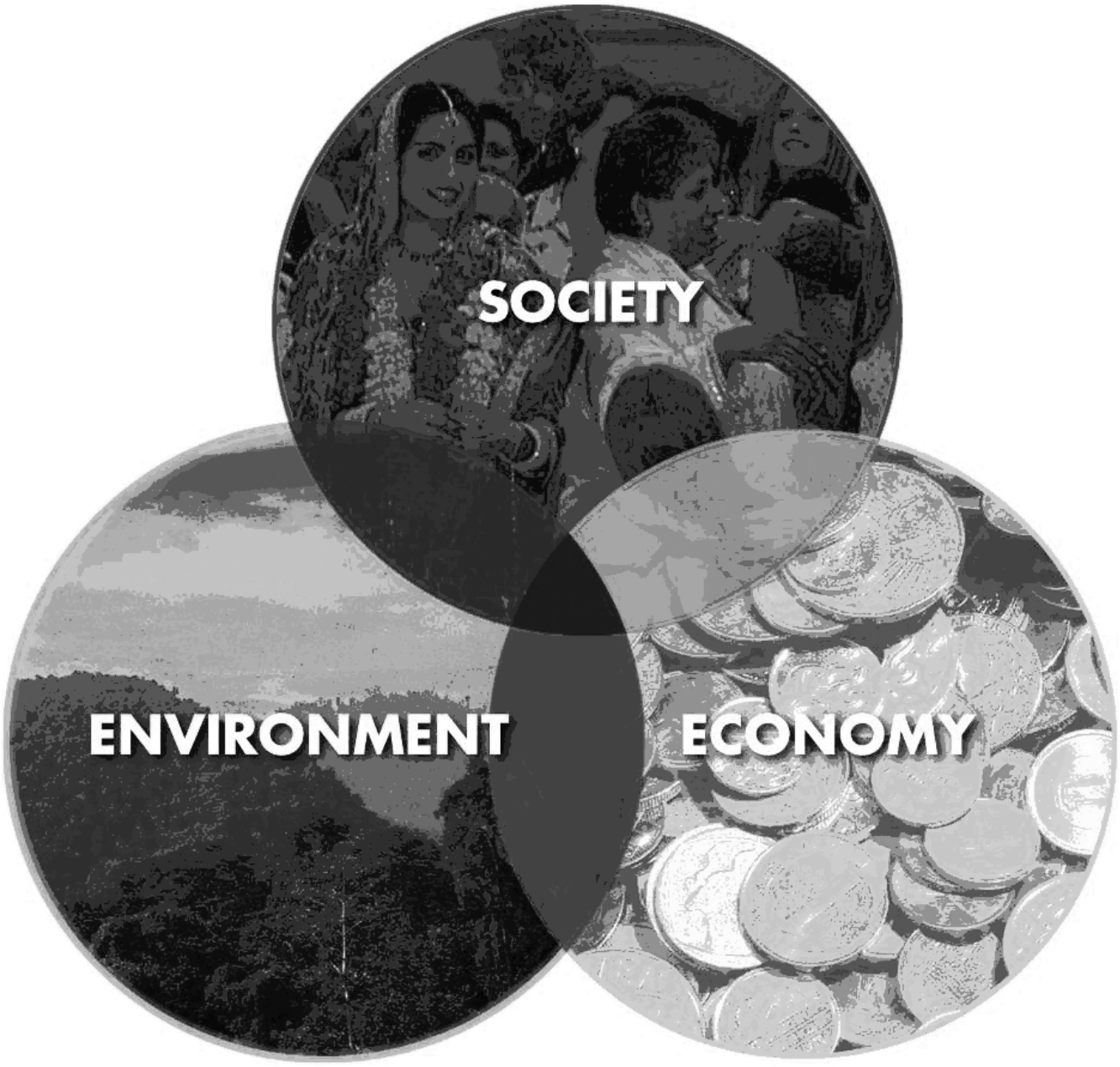
Ancient Futures: Learning from Ladakh, The International Society for Ecology & Culture, 1993, 59 minutes, **www.isec.org.uk**. This video documents the changes that Western development brought to the high mountain city of Ladakh in northern India. Ladakh, a culture of Tibetan Buddhism and sustainable agricultural practices, struggled with the coming of television, drugs, consumerism, and industry.

Websites

www.iisd.org—The International Institute for Sustainable Development (IISD) engages decision-makers in government, business, NGOs, and other sectors to advance policies that are beneficial to the global economy, environment, and social well-being.

www.naturalstep.org—The Natural Step is a nonprofit international organization working to build an ecologically and economically sustainable society through education, scientific research, and services for business and government.

Components of Sustainability



Toil

In this oil extraction simulation, students experience the increasing difficulty of extracting a limited, nonrenewable resource over several years. Students consider and discuss renewable energy sources.

For Oil

Key Issues/Concepts

- Renewable and nonrenewable resources
- Population growth
- Scarcity

Integrated Subject Areas

- Social Studies (Geography, Global Studies, U.S. History, Economics)
- Math

Inquiry/Critical Thinking Questions

- What happens when a nonrenewable resource is extracted over several generations?
- What are the impacts of exploiting a natural resource?
- What renewable energy sources can be used to meet our energy needs, and what are the benefits of those sources?

Objectives

Students will:

- Experience the increasing difficulty of extracting nonrenewable oil resources over time
- Consider the social, environmental, and economic impacts of using a nonrenewable energy resource
- Identify clean, renewable, and sustainable energy sources

National Science Education Standards Addressed

D - Earth and Space Science
- Structure of the Earth System

E - Science and Technology
- Understandings about Science and Technology

F - Science in Personal and Social Perspectives
- Populations, Resources, and Environments
- Science and Technology in Society

Vocabulary

- **Nonrenewable resource**—A resource, such as coal or petroleum oil, that cannot be replenished as it is consumed.
- **Renewable resource**—A resource, such as wind, geothermal, or solar energy, that can be replenished as it is consumed.

Materials/Preparation

- 2 pounds of dried red beans, for a class of 25 or fewer students
- 2/3 cup of dried black beans, for a class of 25 or fewer students
- 1 medium size bowl per 10-12 students; put 1 pound of red beans and 1/3 cup black beans in each bowl
- Timer, or watch with a second hand, to time activity
- Handout: Oil Extraction Data Sheet, 1 copy per student

Activity

Introduction

1. Review the vocabulary, introducing the concept of renewable and nonrenewable resources.
2. Ask students to provide an example of a renewable resource and why it is considered renewable. Ask students if petroleum oil is a renewable or nonrenewable resource, and have them explain their answers.
3. Tell the class that today they are going to "drill" for oil, a nonrenewable resource, and they will model the extraction of oil reserves over 3 years.

Steps

1. Give each student 1 copy of the handout, Oil Extraction Data Sheet, and go over it with them. Show them the bowls, explaining that the red beans represent dirt and the black beans represent oil.
2. For a class of 25 or fewer, divide the class into 2 groups. For classes over 25, divide the class into 3 groups. Each group will represent an oil company.
3. Have each oil company choose a name.
4. Place the bowls with the beans in different areas of the room.
5. For each oil company, have 4 students representing the first year gather around the bowl filled with the mixed beans. The remaining students will wait while the Year 1 students extract the oil.
6. Give students 30 seconds to extract the oil by picking out the black beans from the bowl and leaving the red beans in the bowl.
7. At the end of the 30-second period, have the students stop extracting, count their barrels of oil, and record their oil extraction on their data sheets (each black bean is equal to 1 barrel of oil).
8. Have the same 4 students, plus 3 more students representing Year 2 oil drillers, gather around the same bowls and repeat the activity for 30 more seconds, extracting and recording.
9. Have those same students, plus the remaining students in each oil company representing the 3rd year, gather around the same bowls and repeat the activity for 30 more seconds.
10. Have each oil company report their total number of barrels.
11. Have students complete the questions on the Oil Extraction Data Sheet, either individually or in their groups.
12. Conclude with the following reflection questions.

Assessment

Reflection

1. What happened to the oil production as the number of oil drillers increased with each year? What might this simulate (e.g., population increases, increased use per person)?
2. With each year, was it easier or harder to extract the oil? (More drillers are able to extract more oil, but oil also runs out faster. As oil supplies are depleted, it becomes increasingly difficult to extract the oil, with wells having to be dug deeper and deeper. This simulates the difficulty of extracting a depleted nonrenewable resource.)
3. Are there any resources that are less available now than there were for your grandparents? What are some of these resources? How does this affect you? Do you ever think about future generations (your potential children and grandchildren) when you use resources today?

4. Discuss and list ways to reduce the use of nonrenewable resources.
5. Discuss and list clean, renewable energy sources (and their benefits) that could be used in place of nonrenewable sources.
6. What happens to a resource when you have infinite population growth and a finite resource?

Technology Connection

Have students visit the Climate Analysis Indicators Tool (CAIT) developed by the World Resources Institute at **http://cait.wri.org**, where they can research and create a multitude of charts and graphs on global climate change and energy use by sector and country. For example, students can investigate how energy use and greenhouse gas emissions are correlated and how countries rank in terms of their emissions and energy use. Graphs can be viewed for several variables, such as CO2 emissions per capita.

Action Project

Organize a walk or bike-to-school day as part of an awareness campaign about the health benefits of walking and biking, as well as air quality and the environment. Link up with a national initiative online at: **www.walktoschool-usa.org**.

Additional Resources

Films

French Fries to Go, Howard Donner, 2003, 15 minutes, **www.greenplanetfilms.org**. French Fries is the story of a guy, his truck, and a bunch of used vegetable oil. This funny and inspiring piece follows Charris Ford as he makes the rounds in his veggie fuel powered rig.

Oil on Ice, Dale Djerassi/Bo Boudart Productions, 2004, 90 minutes, **www.greenplanetfilms.org**. A vivid, compelling, and comprehensive documentary connecting the fate of the Arctic National Wildlife Refuge to decisions the U.S. makes about energy policy, transportation choices, and other seemingly unrelated issues. Caught in the balance are the culture and livelihood of the Gwich'in people and the migratory wildlife in this fragile ecosystem.

Website

www.wri.org—The World Resources Institute is an environmental think tank that goes beyond research to find practical ways to protect the earth and improve people's lives. Their website includes extensive data on renewable and nonrenewable energy use worldwide.

Oil Extraction Data Sheet

Student Name: _____ **Oil Company:** _____

Keep track of your oil company's total barrel extraction. Each black bean is equal to 1 barrel of oil.

	Year 1 (total from all oil drillers in your company)	Year 2 (total from all oil drillers in your company)	Year 3 (total from all oil drillers in your company)
Barrels of oil extracted			

1. How many drillers did your company have in Year 1?_____ in Year 2?_____ in Year 3? _____
2. In which year was the largest number of barrels extracted? _____
3. In which year was the second largest number of barrels extracted? _____
4. Which year had the least number of barrels extracted? _____
5. How does this activity mirror real oil extraction? _____
6. Explain the difference between a nonrenewable energy source and a renewable energy source.
7. List 5 things you can do personally to conserve energy.
8. List 3 policies, laws, manufacturing practices, or other types of legislation that could be implemented to reduce dependency on nonrenewable energy sources.

Every Drop Counts!

8

Through a series of water-related lessons, including a water trivia game and a short demonstration, students learn how much of the earth's water is available for human and other species' needs.

Key Issues/Concepts

- Water cycle
- Scarcity
- Water distribution and use
- Conservation

Integrated Subject Areas

- Social Studies (Geography, Global Studies)
- Math

Inquiry/Critical Thinking Questions

- How much available fresh water exists worldwide?
- What are the causes and consequences of unequal water use around the world?
- How is water availability and use connected to other global issues?
- What can be done to conserve water resources and increase water availability?

Objectives

Students will:

- Recognize that water is a renewable resource that is continually cycled on Earth
- Understand that the world's fresh water supply is finite
- Consider the global implications of fresh water use and discuss solutions to water scarcity

National Science Education Standards Addressed

D - Earth and Space Science
- Structure of the Earth System

F - Science in Personal and Social Perspectives
- Populations, Resources, and Environments

Materials/Preparation

- Overhead: The Water Cycle
- Teacher Master, Water Trivia
- 1000 mL of water in a clear container
- Clear, wide mouth container, such as a 1000 mL beaker (Optional: Add a drop of blue food coloring to the cup so that when you add the water it will be more visible from the back of the class.)
- 25 mL graduated cylinder
- Dropper or other device for transferring water

Activity

Introduction

1. Review the water cycle. You may have students draw the water cycle on the board, asking each student to add 1 component to the cycle, or you may use The Water Cycle overhead to assist students in visualizing how water cycles through natural environments. Ask students if they consider water a renewable or nonrenewable resource.
2. Do a trivia game using the Water Trivia teacher master sheet. Ask students all or part of the trivia questions. If you want to set it up as a competition, divide the class into 2 teams. Each team will choose a spokesperson. Give each team 10 seconds to discuss the question and give their answer. If the team that is asked the question gets it wrong, the other team may answer.
3. Have students brainstorm all the things they do or use that require water. Create a list on the board or overhead under the headings: Domestic, Agricultural, and Industrial.
4. Ask students if they know how much fresh water there is on the planet.
5. Tell them you are going to demonstrate how much fresh and available water there is on the planet.

Steps

1. Show the class 1000 mL of water.
2. Take out 2.5% (25 mL) and place it in a clear container to represent the amount of fresh water on Earth.
3. From this amount, remove 70% (17.5 mL) to represent the amount of water trapped in glaciers or too deep in the ground to realistically be recovered. The remainder (7.5 mL)—less than 1% of the earth's total water supply—is left to support human needs for agriculture, drinking, and washing, as well as lakes, rivers, and fresh water ecosystems.
4. Conclude with the following reflection questions.

Assessment

Reflection

1. Given that there is a fixed amount of fresh water on the planet, what will happen to the distribution of water resources as global population grows?
2. What happens when people do not have enough water to meet their basic needs?
3. What happens when a fresh water resource is polluted? Why is it important to protect fresh water resources from pollution?
4. What are some other purposes/uses of fresh water aside from human consumption?
5. How can we reduce our personal water use?

Lesson Extension

Have the class determine and diagram the source of their community's fresh water. Graph the available limits of the community's water resources over the period of an average year. Predict events or circumstances that could negatively affect the availability of the community's drinking water. What would the impact be if the community water source ran dry? Brainstorm ways in which the community could reduce its fresh water consumption.

Writing Connection

Have students write a story as if they were a drop of water moving through the water cycle or their local watershed. They should describe what they see, hear, smell, taste, etc.

Action Project

Perform a water use audit using the handout, Personal Water Use Audit. Students can use the worksheet to measure how much water they and their family use.

Additional Resources

Film

Environmental Ethics: Examining Your Connection to the Environment and Your Community, The Video Project, 2005, 62 minutes, **www.videoproject.com**. This documentary profiles a diverse group of courageous Goldman Environmental Prize winners who have made it their duty to protect their local environments. An accompanying study guide may be purchased at **www.envethics.org**.

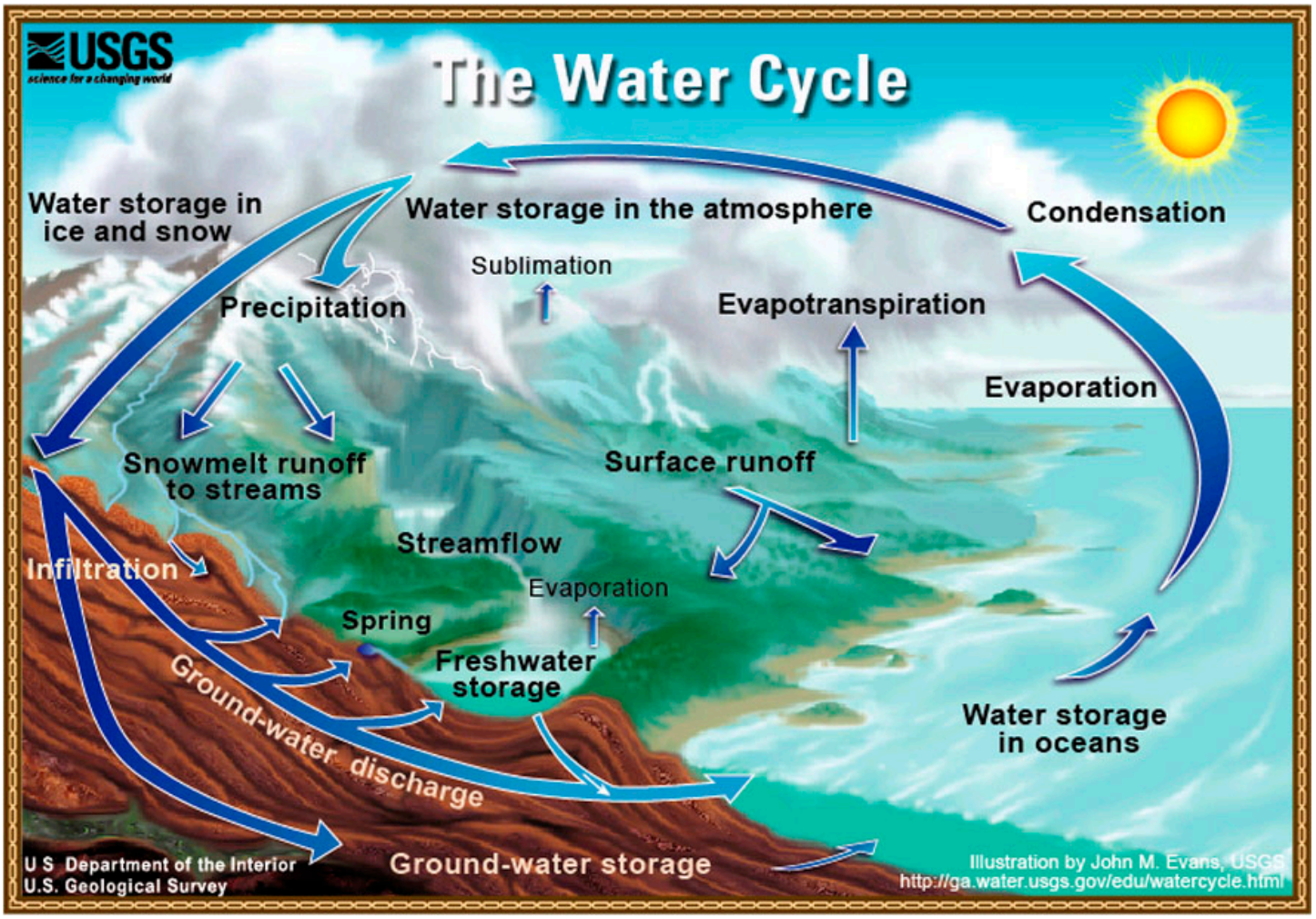
Book

Water: The Fate of Our Most Precious Resource, Marq de Villiers, Mariner Books, 2001. An eye-opening account of how global population growth, unchecked development, and cross-border struggles are stressing and depleting the world's fresh water supply.

Websites

www.water.org—WaterPartners International is committed to providing clean drinking water to communities in developing countries. Working in partnership with donors and those in need of safe water, they have helped thousands of people develop accessible, sustainable, community-level water supplies.

www.unep.org—The United Nations Environment Programme (UNEP) provides leadership and encourages partnership in caring for the environment by inspiring, informing, and enabling nations and peoples to improve their quality of life without compromising that of future generations. Their website includes extensive information on global water resources, use, and conservation.


USGS
science for a changing world
The Water Cycle
Water storage in ice and snow
Water storage in the atmosphere
Condensation
Sublimation
Precipitation
Evapotranspiration
Evaporation
Snowmelt runoff to streams
Surface runoff
Streamflow
Infiltration
Evaporation
Spring
Freshwater storage
Ground-water discharge
Water storage in oceans
U S Department of the Interior
U.S. Geological Survey
Ground-water storage
Illustration by John M. Evans, USGS
http://ga.water.usgs.gov/edu/watercycle.html

Water Trivia

1. What percent of the earth's water is available for people to use?
   a. less than 1% b. 5% c. 10% d. 20%
2. What percentage of people in the world lack access to safe drinking water?[1]
   a. 15% b. 25% c. 35% d. 45%
1. What is the total amount of water (in gallons) consumed per day by the average person in the U.S.?[2]
   a. 55 b. 150 c. 750 d. 1300
4. About how many gallons per day are needed to sustain life (including the minimum water needed to produce the food we consume)?[3]
   a. 5 b. 13 c. 21 d. 33
5. What percentage of the adult human body is comprised of water?[4]
   a. 10% b. 20% c. 50-65% d. 75-80%
6. What activity accounts for the highest water use worldwide—agriculture, industry, or domestic?[1]
7. What is a proven technology or practice that can decrease agricultural water use?
8. What are other uses and benefits of fresh water aside from human consumption?
9. What percent of his/her income does the average U.S. citizen spend on drinking water?[2]
   a. 0.5% b. 2% c. 10% d. 25%
10. What percent of his/her income does the average Honduran living in the slums of that country's capital city spend on drinking water?[2]
    a. 0.5% b. 2% c. 10% d. 25%
11. Approximately how many people in developing countries die each year from water-related disease?[2]
    a. 100 b. 1000 c. 10,000 d. 10,000,000
12. How many gallons of water does it take to produce 1 pound of corn?[5]
    a. 68 b. 168 c. 568 d. 1268
13. How many gallons of water does it take to produce 1 pound of beef?[4]
    a. 40 b. 400 c. 4000 d. 40,000
14. What are 2 things you can do personally to reduce your water use?
15. What is 1 benefit of a dam?[6]
16. What is 1 negative impact of a dam?[6]
17. Name 3 sources of fresh water.[6]

Water Trivia Answers

1. a
2. b (over 1.5 billion people)
3. d
4. b
5. c
6. agriculture accounts for about 65-70% of water use; industry for about 20-25%; and domestic for about 13%
7. drip irrigation, planting low water use crops
8. stream flow, provides animal and plant nutrients and habitat, wetland filtration, recreation
9. a
10. d
11. d (over 25,000 people every day)
12. b
13. c
14. turn off the water when brushing teeth, plant drought-tolerant landscaping, reduce meat consumption
15. produce hydroelectricity, prevent flooding, control water storage, make navigation easier
16. impede the flow of soil nutrients, impede fish migration, flood rivers upstream
17. melting snow, aquifers, ground water, rainwater, icebergs, desalinization of salt water

[1]United Nations Environment Programme www.unep.org
[2]WaterPartners International www.water.org
[3]World Meteorological Organization www.wmo.ch
[4]MadSci Network www.madsci.org
[5]Environmental Protection Agency http://www.epa.gov/OGWDW/kids/games.html
[6]American Forum for Global Education www.globaled.org

Personal Water Use Audit

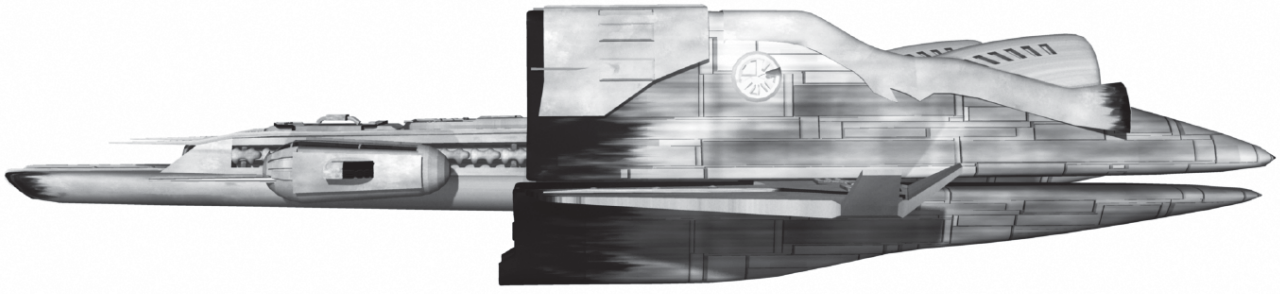
Keep track of how many times you do each activity in 1 day. Keep a running tally throughout the day and then calculate your total times and gallons used at the end of the day.

Activity	Tally times doing activity	Total number	Estimated Water Use (multiply total number by the amount listed to get total gallons)
Washed hands			x 0.1 gallons = gallons
Showered (regular showerhead)			x 30 gallons = gallons
Showered (low-flow showerhead)			x 15 gallons = gallons
Tub bath			x 20 gallons = gallons
Brushed teeth			x 0.2 gallons = gallons
Drank a glass of water			x 0.008 gallons = gallons
Boiled a pot of water for cooking			x 0.25 gallons = gallons
Flushed the toilet (conventional toilet)			x 5 gallons = gallons
Flushed the toilet (ultra-low flush toilet)			x 1.6 gallons = gallons
Washed a load of dishes in dishwasher			x 15 gallons = gallons
Washed a load of dishes in sink (not running the tap)			x 10 gallons = gallons
Washed a load of laundry in conventional machine			x 40 gallons = gallons
Washed a load of laundry in high efficiency washer			x 25 gallons = gallons
Washed a car			x 15 gallons = gallons
Other activity:			
Other activity:			
Other activity:			
Total Daily Gallons			

Adapted from WaterPartners International "Tap Tally Sheet" (http://water.org/assets/PDF/ODsplishsplash.pdf)

Deep

This collaborative activity will help students envision and create a sustainable environment through the design of a "closed system" spaceship that will be in outer space for 3,000 years, and then bring healthy and happy future generations back to Earth.



Space 3000

Key Issues/Concepts

- Closed system
- Sustainable solutions

Integrated Subject Areas

- Social Studies (Geography, Global Studies)

Inquiry/Critical Thinking Questions

- What is a "closed system," and what are the ramifications of living in a closed versus open system?
- How can we create a sustainable environment capable of supporting everyone's physical, social, cultural, and political needs over an extended period of time?

Objectives

Students will:

- Identify the components necessary for human survival, how they are connected, and how to meet those needs in a closed environment
- Draw and list components of a sustainable "closed system" spaceship that meets human needs
- Discuss the connection and application of their spaceship design to planet Earth
- Design and write about sustainable solutions

National Science Education Standards Addressed

C - Life Science
- Structure and Function in Living Systems
- Populations and Ecosystems

E - Science and Technology
- Abilities of Technological Design

F - Science in Personal and Social Perspectives
- Science and Technology in Society

Materials/Preparation

- Butcher paper, 1 sheet per group
- Colored marking pens, 5–6 pens per group
- Handout: Deep Space 3000, 1 per student

Activity

Steps

1. Read the following scenario to the students: Your group is on a mission with the United Nations. The earth's ecosystems have been severely damaged and are unable to support life. Your task is to outfit a spaceship that will be away for 3,000 years while Earth recovers. The spaceship will bring future generations back to Earth alive, healthy, and happy. Assume that on its initial departure from Earth, the spaceship will have a crew of about 1,000 people. The ship will have an orbit around the sun similar to that of Earth's orbit. It will have big windows, and can be as large as you want it to be, within reason. You may bring items with you when your ship leaves Earth, but you may not get any more items once you leave. Once you depart, the ship is a "closed system," which means that you cannot use anything from outside the ship – except for solar energy – nor can you remove anything from the ship except heat. You are allowed to use only today's technology to address human needs sustainably, but should assume that the technical construction of the ship is already figured out.
2. Explain these directions to the class:
    - You will need to address the following in your spaceship design: oxygen, food, fresh water, energy, waste disposal, governance, community rules, entertainment, and quality of life. (Note: you may want to list these on the board or overhead.)
    - Think about the kinds of products, services, and expertise you want to bring.
    - There are no wrong answers, but you will have to explain why you chose what you did, and how it meets the needs of the community. Remember, it is a 3,000 year voyage and you are responsible for your own well-being, and for that of hundreds of generations after you.
3. Arrange students in groups of 4 or 5 and give each group 1 handout of Deep Space 3000, 1 sheet of butcher paper, and 1 set of pens.
4. Using the handout, have each group begin by brainstorming and listing the material and nonmaterial needs of the crew, and what is necessary to meet those needs. Prompts: How do you ensure that you can grow food for 3,000 years? What are the difficulties in producing different products, such as vegetables, exotic fruits, meat, etc.? How will you provide fresh air and drinking water? What form of energy will produce the least waste and is both nontoxic and renewable? How are you handling waste? Is it possible to find ways to use waste for other purposes? How will you ensure the crew's physical and mental health? What kinds of social interaction will you have? How will you entertain yourselves? What type of governance and community rules are necessary to maintain order and solve problems together?
5. After groups have completed their brainstorm and decided on the essential pieces, have them draw a picture of the spaceship, label the contents, show how the various parts relate to each other, and list any rules, community agreements, governance systems, and other nonmaterial aspects they decide on.

6. When the design process is complete, have each group report to the class on their spaceship. Ask them to explain what they identified as essential needs, how they designed the ship to meet those needs, and what issues they might encounter in the future (e.g., population growth, education, old age).
7. Conclude with the following reflection questions.

Assessment

Reflection

1. What did other groups provide for that your group neglected?
2. What need was most difficult to meet?
3. What characteristics of Earth let us know that it is also a closed system, like the spaceship (e.g., finite amounts of land, water, and other resources, and a limited ability to absorb wastes)?
4. How is Earth different from your spaceship (e.g., Earth has more species diversity, it is larger)?
5. How can you apply the concept of sustainability to this activity?
6. How well did the group process work? How did you make decisions (majority-rule, consensus, etc.)? Were you able to come up with creative solutions? Did everyone participate? What can we learn about decision-making processes from this activity?

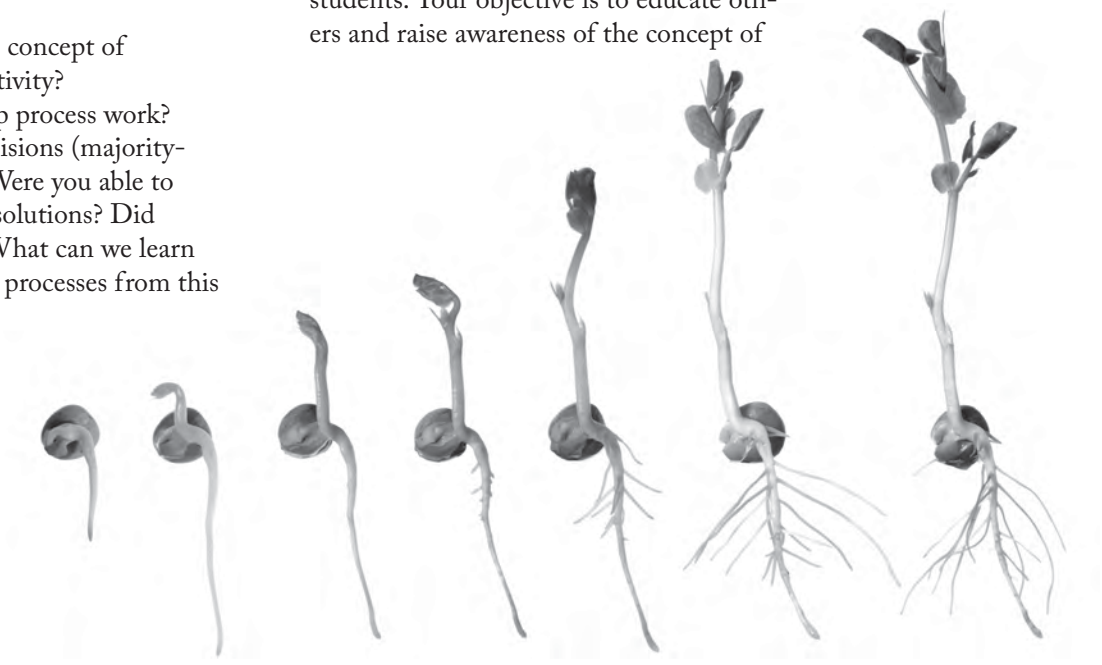
Lesson Extension

Have students create and perform public service announcements (PSAs) according to the following directions.

1. Explain to the class that each group from the Deep Space 3000 activity will focus on 1 component of a sustainable system from their spaceship design and communicate their ideas with the class in the form of a PSA.

   - A PSA, also known as a community service announcement (CSA), is a non-commercial advertisement to promote public well-being. This is typically a community interest item prepared for television or radio broadcast.
   - For examples of global issues PSAs, go to **www.worldbank.org**, click on **Resources for Journalists**, then **Broadcast and Multimedia**, and finally **Public Service Announcements**.

2. Give the following instructions to the students: Your objective is to educate others and raise awareness of the concept of



systems sustainability. Your PSA presentation should be focused on sustainability and 1 particular component of a sustainable system. Each PSA will explain or describe the concept of sustainability and why it is important. Also, each group will examine and describe 1 sustainable component of a larger system. For example, 1 group may come up with ideas for sustainable food production; another group may focus on sustaining good air quality. Your description must include at least 3 specific attributes of the sustainable system. Your PSA should be no longer than 3 minutes and may include a visual aid, such as a poster or model.

3. Give the class 30-40 minutes to create their visual aids and practice acting out their PSAs.
4. Have each group give a live PSA performance to the class. These could even be recorded and shown to other classes, the entire school, or a community group.

Action Project

Do "Project Greenstar," a Service Learning project in which students conduct market research for communities in developing countries that are using solar technology to produce crafts. Students' research will help poor communities support themselves through the use of sustainable energy sources. Visit **www.facingthefuture.org** and click on **Take Action**, and then **Service Learning Projects** for everything you need to get started on this project.

Additional Resources

Film

Cities (from the "Reinventing the World" video series), directed by David Springbett and Heather MacAndrew, Bullfrog Films, 2000, 50 minutes, **www.bullfrogfilms.com**. Focusing on large and diverse cities around the world, this documentary explores the question of how we can live sustainably, given human growth and resource scarcity.

Website

www.bfi.org—The concept of Spaceship Earth was first developed by the architect, engineer, mathematician, and poet, Buckminster Fuller. The Buckminster Fuller Institute serves a global network of design science innovators "to make the world work for 100% of humanity in the shortest possible time through spontaneous cooperation without ecological offense or the disadvantage of anyone."

Magazine

Yes!, a magazine published by Positive Futures Network, highlights work being done to resolve issues of global concern. Yes! promotes the creation of a just, prosperous, secure, and meaningful future. **www.yesmagazine.org**

Deep Space 3000

Name: _____

Human Needs	How You Will Address These Needs in Your Spaceship Design
Food	
Water	
Air/Oxygen	
Energy	
Waste Disposal	
Governance	
Community Rules	
Entertainment	
Quality of Life	
Other Needs	

Ecological Footprint

Student Reading 1

There are certainly many people on the planet right now (over 6.5 billion, in fact!)—twice as many as there were just forty years ago and 78 million more than just one year ago. Even in the time it takes to read this paragraph, about eighty more people will have been added to the planet. [1]

That seems like a large amount of growth. But are there too many people? Have we grown beyond Earth's ability to support us all? Scientists use a term called **carrying capacity** to figure this out. Carrying capacity refers to the maximum number of people the planet can support now, without using up resources that future generations will need to support themselves. In other words, the number of people that is sustainable—not using resources faster than the earth can reproduce them.

Have We Gone Beyond Our Carrying Capacity?

This is a question on which experts disagree because carrying capacity depends on what kind of resources are available and how many there are. It also depends on how they are distributed and how much of them each person uses. Because experts have different assumptions about what these amounts are, there are many different estimates of Earth's carrying capacity—they range from as low as 1 billion people to as high as 44 billion people!

What we do know is that Earth's carrying capacity can be limited by factors such as deforestation, soil erosion, and pollution. Higher levels of resource consumption per person can also reduce Earth's carrying capacity.

Carrying capacity may be increased through technology. Fertilizers, hybrid seeds, and irrigation have increased food production. Modern transportation systems allow food to be moved across oceans, and low-cost energy has boosted industrial production tremendously.

What's Your Shoe Size?

Because it's so difficult to determine Earth's carrying capacity, some scientists have developed another way to study the impacts of human population and consumption. They use a concept called "Ecological Footprint."

Each person has an **Ecological Footprint**, the area of Earth's productive surface that it takes to support that person. This includes farmland, pasture, and fishing grounds to provide food, as well as forested area to provide lumber and paper. It takes into account lakes, rivers, and **aquifers** to provide freshwater. It includes all the area necessary to provide energy and jobs and dispose of wastes (including carbon dioxide). It also includes all the area needed to support the **infrastructure** of our lives, such as homes, highways, hospitals, schools, shopping malls, and baseball fields.

Ecological Footprints vary tremendously with each person's lifestyle and resource consump-

[1] About 253 new people are born worldwide every minute. U.S. Census Bureau, www.census.gov/cgi-bin/ipc/pcwe.

tion choices. Experts calculate that the average person in India has a Footprint of about 2 acres. By comparison, the average Footprint is 6.4 acres in Mexico, 13.8 acres in France, and 23.7 acres in the United States.[2] This is an average, and some people in each of these countries have Footprints that are bigger or smaller. A country's Ecological Footprint is the sum of its people's Footprints, which depends on the number of people and their level of resource consumption.

An acre is about the size of a football field. So now you can imagine the size of these people's average Footprints and see the differences between them. If everyone on Earth had a Footprint the size of the average U.S. citizen (24 football fields apiece), it would take five more planets to support us all![3]

As population grows, the total human Footprint on Earth grows too. If the average level of resource consumption per person increases, the human Footprint on Earth also increases. If both population and resource consumption per person increase—as is the case today—the total human Footprint on Earth grows even faster.

Today, the average human Footprint is estimated to be 5.4 acres. However, available ecological space on Earth is estimated to be 4.4 acres per person.[4] If these estimates are correct, that means that there is an **ecological deficit** because we are using resources more quickly than they can be renewed. That means we are living unsustainably and borrowing resources from future generations.

Reducing Humanity's Footprint

If the global human Footprint is already larger than the earth can support in the long run, what can we do about it?

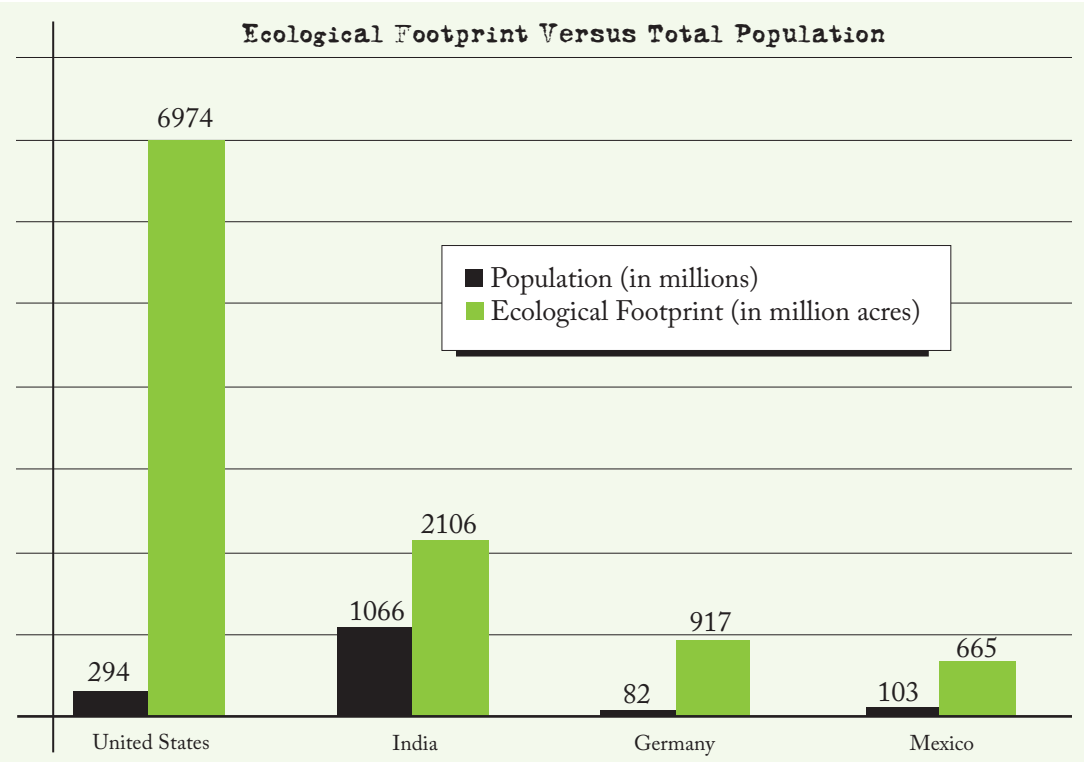
One issue to look at is population. If more people means a bigger global Footprint, then stabilizing our population is one way to limit our Footprint on the planet. If we reduced world population over time, we would have even more resources available for each person.

Another way to shrink our global Footprint is through technology. Much of the human Footprint today is taken up by the wastes we create, especially the land and water area needed to

[2]Based on 2003 data on Footprint size; by hectares: India 0.8, Mexico 2.6, France 5.6, U.S. 9.6. From Global Footprint Network, "Ecological Footprint and Biocapacity (2006 Edition)," http://www.footprintnetwork.org/gfn_sub.php?content=global_footprint.

[3]Based on total available biocapacity of 11.2 billion hectares and total needed biocapacity for 6.5 billion people to each have a 9.6 hectare Footprint (U.S. Footprint). From World Wildlife Fund (WWF), "Living Planet Report 2006." WWF International, Switzerland, 2006. http://assets.panda.org/downloads/living_planet_report.pdf

[5]Of the total average human Ecological Footprint of 2.2 hectares, 1.2 hectares are used for total energy use and of that, 1.06 is for carbon dioxide from fossil fuels. From WWF.



Ecological Footprints

It's not only the number of Footprints—size counts too. Let's compare the Footprints of young people around the world: Bati in Kenya, Jyoti in India, and Warren in the US. [6]

Bati
Average Kenyan Footprint: 2 acres

In Kenya, Bati gets up each day before dawn. He wears thin, patched shorts passed down from his two older brothers. Bati helps his mother start the wood fire to heat breakfast for him and his four siblings. His sisters fetch water from a stagnant river two miles away. Bati's whole family has a simple diet: twice a day they eat green peas and corn boiled with a little bit of salt. Bati has tasted meat only a few times in his life.

Bati's house is made of mud bricks and a roof of wide leaves. The chickens sleep under the bed that he shares with his two brothers. His mother and two sisters sleep in the other room. Because his father works as a laborer in a town twelve hours away, Bati sees him only twice a year.

After breakfast, Bati goes out into his family's farm to pick peas and corn for the evening meal, and he takes the family's five chickens out to forage for food. Later, he and his two best friends walk seven miles to gather wood for tonight's fire. They have to go farther every day because so many people are cutting trees for wood.

Bati goes to school a few months of every year but is always behind because he misses classes so much. He would like to go to school to become a teacher or work in a store like his uncle does. However, his family can afford to send only the oldest son to high school. Bati knows he will probably be a farmer and raise his own family in this same area.

Bati had malaria last year, and everyone thought he would die. He was carried to the health clinic six hours away. He got medication and eventually got better, but now his mother can't buy the goat she was saving for because she spent the money on medicine.

Warren
Average U.S. Citizen Footprint: 24 acres

On the other side of the world, in the United States, Warren wakes up to his new CD he burned on the computer the night before. He puts on jeans that were made in Pennsylvania, a belt from Nebraska, a shirt made in Taiwan, socks from Massachusetts, and shoes that were produced and boxed in four different countries. His breakfast consists of eggs, bacon, toast, and orange juice. His mom will drive him to school in a car made in Japan and powered by gasoline from Saudi Arabia.

Warren's house has indoor plumbing and electricity. He has a computer that he uses every night for homework and sending messages to his friends. His parents are divorced and his dad works a lot, so Warren sees him about once a week.

Warren spends the majority of his day at school. He gets pretty good grades, and his parents expect him to go to college. His dad wants him to be a doctor, but Warren would rather be a professional athlete or a photographer for a nature magazine. After school, Warren and his friends often ride their bikes to a video arcade, or they go to the skate park to practice skateboarding. Warren visits the doctor and dentist every year. He is pretty healthy, but the dentist said he should eat less candy.

6 These stories are based on interviews with Devin Hibbard in India and Kenya in 2000, and with Ian Byington in the United States in 2000. The children's names have been changed.

Jyoti Average Indian Footprint: 2 acres

In India, Jyoti lives in a mud house with her mother, father, two brothers, and sister. She gets up early and milks the cow. Breakfast is leftover rice and potato curry cooked over a clay stove, using firewood as fuel. Each sister gets a few sips of milk, and Jyoti's brothers get a whole cup of milk each. Jyoti also has water to drink, which her mother draws every morning from the village well.

After breakfast, Jyoti takes the cow out to the pasture while her brothers change into their school uniforms and head to class. She wishes she could go to school too, but only a few of the girls in the village go. The reason Jyoti doesn't attend school isn't because her parents love her less; it's a question of money. In India, sons support the parents as they age, whereas daughters move out when they marry and help support their husband's family. For poor families in this situation, spending their few resources to educate sons makes more sense than educating their daughters.

Jyoti has a busy day. She and her sisters work in the family's fields and then collect cow dung to be dried for fuel. In the afternoon when the sun is hot, Jyoti washes the family's clothes in a small bucket. Before dinner, she fetches the cow, gathers vegetables, and helps her mother prepare dinner. Her sisters fetch firewood in the forest thirty minutes away.

There is no electricity or running water in this village, so life is sometimes hard for Jyoti. She and all the other villagers use the fields around the village as their bathroom. When someone gets sick, they are taken by bicycle to the doctor. Only the richest family in the village can afford to hire a car to get to the doctor.

absorb our carbon dioxide emissions.[5] Since much of that carbon dioxide comes from burning oil and coal for energy, producing energy in new, nonpolluting ways can reduce our Footprint significantly. The good news is that there are some technologies—such as more effective farming techniques, wind-generated power, and cellular phones—that can help people consume more while not dramatically increasing their Footprint.

We can also shrink our Footprint by reducing resource consumption. Some of this can be done by understanding what we truly need and consuming less. This means looking closely at how we live, including how much and what kind of food we eat, how we get around, what we do for recreation, and what we choose to buy. We can examine how much and what kind of energy we use. For example, switching to new technologies such as hybrid or fuel cell cars and using solar-generated electricity can shrink our Footprint. Finally, we need to examine whether the policies in our country and culture encourage sustainable or unsustainable consumption levels.

One challenge is that some people in the world desperately need to increase their consumption of resources. There are 1.2 billion people who live in **extreme poverty** around the world; they need more food, more education, more health care, and more fuel and energy resources. Only after their basic needs have been met and when they have economic options can these people make choices about sustainable consumption.

Ultimately, the number of people the earth can support depends on the choices we make. Every day each of us makes decisions about our lifestyle, our economic system, our values, and what kind of world we

Vocabulary

aquifer—a naturally occurring underground geologic formation that stores a significant amount of freshwater

carrying capacity—the maximum population that an environment can support

ecological deficit—what occurs when we use resources more quickly than they can be renewed

Ecological Footprint—the area of the earth's productive surface that it takes to support everything a person uses

extreme poverty—the conditions under which people live on the equivalent of $1 U.S. a day or less

infrastructure—the basic facilities and services for the functioning of a community or society, such as transportation and communications systems, water and power systems, and public institutions

Checking for Understanding

1. Define carrying capacity in your own words.
2. Explain how energy, carbon dioxide, and Ecological Footprint size are related.
3. Apply the concept of Ecological Footprint by comparing Warren's lifestyle to either Bati's or Jyoti's. Describe their use of resources in your comparison.



Sustainability

Student Reading 2

Never has our world been so interconnected. People can travel halfway around the world in a matter of hours. Businesses based in one country can make and sell products in other countries. Students from different countries can collaborate on projects in "virtual classrooms." Many of these connections and issues are positive, such as today's high-speed technology that makes instant communication possible throughout the world.

On the other hand, experts think some globally connected issues are so serious they could threaten the health, happiness, and productivity of people and societies around the world. Some of these **global issues** include rapid population growth, environmental damage, high resource **consumption**, national and international conflict, and the growing number of people living in poverty.

Why might these global issues present a real challenge? One reason is that the earth can produce resources at only a certain rate. Increases in human population and use of resources strain our ability to meet the growing demand for Earth's resources.

The impact of humankind on the earth depends partly on the kinds of resources we use. For example, it takes most trees twenty to one hundred years to grow to maturity. Trees are considered a **renewable resource** because with forest management, new trees can grow and provide wood products. However, trees grown for human use in tree farms don't always provide all of the benefits that a natural forest offers, such as **species diversity** and **habitat** for animals.

Unlike trees, coal is considered a **nonrenewable resource** because it takes thousands of years to form. Once it is used, it can't be created again within a single human lifetime. In addition, when coal is burned, it creates air pollution and releases **carbon dioxide**, which can damage the environment.

A helpful way to think about renewable and nonrenewable resources is through the concept of **sustainability**.

What Is Sustainability?

Sustainability means that we meet our own needs without limiting the ability of future generations to meet their needs.[1] How do we know if something is sustainable? There are three main areas of sustainability: environment, society, and economy. To be sustainable, each of these areas should be healthy. Improvements to any one of these should not make any of the others worse.

For example, imagine that you are a fisherman living in a small village. Your family has lived in this village and fished for generations. Everyone in your family, as far back as your great-grandmother, has caught 1,000 fish each year to sell at the local market. The family fishing boat has been passed down to you so that you can begin fishing like your family before you. But now there is a new net you can buy that will allow you to catch 1,200 fish each year.

[1] From the 1987 United Nations Brundtland Report's definition of sustainable development. G. Brundtland, Our Common Future, World Commission on Environment and Development (London: Oxford University Press, 1987).

The net drags behind your boat and scoops up the fish. Using the net will allow you to catch more fish for the next ten years. However, over time, as you and other people in the village take more fish each year, there will be fewer adult fish to reproduce and the total number of fish will decrease.

Even though you can catch more fish in the short term, using the net may be unsustainable for future generations. The number of fish available for your children to catch won't be the same number you can catch now. If there aren't enough fish to sell, the economy of the village will be hurt and your children may not be able to support themselves by fishing.

A sustainable solution to this challenge should protect and enhance the environment, the economy, and society. You want to ensure that the environment is healthy and that enough fish can mature and reproduce. You also need to be sure that the economy is strong so that you and the other fishermen can make a living. Finally, you want to make sure that the society remains vibrant by including everyone in decisions about fishing, and protecting the diversity of culture, language, religion, art, and tradition of your village.

Everything Is Connected

Have you ever seen a mobile? The objects are separate and move in different directions, but they are interconnected and in balance with each other. Touch one piece, and all the others move. Cut one string, and the whole thing gets thrown off balance.

The natural environment is interconnected in the same way as that mobile. Every type of organism, from bacteria to whales to people, is part of a food web that depends on healthy habitats to survive.

The human-made environment is interconnected, too. The shoes you're wearing right now may have been made in Southeast Asia, your pants in Central America, your watch in Japan. Chances are, the sandwich you eat is made with wheat from Canada, tuna fish from Chile, lettuce from Texas, and tomatoes from Mexico.

Just as sustainability connects the environment, the economy, and society, global issues are also interconnected. Population growth, poverty, consumption, conflicts, and the environment all affect each other in many ways. Challenges or solutions in one area can have a dramatic impact on the others.

Because the world is more and more connected, sustainability means considering the needs of the entire planet—and all 6.6 billion people on it. People around the world have different levels of income, consume different amounts of resources, have different cultural traditions, and live in different geographic regions, so figuring out global sustainability is complicated.

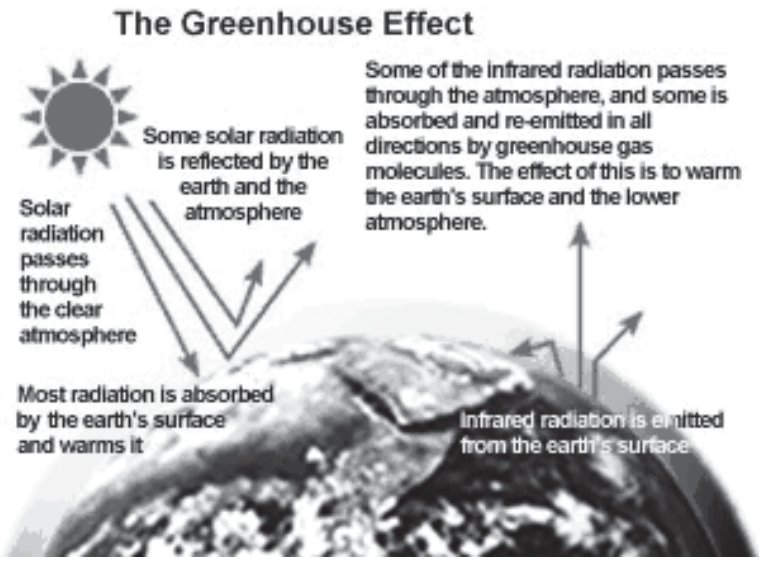
Sustainable Solutions

The good news is that many sustainable practices are already being used today. We can make choices each day to increase sustainability in many areas. Some of those choices are small, such as riding a bike or walking to school rather than driving, recycling so we can keep reusable material out of the landfill, or turning off lights and turning down the heat at night to conserve fuel.

Some choices are larger, such as ones that we all make as we get older. What size family will you have? Will you support government policies that encourage sustainability? Will you buy products that are more sustainable?

Government policies are important in achieving sustainability. Fortunately, many countries are coming together to discuss and implement

> Greenhouse gases trap radiation from the sun near Earth's surface. This increases temperatures on Earth.



Source: United States Environmental Protection Agency

practices that will lead to greater sustainability.[2] For example, many nations and cities have signed the **Kyoto Protocol** to address climate change caused by **greenhouse gas** emissions, including carbon dioxide.

Greenhouse gases, like carbon dioxide, trap radiation from the sun near Earth's surface. This increases temperatures on Earth. This process is called the "Greenhouse Effect."

Also, many renewable energy **technologies**—wind, biodiesel, solar, hydro, geothermal—are being used by more and more governments and people. Using these will help us live sustainably today without depleting the resources people may need in the future. However, just as for good health and physical fitness, we need to work at sustainability throughout our lifetime.

We can't solve the sustainability challenges for all future generations or all global cultures. We can't predict the challenges that people of the future will face or the things their cultures will value. The people of the future are the only ones who can decide what the right choices are for them. But we can try our best to ensure that future generations have a good set of choices and have what they need to survive and prosper.

[2] At the United Nations Conference on Environment and Development (the Earth Summit) in Rio de Janeiro in 1992, 178 countries participated. Agenda 21 was adopted, with strategies to bring about sustainable development in the twenty-first century.

Vocabulary

carbon dioxide (CO_2)—a greenhouse gas that is a by-product of burning fossil fuels

consumption—the process of using natural resources, materials, or finished products to satisfy human wants or needs

global issues—significant issues that are interconnected, occur across political and social boundaries, and affect large numbers of people and environments

greenhouse gases—specific gases and chemicals that accumulate in the atmosphere and lead to global warming

habitat—the place or environment where an organism normally lives

Kyoto Protocol—an international agreement reached in 1997 in Kyoto, Japan, that sets targets for future carbon dioxide emissions by developed countries

nonrenewable resource—a resource, such as coal or oil, that cannot be replaced as it is used

renewable resource—a resource, such as wind, trees, or fish, that can be replaced as it is used

species diversity—the variety of life forms found on Earth

sustainability—meeting our own needs without limiting the ability of future generations to meet their needs

technology—the use of scientific knowledge to solve problems

Checking for Understanding

1. Why are trees considered a renewable resource?
2. Looking at the mobile shown in the reading, describe a scenario that shows how global issues are interconnected.
3. Name 3 sustainable practices mentioned in the reading.

Energy and Sustainability

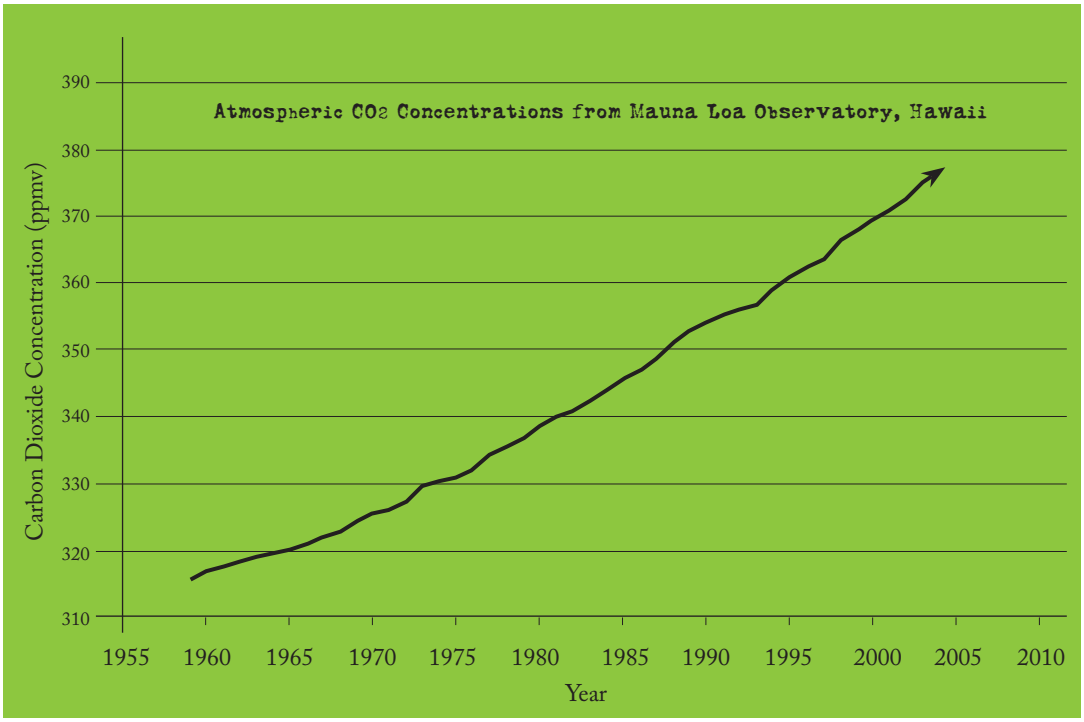
Student Reading 3

The largest component of humanity's Ecological Footprint is energy. Energy is required for everything we do! We need energy to cook, to heat our homes, and to travel from place to place. By learning about the resources required for different types of energy use and the kinds of wastes produced, we can investigate the sustainability of our energy use.

Energy sources, or fuels, are often categorized as renewable or nonrenewable. Renewable sources can provide us with energy indefinitely. For example, wind is a renewable source of energy because wind is continually created. Coal, on the other hand, is a nonrenewable source of energy because it can take millions of years for new coal to be produced.

Nonrenewable Energy Sources

When we burn **fossil fuels** such as coal and petroleum oil, carbon dioxide and other gases are released into Earth's atmosphere. Carbon dioxide, or CO_2, is a greenhouse gas that increases temperatures on Earth's surface by trapping the sun's heat. Greenhouse gases act like a blanket, keeping Earth warm.



Average annual atmospheric CO2 concentrations (shown in parts per million by volume) collected at Mauna Loa Observatory in Hawaii have risen continually from 1959 to 2004.[1] Average air and ocean temperatures on Earth have also risen during the past century.[2]

Climate change caused by greenhouse gases could lead to droughts, rising sea levels, and extreme weather events.[3] Burning fossil fuels is unsustainable not only because of its effects on Earth's atmosphere; fossil fuels are also nonrenewable resources. After we use them, they will not be renewed in our lifetime.

Nuclear power is thought by some people to be a more sustainable source of energy than fossil fuels because it does not produce greenhouse gases. Nuclear energy typically comes from uranium, an element in the earth. Unfortunately, there is currently no known way to dispose of nuclear waste. These wastes are kept in large pools of water until a safe method of handling and disposing of them is developed. Also, if a nuclear reactor overheats, harmful radioactive gases can escape, causing disease and even death.

Renewable Energy Sources

Approximately one-third of all energy is used in buildings as electricity.[4] Energy for use in buildings can be obtained from solar, wind, geothermal, and water resources. These energy sources are renewable because they can be replenished when we use them.

Wind energy is a growing source of renewable energy; wind captured from just 6% of U.S. land area has the potential to supply more than 1.5 times the amount of energy currently used in the United States![5] Wind power is clean, abundant, and inexpensive. **Wind turbines** convert wind energy into electricity; the wind causes a **generator** to turn, which creates electricity. Because wind is a renewable resource, wind energy represents a sustainable method for electricity production.

"Conserve energy. If you live close to school, try walking or biking to school rather than riding in a car or bus.

Transportation accounts for almost 30% of worldwide energy use.[6] Renewable energy sources for transportation needs include ethanol, biodiesel, and hydrogen fuel cells. **Ethanol** is an alcohol derived from grains, such as corn. It is often mixed with petroleum-based gasoline to reduce the amount of harmful gases released when we burn gasoline. **Biodiesel** is made from natural oils and fats. Recycled vegetable oil is one source of biodiesel. Hydrogen fuel cells use chemical energy from hydrogen and oxygen to create electricity. The byproducts of this process are heat and water.

You Have the Power

We can all reduce our Ecological Footprint by using sustainable sources of energy. One way to promote renewable energy resources is to purchase "green power," or electricity generated from sustainable sources. Purchasing green power instead of nonrenewable sources of energy reduces greenhouse gas emissions and helps the development of sustainable energy sources. You can contact your local electricity provider to inquire about purchasing green power.

While using renewable resources is a great way to contribute to sustainability, **conservation** is one way that everyone can make a positive impact on the earth right now. We can conserve energy by making simple changes in our lives at home and at school to reduce energy use. For example, if you live close to school, try walking or biking to school rather than riding in a car or bus. At home, turn off lights, computer equipment, and appliances when you are not using them.

Your voice can be a powerful tool for creating change. You can teach others about the importance of reducing energy use and using renewable energy sources when possible. Just think: if you convince just one other person to live more sustainably, you'll have twice the impact that you would alone!

Vocabulary

biodiesel—a fuel for diesel engines derived from plant oils or animal fats

conservation—careful use and preservation of natural resources, such as forests and water

ethanol—an alcohol made from plant material, such as grain from corn

fossil fuels—sources of energy such as petroleum, coal, and natural gas that are produced by the decomposition of ancient plants and animals

generator—a machine that converts mechanical energy into electrical energy

nuclear power—energy derived from heat that is released when uranium atoms are split apart

wind turbine—a device that uses the mechanical energy of wind to generate electricity

Checking for Understanding

1. What is one activity that produces greenhouse gases?
2. How are greenhouse gases related to climate change?
3. Name one benefit and one drawback of nuclear power.
4. List and describe three renewable sources of energy.

[1] Data from C.D. Keeling and T.P. Whorf, Scripps Institution of Oceanography, 2005, http://cdiac.esd.ornl.gov/ftp/trends/co2/maunaloa.co2.

[2] Intergovernmental Panel on Climate Change. "Climate Change 2007: The Physical Science Basis." http://www.ipcc.ch

[3] IPCC

[4] Worldwatch Institute, State of the World 2004 (New York: W. W. Norton & Co., 2004), p 32.

[5] Energy Efficiency and Renewable Energy, U.S. Department of Energy, "Wind Energy Resource Potential," March 27, 2007, http://www1.eere.energy.gov/windandhydro/wind_potential.html.

[6] Worldwatch Institute, p 28.

Sustainable Solutions —We Can Do It

Student Reading 4

It's easy to feel overwhelmed, guilty, discouraged, or even angry when we hear about all the challenges in the world. However, there is good news. There are many actions that people can take to help build a bright and sustainable future. In fact, the most important solutions are ones we already know about. We just have to decide—as individuals, communities, and nations—to do them.

Not all people have the ability to work toward sustainability. Many people who are living in poverty are simply struggling to meet their basic needs. However, as people gain more economic stability, they have more choices open to them.

Working Toward Local Sustainability

"If you think you are too small to be effective, you have never been in bed with a mosquito."

Reduce Your Footprint

Every day, people make dozens of choices that affect their own Ecological Footprint. If you want to shrink your Ecological Footprint, there are hundreds of ways to do it. The key is to know what actions have the biggest impact. When you're just getting started, it's a good idea to focus on the actions that make the biggest difference and not to worry if you can't do all the small things. According to scientists who study human impact, the actions below are some of the most important ones you can take to shrink your Footprint:[1]

1. **Your Family Car**—Transportation in cars and trucks is the single most environmentally harmful personal activity. To lessen your impact, there are two key things to do. First, research how many miles per gallon (mileage) your family's car(s) gets. The higher the mileage, the better. Second, if your family is going to buy a new car, consider getting one that is fuel efficient and minimally polluting.
2. **Alternative Transportation**—Whenever you can, use your feet, a bicycle, a skateboard, or a bus to get around. When you don't drive, you eliminate almost all of the pollution and greenhouse gases produced by your car or truck.
3. **Low-Impact Foods**—The food we eat has almost as big an impact on the earth as our transportation choices. Consumption of meat requires many resources. Overall, a vegetarian diet requires two to four times

[1] Michael Brower and Warren Leon, The Consumer Guide to Effective Environmental Choices: Practical Advice from the Union of Concerned Scientists (New York: Three Rivers Press, 1999), p 85.
[2] Worldwatch Institute, Vital Signs 2003 (New York: W. W. Norton & Co., 2003), p 30.
[3] David Suzuki Foundation, "The Nature Challenge," April 12, 2007, http://www.davidsuzuki.org/NatureChallenge/at_Home/.

"The most important solutions are ones we already know about. We just have to decide—as individuals, communities, and nations—to do them.

less land than a meat eater's diet.[2] That doesn't mean you have to give up cheeseburgers altogether! If you want to shrink your Footprint, however, choosing to eat one less meal with meat each week can have a big impact. Another thing you can do is buy locally grown food, which reduces resources used for transportation.[3]

4. **Organic Food**—Organic food helps the planet for many reasons. For one, it is grown without conventional pesticides or fertilizers, which can contaminate water or soil and can make people sick. Also, organic farming can reduce soil loss and water use. Organic food can be more expensive than other food, which means some people can't afford it. However, as more people buy organic food the prices will likely go down, making it accessible to more people.
5. **An Energy-Proof House**—Do a survey of how much energy is used in your house, and then make energy-efficient changes when possible. You can begin by looking for places to install compact fluorescent light bulbs, which are more energy-efficient than incandescent light bulbs. When you need to replace big appliances, look for the Energy Star certification to know if they are energy efficient.

Ask How Much Is Enough

Another big question is deciding when you have enough of something. Is another gizmo really going to make you happier? Can you live just as well without it? Would the environment be better off without it? There is increasing evidence that having more money above a certain income level and consuming more things don't make people any happier.[4]

Don't Throw It All Away

Investigate your neighborhood's recycling services and start reducing the waste you send to the local landfill. Reducing waste and reusing materials helps the environment. Turning your food into compost is also a great way to reduce your trash, and if you have a garden, compost will help you grow your own vegetables.

Flex Your Money Muscles

You can put your money where your mouth is by supporting projects—and items—that are sustainable. In the United States alone, young people between the ages of twelve and nineteen spend $172 billion a year![5] Think about what you buy and the companies you buy from. Does the manufacturer of your favorite clothing use sweatshop labor? Did the beef in your hamburger come from pastureland that was cleared from rainforest? Let manufacturers and stores know that if they want to keep you as a customer, they will have to provide products that don't hurt people or the environment. Economic pressure from consumers like you has caused

[4] David G. Myers, "Happiness," in Psychology, 7th ed. (New York: Worth Publishers, 2004).
[5] National Institute on Media and the Family, "Children and Advertising Fact Sheet," 2002, www.mediafamily.org/facts/facts_childadv.shtm.
[6] Farzaneh Roudi-Fahimi and Valentine M. Moghadam, "Empowering Women, Developing Society: Female Education in the Middle East and North Africa," November 2003, Population Reference Bureau.

huge companies such as Home Depot, McDonalds, and Starbucks to adopt more sustainable practices.

Get Political

The decisions we make today will determine the world we live in tomorrow. Getting involved as a citizen and looking at your country's national and international policies are key steps to achieving greater sustainability. It is up to engaged citizens around the world to lead the way in creating powerful changes toward sustainability. You can help educate your elected officials and media, point out the connections between issues, and remind them that you (and your family) will be voting on these issues now and in the future.

Think Big and Stay Informed

When you hear about problems in the world, ask yourself: What's the bigger picture? What are the underlying conditions? What are they connected to? You know that issues are connected and that many problems have several sides to them. Understanding these connections and different sides may help us find lasting solutions.

Working Toward Global Sustainability

You can make a difference on a global scale in lots of ways. Perhaps you want to get involved politically and write your elected officials. Maybe you will volunteer for a group that works on a global issue you care about. You can educate your peers and others about these issues. Perhaps you have even decided that you will choose a profession that lets you work more on these issues. Once you have decided to get involved, take a look at the policies and programs that can help support a sustainable world. Here are some areas that can have a big impact on global sustainability:

Addressing Extreme Poverty

Poverty is an underlying challenge to achieving global sustainability. Working towards ending extreme poverty would allow people to meet their basic needs. This would have ripple effects on many other issues, such as environmental stewardship, and help create a more sustainable world.

Checking for Understanding

1. Describe how decisions about your family car and alternate transportation can affect your Ecological Footprint.
2. How can you support sustainability by voting with your dollars? Give a specific example.
3. Why do you think addressing poverty may increase global sustainability?

Providing Primary Health Care

Providing primary health care in developing countries can lower infant and child mortality, increase life expectancies, and provide other essential services. If families had access to health care, which prevents most childhood deaths, many families would have only the number of children they wanted. Reproductive health, an important part of primary health, allows parents to choose the number and spacing of their children. It's not very expensive to provide these services, and they allow people who already want to limit family size to do so safely.

Educating and Empowering Women

Education benefits everyone, but educating and empowering girls and women creates particularly positive changes. The majority of the poor, hungry, and illiterate people in the world are female. In some places, women can't own land, borrow money, or even plant trees to restore the environment without permission from men. For every year a girl or woman goes to school, the more likely she is to have a smaller family. This improves the odds she'll have healthy kids and send those kids to school. Educating and empowering girls and women helps slow population growth, protect the environment, and reduce poverty.[6]

Working Toward a Sustainable Future

We can stabilize world population at a sustainable level. We can protect the environment. We can balance the most destructive inequities between nations, individuals, and genders. We have the knowledge, the technology, and the money to do all of this. Helping create a vision of a positive future for people and the planet is the first step toward creating that future. It tells us what we'll need to do to ensure a sustainable world for our children and our grandchildren.

What future will you choose?