Your students can celebrate Earth Day by exploring human impacts on the environment. How can governments, businesses, communities, and individuals take action to be sustainable, even as our population grows? How can we all be a part of the solution?

Reading:
The Human Footprint: Land – Explore the impacts of a growing population on agriculture, cities, wild spaces, and natural resources.

Lesson Plans:
Eco-Ethics (science, social studies, ELA) – Students examine their own values by considering various environmental dilemmas and evaluating how different reactions impact the planet.

If Money Won’t Buy It (science, math, social studies, ELA) – Students evaluate the environmental impact of their lifestyles, by deciding how to spend a limited allotment of "Natural Resource Units."

Meat of the Matter (social studies, math) – Students graph global meat consumption, use manipulatives to explore the environmental impact of four different types of protein, and discuss the pros and cons of a shifting global diet.

Secret Life of Stuff (science, social studies) – Students compare the life cycle stages of four everyday products in order to hypothesize which item has the lowest environmental footprint, and then brainstorm ways to minimize its eco-impact.

Timber! (science, social studies, math) – In a role-playing simulation, students discover what happens to a forest when the demand for wood is greater than the supply.

*For more great resources, visit us at www.PopulationEducation.org!
If you think about the history of the Earth, our time on it as humans is tiny. In fact, if geologic history was a calendar and the Earth formed on January 1 (that was 4.6 billion years ago), you wouldn’t find humans until December 31 at 11:37 pm (about 200,000 years ago). Back then, there weren’t very many of us, and we had yet to make our mark on the planet.

Fast forward to 12,000 years ago. Humans evolve from just hunting and gathering food to staying in one place and farming the land. Before long, we’re clearing forests, building cities and expanding human settlements across the globe.

Some trace the human dominance of Earth to those days of early farming. Others think it started much more recently – about 200 years ago with the Industrial Revolution. That’s when our world began to be mechanized; when we started using fossil fuels to power engines in our factories, on our farms, rivers and rails. Before long, our species had completely remade the Earth’s landscape. By the 1900s, we had vast amounts of land cleared for industrial-size farms, sprawling cities and mining operations. Scientists are now referring to this period since the Industrial Revolution as the Anthropocene, or Human Age. The word comes from the Greek anthropos (human) and -cene (recent) and is meant to show the overwhelming influence humans have had on the environment in such a short amount of time.

Sometimes, people refer to the “human footprint” to describe how our species has made its mark on the planet. One of the most visible signs of this is how we have altered the land. Satellite images of the Earth now show that nearly 40 percent of Earth’s land is used for agriculture – growing crops and grazing livestock. In 1700, just 7 percent of the world’s land was used for farming. Experts agree that today, the remaining land that could potentially grow crops is not ideally suited for farming. Much of this land is covered in forest, and using it for farming would mean clearing valuable ecosystems.

This presents a dilemma, because world population is growing. It is estimated that the world will need to produce 70 percent more food for the expected population we will have by 2050 – approximately 2 billion more people than are alive today. In order to maintain precious ecosystems, we will need to find ways to either produce more food, or use our existing food and croplands more effectively, so that we don’t need to expand agricultural lands.
How land is used to produce food also depends on our choices about what we eat. Eating more meat and dairy, for example, has a greater impact on the environment than eating mostly vegetables, fruits and grains. Farming livestock, like cows, pigs and sheep, requires large amounts of land (80 percent of all agricultural land) but provides only a small amount of food (less than 20 percent of the world’s calories). One-third of all croplands produce feed for livestock rather than for humans.4

FOREST LOSS
Some of the world’s land cleared for crops and livestock was once forest. We depend upon the world’s forests to regulate climate, to clean air and water, to conserve precious soil, and to provide habitat to much of the planet’s wildlife. Forests cover 31 percent of the global land area and are home to 80 percent of the world’s land based plants and animals.5

Since the Industrial Revolution, nearly half of Earth’s forests have been cleared or degraded to make way for agriculture and other human uses. Of greatest global concern is the loss of the Earth’s tropical rainforests and all of its biodiversity. Although tropical forests cover less than 6 percent of the global land surface, they are home to more than half the species of all living things.6 Rainforests are a treasure trove of foods, medicines, and other resources we have only begun to discover. Less than one percent of rainforest species have even been studied for their potential usefulness. Many species are so specialized to microhabitats within the forest that they can only be found in small areas. This specialization makes them vulnerable to extinction. Many countries have committed to finding ways to manage their forests sustainably, so as not to lose further habitat and all of the ecosystem services that forests provide.

AN URBAN PLANET
Wildlife habitat is also lost when land is cleared for development, including the expanding urban areas around the globe. As our population grows, we need more land for building houses, businesses, power plants, roads, schools, and for disposing of waste. Our planet is becoming increasingly urban.7 In 1800, only 7 percent of the world’s population lived in urban areas; today it’s more than half. By 2050, more than two-thirds of the world’s people will make their homes in cities.8

The expansion of human settlements can pose challenges to the natural environment beyond just a change in the landscape. Communities require infrastructure — roads and bridges, public transportation and public utilities — to provide us with water, sewage treatment, power lines and cell phone towers. All of these expand our human impact and take up more space.
EXTRACTING RESOURCES
Another human impact on the world’s land results from resource extraction. The raw materials that provide us with all of the goods and services we need and want come from somewhere. The Earth is a finite system, after all. Look around you. Every item you can see has either been grown in the soil or extracted from deep underground.

The fossil fuels that power our lives – coal, oil and natural gas – are brought to you by mining and drilling operations. Coal is mined from the ground. Oil is pumped from rigs found on land and in the ocean. Natural gas is either extracted from conventional drilling operations, or from hydraulic fracturing (also known as fracking). Fracking has been controversial because it requires huge quantities of water, which become toxic and can leak into underground water sources. When this wastewater is disposed of, it creates pressure in the ground that can cause small earthquakes.

The minerals that comprise everyday objects – copper, aluminum, tin, quartz, clay and so much more – are extracted, either by surface mining or underground mining. Surface mining involves overturning or “stripping” the land to get to the minerals or using explosive to blow the tops off mountains. Underground mining uses shafts and tunnels to get at minerals deep below the Earth’s surface. The effect on the land from mining operations can be permanent. This might include removing topsoil, destroying animal and plant habitat and polluting nearby water sources (such as rivers, lakes and streams) with chemicals and silt.

As humans, both our numbers and lifestyles affect the Earth’s land. Our demand for increasing amounts of food, energy and minerals, as well as our capacity to expand the built environment, has changed our land for all species. Providing for the needs of people while still protecting our remaining wildlife habitat will require a global commitment to land conservation.

Glossary

**Anthropocene**: a term referring to our current period since the Industrial Revolution where humans have had an overwhelming influence on the environment.

**biodiversity**: the variety of life in the world or in a particular habitat or ecosystem.

**hydraulic fracturing (fracking)**: a procedure for extracting natural gas from deep in the ground, using a high-pressure stream of water to split open rock, allowing gas to flow more freely out of the well.

**Industrial Revolution**: a period in history (mid 1700s through late 1800s) when there was a surge of new advances in science and technology.

**infrastructure**: the basic physical and organizational structures and facilities (e.g., buildings, roads, and power supplies) needed for the operation of a society.

**microhabitats**: a habitat that is of small or limited extent and which differs in character from some surrounding more extensive habitat.

**resource extraction**: the act of removing (extracting) minerals and other natural resources from the ground.

**topsoil**: the thin, rich layer of soil where most nutrients for plants are found.

**tropical rainforests**: a forest in a tropical region of the world with high annual rainfall.

**urban**: relating to cities.
ECO-ETHICS

INTRODUCTION

This activity is designed to give students the opportunity to examine their own values and beliefs as they relate to the environment, population and social issues, while gaining an understanding of the complex issues in many of today’s environmental debates. It is not the intent of this activity to prescribe “right” and “wrong” answers for the students. In some cases, students may perceive what would be the most ethical solution to a given problem, while admitting that they realistically might not choose that option. On each Dilemma Card, the action choices are preceded by “will you” rather than “should you.” This will encourage students to offer their most likely action in each given situation.

MATERIALS

• Dilemma Cards (provided)

PROCEDURE

1. Before class, copy and cut the Dilemma Cards so there are enough cards for each student to get one. Since there are only 12 cards, you will most likely need 2-3 copies of each.

2. Divide the class into groups of four and give each group a set of four different Dilemma Cards.

   Note: The card about sex education may only be appropriate for older students. Use your discretion on whether to include this one in the set.

3. Each student silently decides what they would do and formulates their reason.

CONCEPT

We make many difficult decisions in our everyday lives that can have an impact on the environment and society.

OBJECTIVES

Students will be able to:
• Participate in a collaborative, issue-based discussion within a small group.
• Take and articulate positions on dilemmas.
• Formulate and present reasons for their positions.

SUBJECTS

Science (Earth and environmental), social studies (civics, geography), English language arts

SKILLS

Decision making, critical thinking, values identification, communicating

METHOD

Students examine their own values by considering various environmental dilemmas and evaluating how different reactions impact the planet.
4. When all the students in the group are ready, the first student reads their dilemma and the options aloud to the rest of the group. The student gives the option they have chosen and briefly describes the reasoning involved. In turn, each member of the group is invited to comment on the dilemma and what they might do in the situation. The discussion of each dilemma by the members of the group should take about five minutes. Remind students to be respectful when sharing and hearing each other's ideas.

The person whose dilemma is being discussed should have the opportunity to ask questions of the other group members and offer clarification about their decision. The discussion gives the students experience in having ideas examined by peers and is intended to remind the students of the need to take personal responsibility for decision making. It is not necessary and may not be desirable for the students to reach consensus; there are legitimately diverse views of the most appropriate and responsible actions to take in many situations. The purpose is to provide students with an opportunity to examine, express, clarify and take responsibility for their own reasoning.

5. Continue this process until each student has had the opportunity to present their dilemma along with their decision and rationale about the dilemma.

6. Bring students together and go over the Discussion Questions as a class.

**ALTERNATE PROCEDURES**

1. Have students write their own Dilemma Cards, incorporating local issues and debates. These may even be dilemmas they have experienced or observed.

2. Cut off the suggested options on the Dilemma Cards and have students create their own responses.

**DISCUSSION QUESTIONS**

1. Which of the dilemmas generated the most discussion in your group? Why do you think that was the case?

2. Aside from environmental impact, what are some of the other considerations when choosing an option?

3. For any of the dilemmas, did you choose an option that was different from what you think you should do in that instance? If so, what were the reasons?

4. Are any of these situations similar to something you have encountered? If so, how did you resolve that dilemma?

5. In discussing possible responses to one of the dilemmas, did any of your group members persuade you to choose a different option from the one you originally considered? If so, what about that person’s arguments persuaded you? If not, can you think of any other times when you changed your opinion based on persuasive arguments?
ASSESSMENT

Students choose a dilemma and write a short paragraph on the positive and negative effects of all the options listed for that dilemma. Students should indicate what additional information, if any, is needed to make a responsible and informed decision. Students should identify what seems, in their judgment, to be the most responsible decision and explain their reasoning.

FOLLOW-UP ACTIVITY

Even when trying to make the most eco-friendly choices, it’s difficult to know what the best strategies are. There may be environmental pros and cons to different choices and the best choice may not be obvious and may require some research. Choose one of the situations below and structure a student debate. Have each side conduct research to find evidence for their position.

- Which creates the worst environmental impact – paper grocery bags or plastic grocery bags?
- Which creates the worst environmental impact – disposable coffee cups or a coffee mug that needs to be washed repeatedly?
- Which creates the worst environmental impact – disposable diapers or cloth diapers?

Adapted from the Project WILD activity “Ethi-Reasoning.” ©2003 Council for the Environmental Education.
ECO-ETHICS
DILEMMA CARDS

Here's Your Dilemma
You are at a park with your family for the day. One of the park rules is that visitors are responsible for bringing their trash out of the park (there are no trash cans). You see another family leaving to go home without gathering up their soda bottles and food waste. It is clear the other family intends to leave it behind. What will you do and why?

Will you:
• Go up to them and ask them to pick up the trash before leaving?
• Wait for them to leave and pick up the trash they left and add it to your family’s garbage bag?
• Do nothing?
• Other? (specify)

Here's Your Dilemma
Your friend gives you a lovely ivory necklace that she purchased on a trip to Botswana, Africa. You are aware that African elephants are being slaughtered for their ivory tusks and are now an endangered species. What will you do and why?

Will you:
• Accept the necklace and wear it often?
• Accept the necklace but not wear it?
• Explain to your friend why you do not wish to accept her gift?
• Other? (specify)

Here's Your Dilemma
Your school cafeteria prepares food items that are popular with students and familiar to them (burgers, hot dogs, pepperoni pizza, chicken nuggets, etc.). You know that most of these items are high on the food chain, requiring lots of water and energy to produce. You are also aware that much of the grain produced in this country is used to feed livestock. What will you do and why?

Will you:
• Visit with school administrators to suggest having meatless lunches served at least once a week?
• Bring your own lunch and not worry about the cafeteria menu?
• Eat whatever is served?
• Other? (specify)

Here's Your Dilemma
Your parents make you mow and water your lawn. The area hasn’t had much rainfall for some time and area officials are recommending that everyone conserve water. However, your neighborhood has strict rules about keeping each yard in order and without regular watering, your lawn will turn brown. What will you do and why?

Will you:
• Ignore the conservation warning and continue watering your lawn to keep it looking nice?
• Sacrifice the beauty of your lawn by watering less often?
• Plant different things in your yard that do not require so much care?
• Other? (specify)
Here's Your Dilemma

A friend asks you a question about sex and how to prevent pregnancy. Although you don’t know the answer for sure, you know enough to guess. What will you do and why?

Will you:
- Make up an answer based on the facts you know?
- Try to help find the answer in online?
- Suggest your friend talk to his/her parents or a teacher?
- Admit to your friend that you do not know for sure?
- Other? (specify)

Here's Your Dilemma

The school you attend is not in walking distance from your home. Your parents give you the option of catching the bus on the corner or getting a ride from one of them in the family car. The car would get you to school faster and without waiting outside. But the bus uses less gas per passenger. What will you do and why?

Will you:
- Take the bus?
- Get a ride in the car?
- Carpool with other kids nearby?
- Ride your bicycle?
- Other? (specify)

Here's Your Dilemma

There is an undeveloped green space in your town where you and your friends sometimes go to hang out. It is home to some local wildlife and a small creek. The town officials are thinking about developing the land as a recreation center with a skateboarding park, basketball and tennis courts. What will you do and why?

Will you:
- Support the building of the proposed recreation facilities?
- Oppose the project altogether?
- Go to a city planning meeting to see if the committee would consider a different site for the project?
- Do nothing and let the adults decide?
- Other? (specify)

Here's Your Dilemma

Your soccer team is raising money to buy new uniforms and decides to sell chocolate bars as a fundraiser. In science class, you’ve been learning about the threats to tropical rainforests and how millions of acres are cleared to plant palm oil plantations. Palm oil is in many foods, including popular chocolate bars, but its production often leads to the destruction of rainforests. What will you do and why?

Will you:
- Urge your coach and team members to only sell palm-oil free chocolate bars for the fundraiser and raise awareness of rainforests while raising money for your new jerseys?
- Sell mass-market chocolate bars that contain palm oil because it’s more economical.
- Suggest the team sells something other than chocolate bars.
- Other? (specify)
Here’s Your Dilemma

After months of pleading, you were given a small pet fish for your birthday, along with a book discussing how to best care for your pet. Until then, you and your parents were not aware that fish can live up to 20 years in captivity. Several months have passed and you are tired of feeding and cleaning up after your new pet. What will you do and why?

Will you:
- Flush the fish down the toilet?
- Release the pet into a local river knowing it will not have a good chance of surviving in this new habitat?
- Beg a friend to take your fish without telling them about its long life?
- Secretly drop the pet off on the door step of a local veterinarian or pet rescue agency?
- Other? (specify)

Here’s Your Dilemma

You love playing video games and own a couple of different game consoles. You recently learned that these consoles use a lot of energy. One recent study showed that all of the country’s game consoles use roughly the same energy as the entire city of San Diego, California! Most of the energy is generated from coal-burning power plants. You are concerned about the environmental impact of playing these games, but it’s one of your favorite forms of recreation. What will you do and why?

Will you:
- Keep playing the games but diligently turn off the consoles when not in use to save energy?
- Give away your consoles and only play video games when you go to friends' houses?
- Keep playing the games at home, but write to the game console manufacturers urging them to make more energy-efficient models?
- Other? (specify)

Here’s Your Dilemma

At the recreation center, you see the trash cans full of empty, plastic water bottles. You have heard that all of these bottles pile up at trash dumps or float around in the ocean. What will you do and why?

Will you:
- Ask the people running the center to offer water filling stations and provide visitors with refillable bottles?
- Ask the manager to set up recycling bins for plastic bottles?
- Bring your own refillable bottle from home to use and maybe talk to your friends about doing the same?
- Do nothing?
- Other? (specify)

Here’s Your Dilemma

As your class is going to lunch, you notice that the AV equipment and lights are still on. You know that high energy use has a negative impact on the planet. What will you do and why?

Will you:
- Turn off everything yourself?
- Point it out to the teacher or principal?
- Start a class discussion about saving energy?
- Do nothing?
- Other? (specify)
IF MONEY WON’T BUY IT

INTRODUCTION
As individuals, our days are filled with lifestyle choices such as what and where to eat, how to get from place to place, and how to spend our free time. Very often, we make decisions based on how the outcome will impact our daily life – will it save us money? Be more convenient? Provide entertainment or comfort? By doing so, we neglect to consider the built-in environmental impacts of our actions. Other times, we know the environmental impact of our choices but decide that the personal cost of making the eco-friendly choice is too high to change our behaviors. For instance, you may know that biking is more eco-friendly, but it would take a lot longer and is not enjoyable in bad weather. Evaluating the environmental impact of our daily actions and the motivations behind our decisions is an important step in pursuing a sustainable lifestyle.

MATERIALS
• Action Rating Sheet (provided)
• Student Worksheet

PROCEDURE
1. To set the stage for this activity, tell students they will be using the class period to spend a new kind of money. Distribute the Action Rating Sheet and the Student Worksheet and then describe the natural resource units system by reading the paragraph below:

“How would we react if the government issued every person a new charge card that limited negative environmental impacts? Today, you will imagine what it would be like to live in a society where people are assigned ‘Natural Resource Units,’ or ‘NRUs.’ These units will be used alongside our monetary currency and the NRUs are to be presented when conducting daily activities related to transportation, food, waste, water and electricity use. The bigger environmental impact the activity has, the more NRUs it will cost.”

CONCEPT
Everyday decisions about our lifestyles have an environmental impact that must be balanced against personal choice.

OBJECTIVES
Students will be able to:
• Determine how their lifestyle choices would change if based on environmental impact rather than monetary value.
• Make lifestyle decisions based on an environmental impact budget.
• Express their values through personal choices and decisions.
• Calculate the environmental cost of everyday actions.

SUBJECTS
Science (Earth and environmental), social studies (geography, economics), family and consumer sciences, math

SKILLS
Problem solving, decision making, critical thinking, values identification, prioritizing

METHOD
Students participate in a budgeting activity to weigh everyday actions against their environmental impact.
2. Have students look at the Action Rating Sheet, and explain that the NRU points are totaled based on the action’s environmental impact in three categories: use of energy or resources, disturbance to natural areas, and pollution to the air, land or water. Display the following chart or describe the categories.

<table>
<thead>
<tr>
<th>Uses energy or resources</th>
<th>Disturbs natural areas</th>
<th>Pollutes air, land or water</th>
</tr>
</thead>
<tbody>
<tr>
<td>How much energy or resources does this action require?</td>
<td>Does this action impact the natural environment?</td>
<td>Does this action cause any pollution?</td>
</tr>
</tbody>
</table>

3. Now explain the day’s activity by reading the following:

“It is January 1st and you have been allotted 60 NRUs for the year. How will you spend them? Will you be able to do everything you’d like while staying within your annual NRUs budget? Will meeting that budget have personal costs?”

4. Reference the Rating Sheet and remind students that this is only a simulation and that the environmental impact listed accounts for the impact of using a resource and not always for the full impact of production. Also, clarify that they are to make these decisions as individuals who can freely determine how much energy they use and what items they own. (You may want to tell them to imagine that they are a little older and have their own apartment.)

5. Allow students time to fill out the chart on the Student Worksheet. Then divide students into groups of 3-4 to discuss their choices and answer the questions on the Student Worksheet.

   **Note:** The last column on the Student Worksheet has students consider if they would personally be impacted by the action. If they think yes, they should put a check, and explain their thinking. If they think no, they should leave it blank. For example, one of the options for the Food Shopping category is to shop at a farmer’s market and this would limit you and your family to only seasonal or local foods. In this case, the personal impact is the freedom to select out of season/non-local products.

6. To add a quantitative component to the activity, you can have students make a class bar graph at the front of the room with sticky dots on paper or hatch marks on a whiteboard. The bars would represent different NRU totals in bands of 5 or 10 (e.g. 31-40, 41-50, 51-60, 61-70 and 71-80). Another option would be to record all of the totals and come up with a class average.

7. Bring the class back together and go through the Discussion Questions.

**DISCUSSION QUESTIONS**

1. Are there any actions on the Rating Sheet that cost more or fewer NRUs than you think they should cost, based on their environmental impact?

   *Answers will vary. Students should feel free to share the ratings that they think certain items should have had.*
2. Most of the actions on the Rating Sheet are decisions that people make every day. Are there any actions that you think should be added to the Rating Sheet? If so, how would you represent the breakdown of NRUs? How might this impact your ability to stay under budget?

3. Was it hard to make decisions about which things you could “afford” given the NRUs you had? Why or why not? (Have students refer to their Student Worksheets and the items they checked as having a personal impact.)

4. Which lifestyle choices do you think would enable you to have the most positive impact on the environment?

5. If you were given a budget of NRUs for a household of four people, which actions do you think might be multiplied by four and which might stay the same? What would be some of the considerations?

   \textit{Answers may include: driving a vehicle could stay the same if everyone drove together but would be multiplied for multiple cars and drivers; the thermostat in the house or apartment would be the same even with more people; showers are an individual activity, so that would be multiplied; food choices would be multiplied; TV watching and gaming could be group activities but using the computer might be multiplied.}

6. Looking at the choices you made, which ones might be affected by where you live?

   \textit{Answers may include: the use of heating and air conditioning might depend on the climate in your area; if you live in an urban area, you may have more opportunities to take public transit, while residents of suburbs and rural areas are more dependent on cars; depending on where you live, you may or may not have access to a farmer’s market.}

**ASSESSMENT**

Evaluate students’ participation in the small group discussions and review answers to the Student Worksheet to gauge understanding.

**FOLLOW-UP ACTIVITY**

Students select one of the actions from the Action Rating Sheet that has a total NRU Rating of “5” or higher and research why that action might have the environmental impact indicated on the chart. They should write up a paragraph explaining the specific impacts on the environment (e.g. deforestation, air or water pollution, etc.). If they disagree with the point value assigned on the chart, they should explain why.
## IF MONEY WON’T BUY IT

### ACTION RATING SHEET

Natural Resource Units (NRUs) are assigned in each category on a scale of 0 to 4. These numbers show the environmental impact of each item.

0 = no impact  
1 = very little  
2 = some impact  
3 = quite a bit  
4 = heavy impact

### Impact in Natural Resource Units Per Year

<table>
<thead>
<tr>
<th>Action</th>
<th>Uses energy or resources</th>
<th>Disturbs natural areas</th>
<th>Pollutes air, land or water</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Transportation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Driving a gas/electric hybrid (50 mpg)</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Driving a small economy car (35 mpg)</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>Driving a truck (15 mpg)</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>12</td>
</tr>
<tr>
<td>Driving large, luxury car (20 mpg)</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>12</td>
</tr>
<tr>
<td>Using mass transit</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Biking/walking</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Riding on an passenger jet for one vacation</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td><strong>Diet</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eating a diet that includes meat &amp; dairy</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td>Eating vegetarian (includes dairy but no meat)</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Eating vegan (no meat or dairy)</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td><strong>Food Shopping</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grocery shopping at a farmer's market</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Grocery shopping at a supermarket</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Grocery shopping online</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td><strong>Waste disposal</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Composting</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Recycling paper, aluminum and glass</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Mixing trash (no recycling)</td>
<td>2</td>
<td>4</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>Using disposable food-ware</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>7</td>
</tr>
</tbody>
</table>
### Impact in Natural Resource Units Per Year

<table>
<thead>
<tr>
<th>Action</th>
<th>Uses energy or resources</th>
<th>Disturbs natural areas</th>
<th>Pollutes air, land or water</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dining</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Getting takeout most of the time</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>Cooking at home most of the time</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Eating out most of the time</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td><strong>Electricity Use</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Watching TV for 4 hours/day</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>Using the computer for 4 hours/day</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>Using a gaming console 2 hours/day</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>Using air conditioning every day in the summer</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td>Using fans</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Turning the thermostat to 70°F in the winter</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>Layering clothes in the winter and setting thermostat to 65°F</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td><strong>Water Use</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Washing dishes by hand</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Using the dishwasher</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Taking 10-minute showers daily</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Taking 30-minute showers every other day</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>Taking baths</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>7</td>
</tr>
</tbody>
</table>
IF MONEY WON’T BUY IT
STUDENT WORKSHEET

Name: ___________________________  Date: ___________________________

Answer the questions and fill out the audit below in pencil. Remember, you are only allowed to spend 60 NRUs.

<table>
<thead>
<tr>
<th>Impact in Natural Resource Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Action</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Transportation (Choose 2-4 actions)</td>
</tr>
<tr>
<td>Diet (Choose 1 action)</td>
</tr>
<tr>
<td>Food Shopping (Choose 1-2 actions)</td>
</tr>
<tr>
<td>Waste Disposal (Choose 1-3 actions)</td>
</tr>
</tbody>
</table>
### Impact in Natural Resource Units

<table>
<thead>
<tr>
<th>Action</th>
<th>Uses energy or resources</th>
<th>Disturbs natural areas</th>
<th>Pollutes air, land or water</th>
<th>Total (Add up ALL NRUs for that category and write it in the box)</th>
<th>Personal Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dining (Choose 1 action)</strong></td>
<td></td>
<td></td>
<td></td>
<td>Total Dining NRUs</td>
<td>Dining Personal Cost</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Electricity Use (Choose 3-4 actions)</strong></td>
<td></td>
<td></td>
<td></td>
<td>Total Electricity Use NRUs</td>
<td>Electricity Personal Cost</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Water Use (Choose 2 actions)</strong></td>
<td></td>
<td></td>
<td></td>
<td>Total Water Use NRUs</td>
<td>Water Use Personal Cost</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total NRU Usage for All Categories:

Please answer the Discussion Questions on the next page.
Discussion

In your group, compare your results and discuss the following questions. Record your answers below.

1. What was the average NRU usage for your group? Show your work below.

2. Did you spend more or less than the average of your group? What choices do you think contributed most to your NRU use being low or high?

3. Were you able to stay under 60 NRUs on your first try? If not, what changes did you make to reduce the amount of NRUs you spent to get you to 60 or fewer?

4. What was the most difficult choice for you to make?

5. If you had more NRUs to spend, would you make different choices? Explain where you might spend them.

6. If you had to try again, but this staying under 50 NRUs, what choices would you make differently?

7. What was one major personal cost you identified? Compare with a member of your group and see if they agreed or had a different personal cost for that category.
MEAT OF THE MATTER

INTRODUCTION

It takes a lot of resources to grow food for our global population, and the way that we produce food can have a huge impact on the environment. To plan for a sustainable future, we’ll need to consider how the different foods we eat impact the planet differently. Not all sources of protein have the same environmental footprints: different proteins need different amounts of space, water, and contribute differently to greenhouse gas emissions. In general, the footprint from animal-derived protein is much greater than the footprint of plant-based protein. The footprint from red meat is much greater than the footprint of other meats.

Consider this: 25 percent of the planet’s ice-free land is used for livestock grazing. And 33 percent of all cropland is used to farm food for livestock. Meanwhile, global meat production has increased nearly five times since 1961 and will not likely slow anytime soon.

The Food and Agriculture Organization of the United Nations estimates that human population growth and rising incomes are driving an increase in meat consumption worldwide. They believe that population growth will drive increasing meat consumption in lower income regions, while rising incomes will drive per capita consumption in transitioning economies and high-income countries. Making informed choices about the type and quantity of meat we eat, and understanding the environmental risks of different agricultural processes and technologies, are critical to a sustainable future.

MATERIALS

• Student Worksheet
For each group of four students:
• Environmental Impact Grids 1 – 4 (provided)
• Bingo chips*:  
  • 60 blue bingo chips
  • 80 red bingo chips
  • 90 green bingo chips
• If not using bingo chips, distribute one red, blue, and green marker per group.

CONCEPT

Demand for meat rose dramatically over the past 60 years and increased production has a number of environmental impacts. The extent of these impacts vary depending on the protein source.

OBJECTIVES

Students will be able to:
• Graph and interpret global meat production data.
• Compare and contrast the environmental footprints of four different sources of protein (three livestock-based and one plant-based).
• Evaluate the social and environmental implications of a shifting global diet.

SUBJECTS

Science (Earth and environmental), social studies (geography), family and consumer sciences

SKILLS

Graphing and analyzing data, interpreting line graphs, comparing and evaluating, critical thinking

METHOD

Students graph global meat production, use manipulatives to explore the environmental impact of four different types of protein, and discuss the pros and cons of a shifting global diet.
PART 1: GLOBAL MEAT PRODUCTION TRENDS

PROCEDURE

1. To get students thinking about historical trends in meat production, ask the following: Do you think people today eat more or less meat on a global per-capita basis than they did 60 years ago? Why or why not?

2. Divide students into pairs and distribute the Student Worksheet to each pair. Have each pair graph the data provided on the Worksheet.

3. Once students have graphed their data, each pair should discuss their initial observations with another pair.

4. As a class, briefly discuss trends observed. Then ask students to hypothesize why global meat production has been on the rise for the past 60 years.

   Answers may include: the global population is rising, and having more people on the planet will mean needing more food to feed everyone. Also, people around the world are eating more meat in their diets. Many people in higher income nations, like the United States and Argentina, eat a lot of meat already. And incomes are rising in many other nations, like China and Brazil, where the average person is eating more and more meat as their income increases.

5. Ask students what kind of social and environmental impacts might occur with the rising demand and production of meat around the world.

   Answers may include: health complications from overconsumption of meat (particularly red meat), increased demand for meat may increase demand for factory farms, increased CO2 emissions, and environmental degradation.

Answer to Student Worksheet
PART 2: COMPARING THE ENVIRONMENTAL IMPACTS OF DIFFERENT PROTEINS

PROCEDURE

1. Draw three columns on the whiteboard, and label the columns with “Water,” “Greenhouse Gas,” and “Land.” Explain that you will be examining the environmental footprints of four different types of protein: three types of meat (poultry, pork, and beef) and one plant-based protein (soy).

2. Ask students for ideas on how water is used to produce meat or to grow soy. Write student ideas in the “Water” column. Ask for ways meat production and soy farming contribute to greenhouse gas emissions. Add ideas to the “Greenhouse Gas” column. Ask for ways in which land is needed for meat production and soy farming. Add ideas to the “Land” column. If students struggle to generate ideas, use some of the ideas below to encourage brainstorming.

<table>
<thead>
<tr>
<th>Water</th>
<th>Greenhouse Gas</th>
<th>Land</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Water for animals to drink</td>
<td>• Methane from animals burping and flatulence</td>
<td>• Space to grow soy</td>
</tr>
<tr>
<td>• Water to irrigate soy</td>
<td>• Methane from rotting manure</td>
<td>• Space for animals to graze, barns, pastures</td>
</tr>
<tr>
<td>• Water to clean farm equipment or barns</td>
<td>• Emissions from gas used in farm vehicles and to transport animals and crops to processing plants</td>
<td>• Space to grow crops used for animal feed</td>
</tr>
<tr>
<td>• Water to irrigate crops for animal feed</td>
<td>• Emissions from electricity needed on the farm, to keep meat chilled during transportation, and in the factories that process soy and meat</td>
<td></td>
</tr>
<tr>
<td>• Water used in the factories</td>
<td>• Nitrogen from fertilizer on soy and on animal feed</td>
<td></td>
</tr>
<tr>
<td>to process and package meat and soy</td>
<td>• Carbon released when trees are cleared to make more pasture or crop land</td>
<td></td>
</tr>
</tbody>
</table>

3. Divide students into groups of four. You may want to combine sets of pairs from Part 1.

4. Distribute the following to each group:
   a. One of each Environmental Impact Grid (beef, pork, poultry, soy)
   b. One pre-assembled set of bingo chips, which contains:
      • 60 blue bingo chips
      • 80 red bingo chips
      • 90 green bingo chips (only 17 will be used on the grids)

   **Note:** The number of bingo chips does not need to be exact, as long as students have more chips than they need to complete the activity. There will only be space for 17 green chips to be used between all four grids. If using markers, distribute one blue, red, and green marker to each group.
5. **Explain to students that they are going to examine how much water is used, how much greenhouse gas is emitted, and how much land is needed to produce one pound of beef, pork, poultry, and soy.** Students will use bingo chips placed on a grid to visualize the size of water, greenhouse gas, and land footprints. If using markers rather than bingo chips, students will color in grid squares using the appropriate color. Each group member is responsible for completing an Environmental Impact Grid on one of the four types of protein.

6. **Allow time for groups to determine which student will be responsible for which protein.**

7. **From the Teacher Environmental Impact Sheet, read aloud the Water Footprint statistics.** Each student listens for the amount of water needed to produce their protein, and adds the appropriate number of blue “water” chips to their grid.

8. **Repeat the process for the Greenhouse Gas Footprint and Land Footprint statistics.** Note that students will not have enough grid squares to represent the entire land footprint of beef.

9. **Allow students a few minutes to discuss their observations within their group.**

**DISCUSSION QUESTIONS**

1. **How do the water, greenhouse gas, and land footprints compare among the four types of protein? Why do you think some footprints are larger and some are smaller?**

   *Soy has a much smaller environmental footprint than the animal proteins. Poultry is the next biggest, followed by pork. Beef has the biggest footprint. For example, beef’s greenhouse gas footprint is 20 times larger than soy’s. Pork’s greenhouse gas footprint is 2.5 bigger than soy’s, and poultry’s is 2 times bigger than soy’s.*

   *Cows are larger animals than pigs or chickens, and they live longer. They need significantly more food and water over the course of their lives, and they create more manure. Cows have larger land, water, and greenhouse gas footprints. Soy does not emit greenhouse gases through digestion like animals do, so its greenhouse gas footprint is less than an animal’s.*

2. **Look at your global meat production graph alongside the Environmental Impact Grids for poultry, pork, and beef. The global meat production graph looks at the total amount of each meat produced in the world. The Environmental Impact Grids show the impact of a small amount (one pound) of each type of meat. Looking at these data sets side-by-side, which meat do you think will have the biggest environmental impact in the world in the next ten years? Why?**

   *Answers will vary. Beef has the largest environmental footprint per pound, but there’s currently less of it raised than pork and poultry. Some students may point out that the demand for poultry seems to be growing fastest, and in ten years, there may be much more poultry production than beef or pork production. Alternatively, students may conclude that because the beef footprint is so much larger than poultry or pork, that beef will have the biggest impact in ten years, even if it isn’t the most-produced meat.*
3. A rise in global meat consumption means a rise in the demand for animal feed. Currently, 75 percent of all soybeans grown are used to feed livestock. The graph below shows historic global soy production. What is the trend for global soy production: is it growing, shrinking, or staying steady? What might this graph tell you about the need for farmland?

*Overall, soy production has increased from 1961 to 2018, even if it has shrunk for a year or two along the way. The graph tells us that we will most likely need more farmland in the future to keep up with the growing demand for soy products.*

![Global Soy Production 1961-2018](image)

Source: Food and Agriculture Organization of the United Nations

4. Global meat and soy production will most likely continue to rise. What challenges does this present for the environment? For the global community?

*Environmental problems may include: land degradation caused by intensive livestock farming and overgrazing, deforestation in order to grow more soy or create grazing pastures, surface and groundwater contamination from animal wastes and farming pesticides and fertilizers, increases in greenhouse gases leading to climate change. Social problems may include: health and obesity problems from high meat consumption, the threat of antibiotic resistance, the inhumane treatment of animals in concentrated animal feeding operations (CAFOs).*

5. What are some things that farmers and ranchers are doing, or can do, to lower the environmental impacts from producing beef, pork, poultry, and soy?

*Beef farmers can graze their cattle on pasture, rather than feeding them soy and other grains, in order to lower the land and water footprint. When farmers choose grains for feed, they can choose grains that have less impact on the environment. Some grains even limit the amount of methane cows produce. Livestock farmers can redesign how they capture and store manure to reduce greenhouse gas emissions. Farmers can buy livestock feed from places that use sustainable agricultural practices like reducing the use of fertilizers and chemicals and using crop covers to control erosion and restore soil health. Soy farmers can use different kinds of fertilizers, lower amounts of fertilizers, or apply fertilizers at different times in order to reduce the impact to water and the greenhouse gas emissions from nitrogen.*
6. What can individuals do to lower the environmental impacts of protein in their diets?

People can choose to eat fewer or no meat products, or go meatless on certain days of the week. Aside from soy, people can eat other plant-based proteins like beans, peas, nuts, and seeds. Individuals can also choose to eat poultry rather than beef to lower their impact on the environment. They can purchase meat products from local farms to reduce greenhouse gas emissions from shipping meat. Or they can purchase meat from farms that use sustainable agricultural practices, like crop and livestock integration, to improve the health of soils and the environment. Unfortunately, sustainably and locally sourced meats can be more expensive than their conventional counterparts. There are ways to make sustainably-raised meat more accessible to a wide range of socio-economic groups. Across the United States, cooperative grocery stores and wholesale retailers work to provide low-income communities with high quality, sustainably-sourced meat and produce.

7. What can governments or organizations do to lower the impacts from producing beef, pork, poultry, and soy?

Governments can help farmers pay for some of the expensive changes they might want to make to lower the environmental impacts of their farm. Organizations can encourage people to eat less meat. Countries can protect wild places at risk from expanding farmland.

ASSESSMENT

Students create a visual representation, through words or drawing, of three things they learned about protein production and its impact on the environment.

FOLLOW-UP ACTIVITY

1. Have students explore three interactive maps from Ensia to identify projected changes in beef, pork, and poultry consumption by country and document their observations.

2. Have students reflect on their experience in this activity by creating a poster or brochure to educate the public about the environmental impacts of meat consumption.

3. Have students research specific agricultural technologies or innovations that lower environmental footprints.

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TEACHER ENVIRONMENTAL IMPACT SHEET

Water Footprint*: 1 blue chip = 60 gallons of water

Soy: It takes approximately 300 gallons of water to produce 1 pound of soybeans. Place 5 blue chips on your grid.

Poultry: It takes approximately 540 gallons of water to produce 1 pound of poultry. Place 9 blue chips on your grid.

Pork: It takes approximately 720 gallons of water to produce 1 pound of pork. Place 12 blue chips on your grid.

Beef: It takes approximately 1,860 gallons of water to produce 1 pound of beef. Place 31 blue chips on your grid.

Greenhouse Gas Footprint*: 1 red chip = 1 pound of carbon dioxide equivalent (CO2 eq)*

Soy: Approximately 3 pounds of CO2 eq are emitted to produce and transport 1 pound of soybeans. Place 3 red chips on your grid.

Poultry: Approximately 6 pounds of CO2 eq are emitted to produce and transport 1 pound of poultry. Place 6 red chips on your grid.

Pork: Approximately 7 pounds of CO2 eq are emitted to produce and transport 1 pound of pork. Place 7 red chips on your grid.

Beef: Approximately 60 pounds of CO2 eq are emitted to produce and transport 1 pound of beef. Place 60 red chips on your grid.

Land Footprint*: 1 green chip = 20 square feet of land

Soy: Approximately 20 square feet of land are needed to produce 1 pound of soybeans. Place 1 green chip on your grid.

Poultry: Approximately 60 square feet of land are needed to produce 1 pound of poultry. Place 3 green chips on your grid.

Pork: Approximately 80 square feet of land are needed to produce 1 pound of pork. Place 4 green chips on your grid.

Beef: Approximately 1,600 square feet of land are needed to produce 1 pound of beef. Place 80 green chips on your grid.

*A carbon dioxide equivalent (CO2 eq) is a measurement used to compare the emissions from various greenhouse gases based on their potential to warm the planet. The measurement converts methane and nitrous oxide to the equivalent amount of carbon dioxide with the same global warming potential.
MEAT OF THE MATTER

STUDENT WORKSHEET

Name: ___________________________ Date: ___________________________

Directions: Work with your partner to graph and label the data provided below. Discuss what observations you can make from the graph.

Global Meat Production 1964 to 2018

<table>
<thead>
<tr>
<th>Year</th>
<th>Poultry</th>
<th>Pork</th>
<th>Beef</th>
</tr>
</thead>
<tbody>
<tr>
<td>1964</td>
<td>11.2</td>
<td>31.6</td>
<td>34.5</td>
</tr>
<tr>
<td>1973</td>
<td>19.4</td>
<td>44.6</td>
<td>42.8</td>
</tr>
<tr>
<td>1982</td>
<td>31.4</td>
<td>58.6</td>
<td>50.6</td>
</tr>
<tr>
<td>1991</td>
<td>48.3</td>
<td>78.6</td>
<td>59.0</td>
</tr>
<tr>
<td>2000</td>
<td>75.6</td>
<td>99.1</td>
<td>61.5</td>
</tr>
<tr>
<td>2009</td>
<td>104.4</td>
<td>117.0</td>
<td>69.0</td>
</tr>
<tr>
<td>2018</td>
<td>140.3</td>
<td>133.2</td>
<td>74.2</td>
</tr>
</tbody>
</table>
MEAT OF THE MATTER
ENVIRONMENTAL IMPACT GRID 1: BEEF

Water Footprint: 1 blue chip = 60 gallons of water

CO₂ Footprint: 1 red chip = 1 pound of carbon dioxide equivalent (CO₂ eq)

Land Footprint: 1 green chip = 20 square feet of land
<table>
<thead>
<tr>
<th>Water Footprint: 1 blue chip = 60 gallons of water</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO2 Footprint: 1 red chip = 1 pound of carbon dioxide equivalent (CO2 eq)</td>
</tr>
<tr>
<td>Land Footprint: 1 green chip = 20 square feet of land</td>
</tr>
</tbody>
</table>
MEAT OF THE MATTER
ENVIRONMENTAL IMPACT GRID 3: POULTRY

Water Footprint: 1 blue chip = 60 gallons of water

CO2 Footprint: 1 red chip = 1 pound of carbon dioxide equivalent (CO2 eq)

Land Footprint: 1 green chip = 20 square feet of land
MEAT OF THE MATTER
ENVIRONMENTAL IMPACT GRID 4: SOY

Water Footprint: 1 blue chip = 60 gallons of water

CO₂ Footprint: 1 red chip = 1 pound of carbon dioxide equivalent (CO₂ eq)

Land Footprint: 1 green chip = 20 square feet of land
SECRET LIFE OF STUFF

INTRODUCTION

Our “stuff” has a secret life – a life that exists long before it reaches your hand as a consumer and extends long after. For instance, consider the shirt you are wearing. Your shirt may have begun its life in a field of cotton requiring water and, most likely, fertilizers. The cotton was then processed and manufactured, using a lot of energy and chemicals and perhaps traveling quite a distance along the way. Next, the shirt was packaged with a variety of materials, each of which has its own life, and then lastly, it was transported to the store. Once at home, it gets washed and dried regularly, which uses a lot of water and electricity. When it finally wears out (or you become sick of it) it will end up in the landfill, where it lives out the rest of its days.

Most people aren’t aware of the stages our stuff goes through, not to mention how those stages impact the planet. A life cycle analysis, or LCA, is a technique that assesses the environmental impact of a product and can help identify changes that will decrease a product’s eco-impact over the course of its life. With population growing and more goods being consumed, it’s important that we consider the impact of not only ourselves, but also our stuff.

MATERIALS

• Student Worksheet
• Several of each “analysis item”
• Life Cycle Analysis Chart (provided)

PROCEDURE

1. Before class, set up four Analysis Stations, each with several of the “analysis items.” Make substitutions as necessary. (One station will have several pairs of jeans, the next will have several pairs of sneakers, etc.)

   Analysis Items
   Jeans       Ear buds
   Sneakers   Small lamp (without lightbulb)
2. Hold up a paper grocery bag in front of the class and explain that the bag, an everyday product, has a secret life – a life cycle just like living things.

3. Ask students to hypothesize what they think it means to conduct a life cycle analysis (LCA) of a product and then brainstorm the paper bag’s life cycle as a class. You can show students the circle image on the front page if they have trouble determining the five stages. As you go through each stage as a class, ask students to think about what factors influence the environmental impact of that stage.

4. Here’s an overview of potential impacts during each stage:

   **Materials** – The materials used to create a product must come from somewhere. Some are extracted from mines, others are grown specifically to be used by humans, while others might be taken from the ocean or a forest. Removing these materials impacts the Earth’s natural resource base and gathering them requires energy. If the materials are recycled or sustainably managed, their footprint is decreased.

   **Manufacturing** – Each piece of a product has to be created separately before being combined with the other parts. The manufacturing of each piece requires energy and can produce toxic waste. The processing of metals and plastics is especially resource intensive, because they must be melted and refined before use.

   **Distribution** – Many things have to be transported for a product to exist – the raw materials to the production factory, the product to stores, and finally, the product to consumer homes. All of this transportation emits greenhouse gases and contributes to the eco-impact of the product. The product also must be packaged, which can require additional materials and manufacturing.

   **Usage** – Some things require energy, or other resources, in order to be used (appliances, electronics, cars, etc.), and this gets factored into their life cycle analysis. Length of use also plays a role – items that can be used longer have less of a footprint, since they don’t need to be replaced by new versions as often.

   **Disposal** – Both the product itself and its packaging must be eliminated. Materials that can be recycled or composted, like cardboard, have less of an impact than those that can’t, like Styrofoam. Some items are also easier to reuse or donate than others.

5. Distribute the Student Worksheet and explain that in small groups, they will be conducting a life cycle analysis for four different products – a pair of jeans, a pair of sneakers, a set of earbuds, and a lamp. Point out the four analysis stations set up around the room.

   **Note:** The following list provides more information on common materials used in everyday products. You can chose to share this information with students before, during, or after the station analysis, or not at all.
6. Before beginning, ask each student to turn to a partner and discuss which of the four products they think has the smallest eco-impact and why. They should record this hypothesis at the top of their Student Worksheet.

7. Divide students into groups of 3-4 and direct each group to one of the four analysis stations – it’s okay to have more than one group at a station.

8. Groups should spend 15 minutes at each station working through the phases of the product’s life cycle. To record their thinking, each student should fill in their Life Cycle Analysis chart. Students do not need to know the exact information for each product/stage. The goal is to have them think through the stages and make reasonable conclusions. Alternatively, or to save time, small groups could each analyze one product, and then the class could come together to discuss each product and determine rankings in each category.

   **Notes:**
   - Students should use a pencil to write rankings, as they will likely change as the lesson progresses.
   - You may need to clarify that the rank identifies how they think that product compares to the other three products on that particular stage of the LCA. For example, in the Materials stage, sneakers may be ranked 1 (most eco-friendly), lamp ranked 2, earbuds ranked 3, and blue jeans ranked 4 (least eco-friendly).
   - You may want to structure the 15 minutes so that students spend the first three minutes observing and the next 12 minutes discussing with peers and recording notes.

9. After all groups have moved through all of the analysis stations, give them time to answer the three questions on the Student Worksheet.

10. Go through the Discussion Questions as a class.

**Answers to Student Worksheet**

*Materials used* - You can share this information after the analysis stations (during discussion), can provide a “word bank” of these materials for students to choose from during the analysis, or not share them at all.

   - **Jeans:** cotton; indigo dye; copper (rivets); steel (buttons, zipper)
   - **Sneakers:** rubber (sole); foam, polyurethane, silicone (middle sole); canvas, leather, nylon (body); plastic (eyelets for laces)
   - **Earbuds:** plastic (outer covering); copper (wire); nickel or copper (plug); plastic or foam (earbud covering)
   - **Lamp:** ceramic, metal, glass, or plastic (base); ceramic, plastic, aluminum, or brass (socket); brass or silver (plug); copper (wire); plastic (wire covering, switch)

Answers to other categories and rankings will vary.
DISCUSSION QUESTIONS

1. How accurate do you think your rankings were? Why?

   Answers will vary. You may need to explain to students that there is not one right answer to which product has the smallest impact. Rankings may differ depending on which criteria individual students focused on (energy use, materials, packaging, etc.)

2. What did you find difficult about conducting a life cycle analysis?

   Answers will vary.

3. Are there aspects of any of the product life cycles that weren’t included in this analysis but would impact their eco-impact?

   Production of the packaging materials (in addition to their disposal), how energy intensive it is to extract different types of materials, what type of energy is being used during the manufacturing stage (coal vs. natural gas vs. renewables), the impacts of maintaining the materials’ source (fertilizers, habitat destruction, etc.).

4. Our human population is rapidly growing. How will this impact the story of our global family’s “stuff”?

   With more people on the planet, there is demand for more products. It is important that we consider ways to reduce the eco-impact of material goods as our population continues to grow.

5. As a consumer, how could you use your knowledge of LCA to decrease your own personal footprint?

   Reduce your consumption of “stuff” – if you don’t buy it in the first place, there is less demand for products to be made. When you do purchase “stuff,” buy products that are locally-made and with locally-sourced materials whenever possible; buy from second hand stores; don’t buy more than you need and don’t buy a replacement until it’s absolutely necessary; support brands that use sustainably managed materials; buy from companies that are making an effort to decrease the eco-impact of their products; buy products with less packaging. Once you’ve purchased an item, unplug it between uses, line dry clothes and cut-down on washing, reuse it or donate it instead of throwing it away after use.

6. Do you think companies should be required to perform LCA’s on their products and to make the results public for consumers? Why or why not?

   Answers will vary.

7. In addition to its eco-impact, what other aspects of a product could a consumer consider before buying it?

   Answers may include: the work environment and wages for the workers who create the product, manufacturing in the U.S. versus abroad, or if a product is fair trade (producers, like farmers, receiving a fair price for their product and their work).
ASSESSMENT

Students pick one item that they are wearing and create a basic flow chart that illustrates that item's life cycle.

FOLLOW-UP ACTIVITIES

1. Ask students to compare and contrast the life cycle of a man-man product with that of a familiar plant or animal.

2. Have students research one of the “analysis” items to see if anything is being done to lower its environmental impact. For example, Nike uses a program called Nike Grind to create sports fields out of pieces of old shoes that were otherwise bound for the landfill.

3. Watch the following videos as a class to give students a real glimpse of what's inside earbuds, LED shoes, and a MacBook pro.
   - How Earbuds are Made – An Inside Look at a Headphone Factory
   - What’s inside LED shoes?
   - What’s inside a Rose Gold MacBook?

Sources: United States Environmental Protection Agency, “Climate Change and Waste.”
SECRET LIFE OF STUFF
STUDENT WORKSHEET

Spend 15 minutes at each station conducting a life cycle analysis of that station’s product. As you move through each stage of a product’s life, rank how you think the product compares to the other three products in regard to that life cycle stage. (Rank of 1 = most eco-friendly within that stage; Rank of 4 = least eco-friendly within that stage) For example, the item that requires the least miles in distribution would rank 1 for the distribution stage.

1. Hypothesis: Which of the four products do you hypothesize will have the smallest eco-impact? Why?

2. Fill out the Life Cycle Analysis chart on the next page. Then answer questions 3-5.

3. Consider your rank of each product along each phase of its life cycle. Do you agree with your hypothesis? Why? If not, which product do you now think has the lowest eco-impact?

4. Choose one product and determine which stage of that product’s life has the biggest environmental impact. What could be done differently during that stage to reduce the product’s overall eco-impact?

5. What might be the challenges of enacting this change? Would any aspect of the product suffer?
# LIFE CYCLE ANALYSIS CHART

<table>
<thead>
<tr>
<th>Product</th>
<th>Materials List</th>
<th>Number of Pieces</th>
<th>Transportation</th>
<th>Resources Required in Use</th>
<th>Average Length of Use</th>
<th>Packaging</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blue Jeans</td>
<td>Rank _____ of 4</td>
<td>Rank _____ of 4</td>
<td>Rank _____ of 4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pair of Sneakers</td>
<td>Materials list:</td>
<td>Number of Pieces:</td>
<td>Transportation:</td>
<td>Resources required in use:</td>
<td>Average length of use:</td>
<td>Packaging:</td>
</tr>
<tr>
<td>Earbuds</td>
<td>Rank _____ of 4</td>
<td>Rank _____ of 4</td>
<td>Rank _____ of 4</td>
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<td></td>
</tr>
<tr>
<td>Lamp</td>
<td>Materials list:</td>
<td>Number of Pieces:</td>
<td>Transportation:</td>
<td>Resources required in use:</td>
<td>Average length of use:</td>
<td>Packaging:</td>
</tr>
</tbody>
</table>
INTRODUCTION

People rely on wood from trees to heat their homes, to cook their food, and to provide building materials and paper for homes, schools, and businesses. The more people there are, the greater the demand for wood. While it takes only seconds to cut down a tree, it takes years to grow a new one. The time it takes for a tree to reach maturity varies and depends on many factors (rainfall, species, and climate). Some trees are slow growers (20-30 years to reach full size) and some are fast (10-15 years). For example, the Red Maple, given the right growing conditions, is a moderately fast grower and could grow 1-2 feet per year once established. We depend on forests to regulate climate, clean the air, filter water, conserve precious soil, and provide homes for many birds and animals. In almost every part of the world, trees are being cut down at a faster rate than they are being replaced.

MATERIALS

For each group:
- Plastic baggie holding 120 craft sticks
- Plastic baggie holding 32 craft sticks
- Watch with second hand
- Forest Chart (provided)
- Graph paper

PROCEDURE

1. Divide the class into groups of four students. Ask students to create a list of:
   a. ways people use wood, both here in the U.S. and around the world
   b. where the wood comes from
   c. how wood is acquired
   
   Answer: Wood is used for building materials, paper, and furniture, or to heat homes and cook food. Wood comes from trees and those trees must be cut down in order for the wood to be used.

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2. For each group, assign the following roles: lumberjack, forest, forest manager, and timer. Tell your students that a town is being developed near a forest and that they will be simulating how trees are harvested for development.

3. Give a baggie of 120 craft sticks to each student representing the forest. These sticks represent the trees in the forest – the supply of trees available to the lumberjack for cutting.

4. Give a baggie of 32 craft sticks to each student representing the forest manager. These sticks represent trees that will grow during the simulation.

5. The forest records the transfer of trees, both those added to the forest and those cut down, for every minute on the Forest Chart.

6. Begin the simulation when the timer gives the signal. After 15 seconds, the timer tells the forest manager to give the forest one tree. Every 15 seconds for the rest of the simulation, the forest manager adds one tree to the forest (that is four trees every minute). In doing so, the forest manager represents the annual growth rate of our hypothetical forest (one minute = one year). This simulates the rate at which trees grow to maturity and become timber reserves in the real world.

7. Stop at the end of the first minute of the simulation and let the lumberjack remove one tree from the forest. The tree represents the amount of wood needed for building materials and other uses in the new town.

8. Continue the simulation. At the end of each succeeding minute, the town’s demand for wood doubles as a result of a growing population. At the end of the second minute, the lumberjack cuts two trees from the forest. At the end of the third minute, the lumberjack cuts four trees from the forest; at the end of the fourth minute, the lumberjack cuts eight trees from the forest; then 16, 32, 64, and 128.

9. End the simulation when the wood reserves in the forest can no longer meet the demands of the lumberjack. At the end of each minute, students should have found the following number of trees available: 123, 125, 125, 121, 109, 81, 21, 0.

10. Tell students to sort the trees back into their original bags (they can simply separate out 32 sticks for the “forest manager” bag and put the remainder in the “forest” bag).

11. Distribute graph paper to students. Explain that graphing situations like that of our forest can give us a clearer picture of the quantity of a resource over time.
12. Students should set up their graph with “Number of Trees” on the y-axis and “Time in Minutes” on the x-axis. Instruct students to use the numbers from their Forest Charts to make a line graph that plots both the number of trees that were cut and the number of trees left in the forest at each minute mark during the simulation. Alternatively, students can create their graph on-line at http://nces.ed.gov/nceskids/createagraph/default.aspx.

Hint: When you create your data set on this site, there will be “seven items” (the minutes) and “two groups” (trees cut down and trees in the forest).

13. Have students suggest possible modifications to the supply (how/why trees are being planted) and demand (how/why trees are being cut) of trees in the forest and run the simulation several more times implementing these changes. Students will discover how changing the supply and demand can impact the fate of the forest and ultimately, will be able to determine a method for sustainable management. Ask your students to determine what human behaviors would need to change in order to achieve their sustainable management strategy.

**DISCUSSION QUESTIONS**

1. How many minutes did it take for the lumberjack to cut all the trees in the forest?

   Just over seven minutes. At seven minutes there were only 21 trees left. In the eighth minute, there would not be enough trees to meet the demand.
2. Was the forest always shrinking? Explain.

No. After the first minute, the forest increased by two trees and stabilized for another minute. After the third minute, the doubling of trees being cut made the forest start to shrink and eventually led to the end of the forest.

3. Do you think this simulation is representative of how real-world forests are harvested? Why or why not?

4. What are some of the dangers of cutting down trees faster than we can plant them?

Answers may include: loss of biodiversity in forest communities, loss of habitat for animals that live in forests, less oxygen, air quality suffers since trees neutralize CO2.

5. In this simulation we looked specifically at logging for development. Can you think of any other reasons why trees are cut down?

Answers may include: clear-cutting for agriculture or ranching, harvesting of a certain fruit (e.g. palm oil).

6. If the forest manager could develop a tree that grows at a rate of one tree per second, would tree growth keep up with timber demand? Why or why not?

No. The doubling of the use of wood due to increased population size would still lead to the demise of the forest. If the simulation was done with 60 sticks given to the forest each minute, it would only increase the life of the forest by two years.

7. What could be done to prevent the demise of the forest?

The forest can be maintained only if we replace what we cut down. This means conserving the use of tree products such as paper, packaging, and lumber. This conservation will become especially important as our global population continues to grow, creating more of a demand for packaging, building, and paper products.

8. What other natural resources do humans use that, if not managed sustainably, could suffer the same fate as the forest?

Answers may include: water, arable land, fish, etc.

**ASSESSMENT**

Students write a short summary that answers the “who, what, where, when, why, how” questions about sustainable forest management.
FOLLOW-UP ACTIVITIES

1. Wangari Maathai (1940-2011) was awarded the Nobel Peace Prize in 2004 for her efforts in conservation. She is a prime example of how to think globally and act locally, as her devotion to planting trees in her home country, Kenya, has turned into a worldwide tree planting movement called the Green Belt Movement. Have your students research Wangari’s conservation efforts and the Green Belt Movement and write a summary on their findings.

2. American poet Ogden Nash (1902-1971) wrote the following verse to describe his feelings about the beauty of trees and the danger they are in:

   "I think that I shall never see
   A billboard lovely as a tree.
   Indeed, unless the billboards fall,
   I’ll never see a tree at all."

   As a class, discuss the meaning of the poem and how, with only a few words, the author has delivered a powerful and memorable lesson. Invite students to write their own short verse about trees. This could be in the form of a limerick, haiku, or other rhyming or non-rhyming verse.

3. Organize a tree planting event at your school or in your community. To organize a tree planting event and secure saplings, contact your local nursery. Alternatively, contact The National Arbor Day Foundation at www.arborday.org for more information.
<table>
<thead>
<tr>
<th>Minutes</th>
<th>Number of Trees at Beginning of Minute</th>
<th>Number of New Trees</th>
<th>Number of Trees Cut</th>
<th>Number of Trees at End of Minute</th>
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