Suggested Time Frame: 2 class periods

Class Period 1

- Engage – Traveling Tomato Game
- Explore – Products' Life Cycle Study

Class Period 2

- Explain – Ecological Footprint discussion
- Elaborate – Greenhouse Gases
- Evaluate – Climate Change Treasure Hunt

Lesson Objectives: Students will be able to:

1. Understand and list at least three steps in product production, or the life cycle of a product.
2. List at least three greenhouse gases.
3. Explain the ecological footprint and impact humans can have, both negative and positive.

Standards: Missouri Standards: Science – Grade 7

- Strand 4: Changes in Ecosystems and Interactions of Organisms and their Environment
  2Ba, 2Bb
- Strand 7: Scientific Inquiry
  1Ba, 1Ca, 1Cb, 1Da
- Strand 8: Impact of Science, Technology and Human Activitiy—applies to grades 9–12
  3Ba, 3Bb

Materials:

Materials Included:

- "Traveling Tomato" game cards
- "The Major Greenhouse Gases" resource page
- Tomato pictures
- Pre and Post Assessment
- "What's That? Impact!" worksheet
- "What Does It Take to Make" resource page

Pass the Tomatoes, Please!

RECYCLING & CLIMATE CHANGE

Suggested Grade Level: Middle School

Program Goal: Students are more aware of the impacts of their choices, particularly related to greenhouse gases and, based on this knowledge, make choices that will have less negative impact.

Concepts Covered: Life cycle of materials; ecological footprint; greenhouse gases; climate change; reduce, reuse, recycle, compost

Engage

Ask the students, *What is one of their favorite things to eat? What do they think are the steps that must happen for you to get that food?*

Let's look at something most people like to eat—pizza!

- What does it take to make pizza?
- What's in that pizza? Dough, sauce, cheese, toppings
- Let's think about what goes into just one part of that sauce—tomatoes!

Play the "Traveling Tomato" game (adapted from *Food Miles: Growing Local Food Connections*; http://www.gardenabcs.com/uploads/foodmiles.pdf).

- Keep the class at their desks. Pass out the first three role cards (of Part One) to three students at the front of the class (the beginning of the tomato journey), and give the last three role cards to three students

at the back of the class (the end of the journey). Everyone else will be the transporters.

- Begin with the student with the # 1 card (Florida Farmer). This person gets the green tomato cut-out. Have that student read the card aloud and follow the directions on their card.
- The "Farmer" passes the tomato to the student holding card #2 (Company Owner/Boss). After reading their card aloud and following the directions on the card, they pass the tomato to the student with card #3 (Truck Driver).
- The "Truck Driver" gets the tomato and reads their card aloud. Once done reading, that student passes the green tomato to the student next to them. The tomato is then passed to each student once as it is "transported". Optional: As each student takes the tomato, they can list a distance it has travelled. (i.e. 100 miles, 200 miles, 300 miles etc.), adding as they go.
- Keep passing the green tomato up and down the rows until it reaches the person with card #4 (Warehouse Owner).
- The "Warehouse Owner" reads their card aloud and then walks the tomato to the teacher's desk. The teacher then discusses how ethylene gas is used to speed up the ripening process of fruits and vegetables shipped from far away. Because many fruits and vegetables are often picked before they are ripe to last the long journey, they need to be ripened quickly once they reach their destination. Ethylene is the plant hormone responsible for changing tomatoes from pale green to pink to red. Ethylene is produced naturally in ripening fruits. Its' presence stimulates further ripening, then aging. The teacher exchanges the green tomato with the red one and hands it back to the student to complete the journey. The "Warehouse Owner" passes the red tomato to the student with card #5 (Grocery Store Owner).
- The "Grocery Store Owner" reads their card aloud and follows the directions on their card, handing the tomato to the student with card #6 (Consumer).
- The "Consumer" reads their card aloud for the class.

Now repeat the exercise, however only with two roles, the "Local Organic Farmer" and the "Consumer". This journey will be much shorter since the farmer lives very close to the grocery store or farmers market and sells directly to the store or consumer. The farmer also only picks his tomatoes when they are ripe for harvest.

- The student with the new card #1a (Local Organic Farmer) starts with the red tomato and reads their card aloud, handing the tomato to the student with card #2a (Consumer).
- That student reads their card aloud for the class.

What was the difference in the two scenarios?

- In the first scenario, the tomato was picked when it wasn't ripe, (so the flavor won't be as good), and then had to travel a long way to get to the consumer. The tomato was also treated with a gas to make it ripen quickly.

- In the second scenario the tomato was picked when it was ripe and travelled a very short distance, which saves fuel.

Explore

Ask the students what they think are the steps, or the life-cycle, in producing a product and getting it to the consumer.* Take answers and try to narrow it to the following general categories:

- Growing and harvesting or removing from the ground = **Extraction**
- Cleaning, preparing for consumption = **Production**
- Shipping = **Distribution**
- Purchasing = **Consumption**
- Disposing of any waste products = **Disposal**

Using the handout, go back to our tomato example. Have the students brainstorm more of what goes into (inputs) and what results from (outputs) each of these steps. This could include:

- Energy and resources used to grow or extract a product
- Fertilizer runoff
- Erosion
- Emissions
- Effects on wildlife
- Labor
- Waste Products

You may want to also have students identify positive consequences of producing and consuming the product, such as economic benefits.

Now have each student choose an item that they use every day and detail it's impact similarly to what you did as a group. Some sample ideas are attached to the worksheet.

Explain

Once the students have completed their research ask them:

** A wonderful resource that gives more information and diagrams the life cycle of a product can be found at http://www.epa.gov/statelocalclimate/documents/pdf/ResourceConservGuide.pdf.*

- *What did they notice?*
- *What do they wonder?*

Ask the students if they've heard of the phrase "**ecological footprint.**" What do they think it means? Explain that a footprint is an impact or mark we leave behind. Therefore an ecological footprint refers to the area of the earth's productive surface, both land and sea, that it takes to support a person's or a population's lifestyle.

Components of an Ecological Footprint include:

- Oxygen—How do we affect the plants around us? (e.g. trees and other plants for absorbing carbon dioxide)
- Food—What do we eat? (e.g. meat, dairy, fish, fruits and veggies, where are they produced?)
- Water—How do we use water? How much do we use? (e.g. drinking, cooking, washing)
- Fiber—What do we wear? What sorts of things do we have in our homes, schools and work-places? What are they made of? (e.g. clothes, wood, upholstery)
- Energy—How much energy do we use? (e.g. fuel for cars, heat for cooking)
- Infrastructure—How do we get around? What kinds of community do we live in? (e.g. highways, hospitals, water facilities)
- Waste Disposal—What do we do with something when we're done with it? (e.g. recycle, compost or landfills)
- Recreation—What do we do for fun? (e.g. soccer fields, golf courses)

Explain that the activity they just completed is a way of starting to analyze that ecological footprint and our impact on the earth, including factors affecting climate change.

After completing their tables, have students brainstorm and list ways to reduce the ecological footprint and other impacts associated with creating or using the object. Give them 5-10 minutes to brainstorm. Students might come up with an alternative to the item, or an alternate way of producing or using it that might impact people and the planet in more positive ways. Ask them to record this information on their sheet of paper.

Note: Be sure to emphasize that this does not mean they have to give up everything they like, but rather should focus on positive ways to reduce their impacts, and acknowledging what they are already doing. For example, instead of saying that people should never drive cars, they could suggest that people ride a bike or carpool to school when possible.

Also, you may want to have students think here about how products can have both negative and positive impacts on consumers. What are ways of consuming products that can have positive impacts on the environment, societies, and/or economies?

Have students present their results and their proposed ideas for reducing the item's negative impacts on people and the planet.

Elaborate

To understand climate change, we need to understand greenhouse gases.

- *What is a greenhouse gas?* Atmospheric gases that trap heat.
- *Where do these gases come from?* Refer to the table of major greenhouse gases.
- *What do they notice about the information in this table?*

Go back to the table each of the students made for their product, and review the inputs and outputs for each of the steps.

- *Can they determine which steps might produce greenhouse gases?*

Next, ask the students to look back at their diagrams.

- *What is the last stage of the process?* Disposal

Look at the Greenhouse Gas Chart.

- *Are there any greenhouse gases produced as a result of the "disposal" stage?* Methane
- *Are wastes only generated in the "disposal" at the end of the process?* No, wastes are generated all throughout the process.
- *What can we do to reduce the amount of methane?*
  - Reduce the amount of products we use, so not as many gases are produced or have to go to a landfill. This is also referred to as "source reduction."
  - Reuse products so that you don't have to purchase as many products, and the ones you do have last longer before being disposed.

    NOTE: "Reduce" and "Reuse" have the greatest impact by cutting waste generation and landfill disposal for the entire life-cycle of the product (extraction, production, and distribution).
  - Recycle as many products as you can. Currently ~25 to 30 percent of waste is recycled, however, 75 percent of what still goes to a landfill can be recycled.
  - Compost organics (leaves, grass, food wastes) to prevent them from going to the landfill where they produce methane as they decompose.

Evaluate

Conduct a "climate change treasure hunt" throughout the school and adjacent school grounds. Give the students a clue to find a particular location on the school grounds – particularly focusing on "3R"(reduce, reuse, recycle)-related objects (i.e. "Your teacher thinks I'm much better than a Styrofoam cup for her morning cup of coffee." Answer: reusable travel or coffee mug. Or, "I can be any shape, material or color, but I can eat most of your garbage no matter what I look like!" Answer: recycling bin). Once the students find the correct location, ask them to think of how these locations can affect the climate—both positive and negative.

Extensions

- An ecological footprint measures environmental impacts, rather than impacts on human societies. Ask the students to refer to their worksheet again and think about what human impacts may be occurring as well.
- CO2 & Methane calculators: Explain to the students that there are many types of calculators available that will estimate their CO2 and Methane production based on their activities. Ask students to complete one of the calculators, and determine ways to reduce their footprints.
  - *http://www.epa.gov/cleanenergy/energy-resources/calculator.html*
  - *http://myfootprint.org/*
  - *http://www.nature.org/greenliving/carboncalculator/*
  - *http://www.epa.gov/climatechange/ghgemissions/ind-calculator.html*
  - *http://www.epa.gov/lmop/projects-candidates/lfge-calculator.html*

Pre and Post Assessment

These questions can be used to assess the students' understanding of the topics covered in this lesson. Ask the students the same questions before and after the unit using the Student Copy Page. Answers are given on the Teacher Answer Page.

Name:_____

Student Copy Page

Pre and Post Assessment Questions for *Pass the Tomatoes, Please!*

Short Answer Questions

1. List 3 (of the 5 possible) main steps in production of a product. (3 points)

2. List 2 benefits to consuming a product made locally. (2 points)

3. List 3 greenhouse gases. (3 points)

4. List 2 components of an ecological footprint. (2 points)

5. List 2 ways to reduce methane gas. (2 points)

Teacher Answer Page

Pre and Post Assessment Questions for *Pass the Tomatoes, Please!*

Short Answer Questions

1. List 3 (of the 5 possible) main steps in production of a product. (3 points)
   - Extraction
   - Production
   - Distribution
   - Consumption
   - Disposal

2. List 2 benefits to consuming a product made locally. (2 points)
   - The product is often better for you and uses fewer resources
   - Less energy is necessary to transport the product
   - The product often has less packaging
   - Supports the local economy

3. List 3 greenhouse gases. (3 points)
   - Carbon Dioxide
   - Methane
   - Nitrous Oxide
   - Ozone
   - Halocarbons/Chlorofluorocarbons (CFCs)
   - Water Vapor

4. List 2 components of an ecological footprint (2 points)
   - Oxygen
   - Food
   - Water
   - Fiber
   - Energy
   - Infrastructure
   - Waste Disposal
   - Recreation

5. List 2 ways to reduce methane gas. (2 points)
   - Reduce
   - Reuse
   - Recycle
   - Compost

Teacher Resource Page

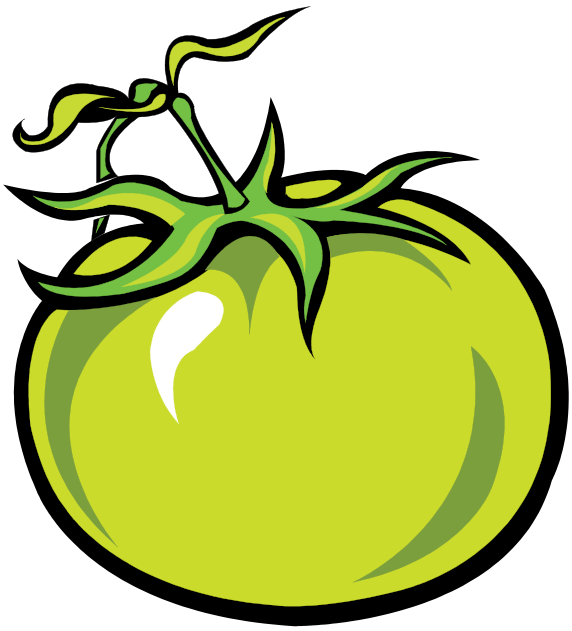
The Traveling Tomato Activity

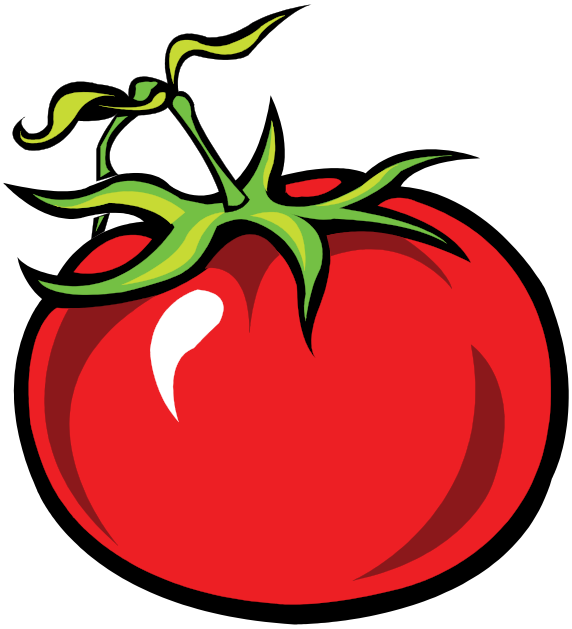
Role Cards for Part 1	
#1 FLORIDA FARMER (HANK) "Look at all these green tomatoes I have to pick today. They're not ripe yet, but I have to pick them anyway. But first I need to spray them with pesticides to kept he bugs away." *Pass green tomato to student with Card #2*	**#2 COMPANY OWNER/BOSS (JUANITA)** "Thank you for the tomatoes Hank. Keep working hard, we have lots of deliveries to make. These tomatoes have to be in St. Louis by next week." *Pass green tomato to student with Card #3*
#3 TRUCK DRIVER (MARK) "It's a long drive to St. Louis. These tomatoes have thousands of miles to travel." *Pass green tomato to student without a card; each student passes tomato to another student without a card (other truck drivers/transportation)*	**#4 WAREHOUSE OWNER (JIM)** "These tomatoes are still green. Before I can deliver them I need to gas them for 24 hours to help them ripen." *Pass green tomato to teacher. Take red tomato from teacher and pass to student with Card #5*
#5 GROCERY STORE OWNER (AUDREY) "Wow, these tomatoes have traveled more than I have! It seems strange to buy a product from far away that we could have grown in our own region." *Pass red tomato to student with Card #6*	**#6 CONSUMER (OWEN)** "Here I am in the grocery store. I need to find some tomatoes to make spaghetti sauce. Here's one…it's kind of hard, and from far away…but it's the only tomato available." *End*

Role Cards for Part 2	
#1A LOCAL ORGANIC FARMER (ETHAN) "I've been taking care of this tomato since I planted it in the spring. Now it's red and ripe to pick. Tomorrow I'll take it to the local market and sell it to someone from the community." *Pass red tomato to student with Card #2a*	**#2A CONSUMER (LUCAS)** "I love coming to the farmer's market…look at this beautiful produce! I also get to see friends, and meet new people from the community. Hi Ethan, your tomatoes look great! I think I'll buy some for lunch." *End*

Teacher Resource Page

The Traveling Tomato Activity





Name:_____

Student Copy Page

What's That? Impact!

	PRODUCT #1: TOMATO	PRODUCT #2:
EXTRACTION Growing & Harvesting or Removing from the Ground	Input	Input
	Output	Output
PRODUCTION Cleaning & Preparing for Consumption	Input	Input
	Output	Output
DISTRIBUTION Shipping	Input	Input
	Output	Output
CONSUMPTION Purchasing	Input	Input
	Output	Output
DISPOSAL Disposing of Waste Products	Input	Input
	Output	Output

Name:_____

Student Copy Page

What's That? Impact!

My ideas for decreasing the ecological footprint are:

Resource Page

What Does It Take to Make

From Facing the Future *Mapping the Impact* lesson (http://www.facingthefuture.org)

CUP OF COFFEE

Beans

- Beans grown in Colombia
- Pesticide from Germany applied to beans
- Beans roasted in New Orleans

Sugar and cream

- Sugar produced in Florida
- Cream from dairy near Seattle

Disposable Cup

- Made from 10% recycled paper
- Virgin paper from trees grown in Canada
- Cup lined with a thin layer of plastic, made from oil drilled in Venezuela

COMPUTER

Computer Chip

- Made of silicon minded in Washington State
- Silicon processed in Oregon
- Sent to chip manufacturer in California
- Copper from Arizona and gold from South Africa applied to chip

Circuit Board

- Made of tin from Brazil and lead obtained from recycled car batteries in Houston

Monitor

- Assembled in Japan
- Plastic created from oil drilled in Saudi Arabia and processed in the U.S.

BICYCLE

Metal Frame

- Recycled steel from Chicago
- Manufactured and painted in Wisconsin

Aluminum gears, brakes, and spokes

- Made from ore minded in Australia and smelted (where metal is pulled from the ore) in Russia
- Manufactured in Japan

Tires

- Synthetic rubber made in Taiwan from petroleum

Resource Page

What Does It Take to Make, continued

From Facing the Future *Mapping the Impact* lesson (*http://www.facingthefuture.org*)

NEWSPAPER

Newspaper is made of recycled and virgin paper

Virgin Paper

- Trees grown in British Columbia

Recycled Paper

- Recycled paper processed in Michigan

Assembly

- Virgin and recycled paper are made into newsprint in a Detroit paper mill
- Ink
- Made from petroleum drilled in Gulf of Mexico

T-SHIRT

T-shirt is 50% cotton/50% polyester

Polyester

- Crude oil drilled in Venezuela
- Crude oil refined in Curaçao
- Refined oil processed in Delaware to create polyester fiber

Cotton

- Cotton grown in Mississippi
- Cotton fibers spun into yarn in North Carolina

Assembly

- Shirt sewn in Honduras

ATHLETIC SHOES

Athletic shoes are made of leather and synthetics

Leather

- Cow raised in Texas
- Cow hides shipped to South Korea for tanning (to make leather soft and durable)

Synthetics

- Synthetic insole made of oil drilled in Saudi Arabia and refined in South Korea
- Synthetic rubber sole made of oil drilled in Saudi Arabia and refined in Taiwan

Cardboard Box

- Made from recycled paper in New Mexico

Resource Page

The Major Greenhouse Gases

From "Teaching About Climate Change." *Green Teacher*. 2008

Gas	Contribution to the Greenhouse Effect	Increase since 1750	Heat-trapping ability (in relation to CO_2)	Lifespan in atmosphere (years)	Sources
CARBON DIOXIDE (CO_2)	53%	31%	1	50-200	Respiration; decomposition; forest fires; evaporation from oceans; burning of fossil fuels
METHANE (CH_4)	17%	151%	25	10	Underground deposits (natural gas is mostly methane); respiration by anaerobic decomposers living in wetlands, rice paddies and the digestive tracts of ruminant animals and termites; landfills
NITROUS OXIDE (N_2O)	5%	17%	200	150	Microbes that break down organic matter in soils; nitrogen fertilizers; burning of fossil fuels and wood
GROUND-LEVEL OZONE (O_3)	13%	36%	2,000	weeks	Very small amounts naturally present atmosphere; formed photochemically when nitrogen oxides and volatile organic compounds in automobile exhaust react in sunlight
HALOCARBONS (CFCs)	12%	None in 1750	Up to 10,000	60-100	Human-made compounds used in refrigerators, air conditioners, foam products, aerosol sprays. There are no natural sources

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