MARIE SELBY BOTANICAL GARDENS

E³: ECOSYSTEMS, ENERGY FLOW, & EDUCATION

# Endangered Earth: Human Impact on the Environment

Eco-systems, Energy Flow, and Education:

# Endangered Earth: Human Impacts on the Environment

## CONTENT OUTLINE

Eco-systems, Energy Flow, and Education:

# Endangered Earth: Human Impacts on the Environment

**GRADE LEVEL:** K-12

**SUBJECT:** Science *(includes interdisciplinary Common Core connections & extension activities)*

**BIG IDEA/OBJECTIVE:** To help students broaden their understanding of the role human activities play on the natural environment. Through completion of these units, students will explore and measure human impact on the environment through monitoring on-going experiments in the scientific community and conducting their own hands-on investigations.

## UNIT TITLES/DRIVING QUESTIONS:

*(Please note: many of the activities span a range of age levels and overlap eachother beyond that specifically listed and can be easily modified to meet the needs of diverse learners)*

(K-3) "Helping & Harming Habitats"
"What can I do to keep habitats healthy?" *(Habitats)*

(3-6) "Alien Invaders"
"How do non-native species impact our ecosystem?" *(Ecosystems & Resource Competition)*

(4-8) "My Human Footprint"
"How are my choices effecting the Earth?" *(Environmental Vulnerability & Energy Flow)*

(6-12) "Bodacious Bioindicators"
"What can lichen health tell us about our environment?" *(Ecosystems & Adaptations)*

## IN-FIELD RESOURCES:

*When you visit Selby Gardens, we have a number of interactive standards-based field opportunities to supplement your students' academic adventure, including:*

- **Fantastic Florida: Florida's Native Plants:** Identify the plants and animals that live along our coast. Investigate the contents and benefits of estuaries and adjoining mangrove forests. With a focus on Florida native plants such as mangroves, sea grapes, sea grasses and other coastal plants, students will learn how these plants are connected to land and sea. A mangrove leaf sorting activity will help students identify the three types of mangroves native to Florida. **(K-12)**

## IN-FIELD RESOURCES (Continued):

- **Plant Parts: Flower Dissection:** Learn plant parts in a fun, engaging way. A good way to learn about the reproductive parts of a plant is by dissecting a flower. Identify the many parts of a flower by carefully disassembling it piece by piece with the use of high quality visuals. Add-on for middle school and above - Name that plant! Classify the plants around you with a simple dichotomous key. By looking at characteristics of a plant and using a dichotomous key, you can identify most living things to the species. The term "dichotomous" means to divide into two groups that are not alike. **(3-12)**

- **Leaf/Algae Lab:** By clipping a variety of leaves of all shapes, sizes and colors just before the tour, kids can see the variety of leaves throughout the garden. Using flat crayons and paper folded in half, children reveal the texture of different plants while taking a closer look. Discussions can surround leaf veins, vascular vs/ non-vascular plants, the purpose of leaf shapes (i.e.: bo tree's drip tip), etc… Preserves samples of various Algae species are also available for investigationn and crayon rubbings. **(K-8)**

- **Soil Dissection:** By scooping distinct types of soil into two buckets, children can examine what makes up the soil while observing the types of plants that grows in either type. The bo tree on the south point of the gardens is a great place to demonstrate sandy, coastal soil vs. one with more humus and other organic matter. Have students sort through soil using toothpicks and record what they see. Components include organic matter such as dirt, leaf and plant debris, animal excrement and decaying animal bodies (insects, etc…), and humus. Inorganic matter such as shell, rock, and sand and silt can also be found. **(3-12)**

# Endangered Earth: Human Impacts on the Environment

## BACKGROUND INFORMATION:

*(Adapted and excerpted from National Geographic http://www.nationalgeographic.com/earthpulse/human-impact.html and SKWIRK* http://www.skwirk.com/p-c_s-57_u-520_t-1393_c-5363/qld/sose-geography/a-question-of-balance-australian-environments/civilisation-and-the-ecosystem/human-impacts-on-the-environment)

Human Impact on the Environment (HIE) Overview:

Humans have altered the face of the Earth more than any other species, and the pace of change is increasing. While many animals (ants, beavers, elephants, etc.) shape their surroundings and remake their environments to suit their purposes, no species has been as thorough or as global about it as humans. Our most obvious impact is on the land, where more than 80% of Earth's surface has been marked by human activity. Our terrestrial transformations go back at least to the beginnings of agriculture more than 10,000 years ago.

Over the centuries, population growth and improved transportation have driven humans to control ever-widening tracts of land, with grave consequences for the species and habitats there. We've left our mark on Earth's air and water as well. Exhaust and emissions from transportation and industry have fundamentally changed our atmosphere, while oceans, lakes, and rivers suffer from our pollution and overfishing. Humans' impact on Earth is not always harmful though. Parks, farmlands, and wilderness areas allow human use while preserving natural habitats. But our role in shaping the Earth is powerful, and the human footprint continues to expand.

Biodiversity:

Humans alter the earth by adding cities, cars, and pollutants; by removing natural vegetation and wildlife; and by introducing non-native species to new areas. The spread of urbanization and industry is slowly closing off the ecological corridors that allow animals to roam freely through the natural environment. While these changes make life more comfortable for us, they can have a significant negative impact on the natural environment. To maintain the delicate balance of biodiversity, we need to be aware of how the daily lives of humans impact the biophysical environment. Here are three primary threats to biodiversity:

1. Habitat alteration and destruction (deforestation) - clearing land for homes, industry and agriculture is the biggest threat to the delicate balance of biodiversity. Deforestation leads to erosion of the land and fragmentation of natural environments.
2. Introduction of new species - non-native species often take over land and compete with the natural species for food, ultimately decreasing biodiversity.
3. Pollution and climate change - pollution kills species through short-term effects like the use of pesticides and long-term effects like climate change.

# Endangered Earth: Human Impacts on the Environment

Interrelationships**:**

The Earth has limited resources to support the organisms that live on it. Increasing human population exerts great pressure on many limited resources and depletes those resources which can not be renewed. Many different natural processes occur within those ecosystems influencing humans. Some of these processes include atmospheric quality, soil generation and conservation, energy flow, the water cycle, waste removal and recycling. Human activities are altering the equilibrium involved in these natural processes and cycles.

Technological Developments & Improvements:

Human activities which disrupt ecosystems have resulted in a loss of diversity in both living things and the nonliving environment. Many environmental risks are associated with our use of fossil and nuclear fuels. Many factors associated with human populations have influenced environmental quality. These include population growth and distribution on our planet, our use of resources, the ability of technology to solve environmental problems, as well as the role of economic, political, ethical, and cultural views in solving these problems. Individual choices and the actions of society can contribute to the improvement of our environmental problems. Moving forward, our choices must include an assessment of the risks, costs, benefits, and trade-offs of new technologies and continued human expansion. All changes and proposed improvements need to consider both the human and environmental impact of the change.

***IMPORTANT NOTE TO THE TEACHER:*** *The preceding investigations are inquiry and project/lab-based. As you progress through each lesson, evoke student curiosity and wonder through hands-on experiences. Asking open-ended questions will develop their ideas and awareness about heat variations in relation to the sun. Resist the temptation to give the correct answer right away -- "thinking time" will encourage contemplation and wonder. Accept all reasonable answers and encourage students to speculate and elaborate on their responses. Allow the students' collective excitment to guide the development of the lesson. All lessons can be modified to reach many K-3 standards, regardless of the age group the lesson is listed under. While undergoing data collection, be sure to verify the accuracy of the data to ensure the validity of your investigation. If you have questions or would like additional support, contact education@selby.org.*

Eco-systems, Energy Flow, and Education:

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# KINDERGARTEN - THIRD GRADE

(Habitats)

## "Helping & Harming Habitats"

*(The original "Fred the Fish" activity, from which this was adapted, was published in Water, Stones, & Fossil Bones and was written by Karen Lind, National Science Teachers Association, 1991, ISBN 087355101X.)*

**Description:** While accompanying "Fred the Fish" as he travels down stream, students participate in a simulation of a river becoming polluted. As the simulation plays out, different items are added to Fred's water habitat to represent various pollutants. The pollutants come from numerous real-life sources ("cause"), resulting it an increasingly polluted environment for Fred ("effect"). Students will explore the means of preventing water pollution problems before they occur, discuss solutions to the problems that water pollutants pose to our water sources, and identify organisms that depend on water for survival.

**Driving Question:**

"What can I do to keep habitats healthy?"

**Objectives:**

- Students will identify cause and effect of water pollution. They will also explore means of preventing the problems before they occur, solutions to the problems that water pollutants pose to the river, and organisms that depend upon the river for survival.
- Students will ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool. *(K-2-ETS1-1)*
- Students will use tools and materials provided to design and build a structure that will reduce the warming effect of sunlight on Earth's surface. *(K-PS3-2)*
- Students will analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs. *(K-2-ETS1-3)*
- Students will communicate solutions that will reduce the impact of humans on the land, water, air, and/or other living things in the local environment. *(K-ESS3-3)*
- Students will construct an argument with evidence that some changes caused by heating or cooling can be reversed and some cannot. *(2-PS1-4)*
- Students will use evidence to support the explanation that traits can be influenced by the environment. *(3-LS3-2)*

## Materials:

- Enlarged copy of each part of the script *(available in the appendix)*, laminated to card stock, for students reading the script. It helps to highlight the reading part in one color and the doing part in another.
- A copy of the script for each child (allowing them to follow along as the simulation takes place). *(For children below third grade or with limited reading ability, consider either reading the script for them, or presenting it through story telling)*
- Light colored sponge
- Permanent marker to draw a face on Fred
- Thin fishing line
- Needle with a large eye
- Weight, either a washer or small lead sinker work well
- Pencil (with flat sides) or a tongue depressor, longer than the mouth of the container
- Tape
- Clear gallon jar or container
- Water
- Paper towels
- Long-handled spoon or stick to stir the contents
- 3 plastic spoons
- Two sets of Index cards, numbered 2-9, One set folded so they will stand in front of the pollutants, the other set for 8 children who will add that pollutant to the container
- Garden soil - "eroded soil" (Script card 2)
- Powdered milk - "fertilizer" (Script card 3)
- Cooking oil - "car oil" (Script card 4)
- Rock salt - "road salt" (Script card 5)
- Small pieces of foil, plastic wrap, paper, etc. - "trash" (Script card 6)
- Liquid laundry detergent - "factory stuff" (Script card 7)
- Red food coloring - "sewage" (Script card 8)
- Green food coloring - "hazardous waste" (Script card 9)
- Word bubbles (optional)
- Comic strip blanks / response sheets (optional)

## Procedures

### PREPARING “FRED” AND HIS TANK

1. Cut a small fish shape from the sponge. Draw a face for Fred
2. Cut a piece of fishing line approximately 60 cm long. (This will depend on the size of your container.)
3. Thread the line onto the needle and draw the line through the fish shape. The line should stick out below the belly of the fish, as well as above the fish.
4. Fill the container with water, allowing some space at the top. Tie the weight to the line below the fish.
5. Tie the line above the fish to the middle pencil or tongue depressor. You will need to adjust the line so Fred is suspended in the middle of the container.

### PREPARING THE “POLLUTANTS”

1. Arrange the "pollutants" beside Fred's habitat.
2. Place the corresponding numbered index cards in front of the containers.
3. Put plastic spoons in the soil (#2), fertilizer (#3), and road salt (#4).
4. Keep paper towels nearby

**THE ACTIVITY**

1. Introduce the activity by introducing Fred. This can be done in various ways, much of which depends on the age of the students. A possible introduction might read: "Students, I would like you to meet a little friend of mine named Fred. Fred is a fish who spent most of his life in a clean, mountain lake, until one day he decided to venture from his lake, downstream. He's lucky, and so are you, because he lived to share his adventure with you. Are you ready to hear about his adventure?"

2. Distribute the script cards, and the index cards to students. Due to the fact that some words may be difficult for students with limited reading ability, be cautious when distributing the script cards. Script card #10 can be optional. If it is used, resulting discussion can include what the children think happens to Fred, what Fred should do, and how the described environmental problems can affect humans.

3. Begin reading the script cards and adding the pollutants to Fred's habitat. Pick some students to read the cards and others to add the "pollutants." The question, "HOW IS FRED?" should be used to initiate class discussion after each pollutant is introduced to Fred's habitat.

*PLEASE NOTE: CARE SHOULD BE TAKEN WHEN DISCARDING THE WATER USED IN THIS ACTIVITY. THE CONTENTS SHOULD BE POURED THROUGH A STRAINER SO THE SOLID MATERIALS AND OIL DO NOT CLOG THE DRAIN.*

## Assessment / Learning on Display

- Oral or written quiz on concepts and key terms
- Once familiar with the activity, student can reenact it for an audience (in various forms, i.e. a skit, a drawing, song, etc.)
- Comic strips/cartoons can be shared

## Related Key Terms

- Habitat: a place that provides living things what they need to survive (food, water, and shelter)
- Environment: surroundings of an organism
- Organisms: living things
- Pollutants: substances that hurt organisms and the environment

## Cross-Curricular Extensions:

- **Social Studies / Language Arts**: Literature Connection: *A River Ran Wild*, can be used to attach Fred to real-life scenarios as it focuses on the revitalization of the Nashua River. Not only could Fred's adventure take place, but it has!

- **Language Arts**: Students can color and cut out Fred (*see appendix*). In the word bubble, they can write what they think Fred might say after surviving his adventure.

- **Language Arts / Visual Arts:** Make a comic strip representing Fred's adventure

- **Visual Arts**: A wall mural of Fred's adventure can be made for the classroom

- **Science Demonstartion**: A homemade water filter, using sand and charcoal, can be made to filter the water. This demonstrates how water is purified naturally as it passes through the soil. *(See Resources for details)*

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# THIRD - SIXTH GRADE

(Ecosystems & Resource Competition)

"Alien Invaders"

**Description:** Students will explore the impacts that invasive species may have on native species and habitats, and will investigate some of the most common methods used to control invasive species. Students will independently research and prepare 'case studies' for different invasive species which can be used as a basis for wider classroom discussion and collaboration.

## Driving Question

"How do non-native species impact our ecosystem?"

## Objectives

- Students will explore the issue of invasive species and will learn to differentiate between invasive species and introduced species. Students will investigate the impacts that invasive species have on the environment, including the effects that they have on native species and habitats, and will discuss the characteristics that make certain species good invaders. Students will make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change. *(3-LS4-4)*
- Students will construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems. Students will undertake independent research to prepare a 'case file' for a different invasive species, and will use the information they have collated to participate in a class or group discussion on the impacts of invasive species. *(MS-LS2-2)*
- Students will use evidence to support the explanation that traits can be influenced by the environment. *(3-LS3-2)*
- Students will evaluate competing design solutions for maintaining biodiversity and ecosystem services. Students will think about the different ways in which invasive species can potentially be controlled, and will look at an example of successful invasive species management efforts in Southwest Florida. *(MS-LS2-5)*

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## Materials:

- Interactive whiteboard or projector
- Computer / internet / projector
- Invasive species PowerPoint presentation
- Invasive species - case study template (one per student)
- Invasive species - suggested species list (or http://www.eddmaps.org/florida/species/)
- Computers or laptops with internet access for student research

## Procedures:

Preparation:

- Download the invasive species PowerPoint presentation from http://www.arkive.org/education/teaching-resources-11-14
- Ensure there are enough laptops/computers with internet access for students to work alone or in pairs when they are carrying out research for their case study.
- Print the case study template (one per student/student group).
- Assign students a species to research, or allow students to pick their own species from the list. The suggested species list is not exhaustive and is intended to help you as a guide or starting point. If you prefer, you could allocate students different invasive species that are found in your local area/country to allow them to explore how the issue of invasive species may be impacting the species and habitats with which they are familiar. A list of Florida's invasive species can be found here: http://www.eddmaps.org/florida/species/

1. Begin by introducing the theme of the session. Elicit students' prior understanding of terms such as invasive species, alien species, non-native species, and introduced species, to assess their prior level of subject knowledge. As an optional activity, have the class read the ARKive blog to find out more about making the distinction between alien and invasive species: http://blog.arkive.org/2011/07/in-the-news-making-the-distinction-between-alien-and-invasive-species/.
2. Work through the PowerPoint presentation to introduce students to examples of invasive species, the characteristics that make certain species successful invaders, the different ways that species can be and have been introduced to new environments, and the impacts that invasive species may have on non-native environments. See notes on the PowerPoint slides for further guidance and information.

3. Before moving on to the main activity, introduce students to some of the different ways that invasive species could be controlled outside of their native environment and explore examples of successful invasive species control, including a focus case study Australian Pines along the Gulf Coast (http://www.eddmaps.org/florida/species/subject.cfm?sub=3268). The Australian Pine *(Casuarina cunninghamiana)* is an allelopathic species. It releases toxins through its root system and abundant leaf litter that quickly render an area uninhabitable for other trees and vegetation. (*Coastal clean-up and removal of Australian pine seedlings can be organized through the Sarasota Bay Estuary Program & through Lido Beach Residents Association*).
4. Following the presentation, assign each student a different invasive species, or allow them to choose their own. You can either use the list provided, or you could compile a list of your own if you would prefer to focus more on the impact of invasive species in your country or local area. See http://www.eddmaps.org/florida/species/ for Florida species list.
5. Ensure each student has access to the internet, books, journals, newspaper articles and any other relevant materials that will enable them to research information on invasive species. Students should compile a case study which includes the common and scientific names of their allocated species, as well as detailed information about where the species is indigenous, where (besides Florida) it has been introduced, how the species was introduced, what impact the species is having on native species and habitats, and what management or control measures are currently in place (if any). Students should gather supporting material for their 'case file' including photographs, newspaper articles, maps of where the species has become invasive, etc.
6. To finish the activity, students should use the information they have collected on the species to give the species an 'invasive rating'. Based on their research and observations, students should fill in the assessment section of the case file, discussing the extent to which their species is causing a problem for the ecosystem that it has invaded. Students should attempt to give the species an 'invasive rating' using a scoring system between 1 to 5, based on how seriously this species is impacting native species and habitats and how hard it is to control (5 = species is not very invasive and/or is easy to remove, 1 = highly invasive and/or difficult to eradicate). Based on their research, students should also suggest whether there are any additional management or control measures that could potentially be appropriate for their species.
7. To conclude the session, have students engage in a group or class discussion on the impacts of invasive species. Students should compare the species they have each researched with other invasive species, and as a class should try to rank their selected species in order of their invasive impact, starting with the species that has the worst effect on non-native species, habitats or ecosystems. Students should write down the list of species in order and justify their reasons for the placement of each species on the list.

## Assessment / Learning on Display:

- Students could design and prepare posters or presentations, or could participate in a debate arguing for and against the use of biological control, drawing on the examples of successful and unsuccessful case studies to support their argument
- Photodocument your community service project and share with your community to inspire their own contributions

## Related Key Terms:

- Invasive Species: a non-native organism brought to live somewhere other than its original habitat that competes with (or takes over) native species
- Indigenous: an organism originally from an area
- Ecosystem: a biological community of organisms interacting with their physical environment

## Cross-Curricular Extensions:

- **Mathematics**: Use real-life data to chart the impact of invasive species in your area
- **Language Arts:** Create a comic strip depicting the impact of non-native species in the wild
- **Community Connection:** (Coastal clean-up / removal of Australian Pine seedlings along North Lido Beach can be organized through the Lido Beach Residents Association and the Estuary Bay Program).

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# FOURTH - EIGHTH GRADE

(Energy Flow & Environmental Vulnerability)

## "My Human (Consumer) Footprint"

**Description** Students will be exposed to the statistical amount of goods they consume over the course of a month/year/lifetime and will conduct an experiment to gather actual data about their consumption. They will investigate the impact their consumption has on the natural world and the "perils of plastic" as a consumer by-product. Following their experiments and research, students will create engaging infographics to share their findings with the school student body and local community.

### Driving Question

"How are my choices effecting the Earth?"

### Objectives

- Students will generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans. *(4-ESS3-2)*
- Students will obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment. *(5-ESS3-1)*
- Students will construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations. *(MS-LS2-4)*
- Students will evaluate competing design solutions for maintaining biodiversity and ecosystem services. *(MS-LS2-5)*
- Students will apply scientific principles to design a method for monitoring and minimizing a human impact on the environment. *(MS-ESS3-3)*
- Students will analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success. *(MS-ETS1-3)*
- Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems. *(MS-ESS3-4)*

## Materials

- internet access
- measurement tools (scales, etc. - will vary)
- receptacles to collect gathered recyclable trash
- copies of video response sheet *(see appendix)*

## Procedures - Part One

**DAY ONE**

1. Preview the upcoming lesson by having the students brainstorm and respond to the following question: "In what ways do you think your life as an individual impacts the natural environment (earth)?" Consider making it a competition (for small groups or as individuals) that whoever thinks of the most ways receives something -- bragging rights, a high-five, bonus points and homework passes work well.

2. (Flipped Lesson Plan) Before beginning the lesson, assign the students to watch the following three video segments (thirty minutes total) for homework and to answer the following questions about it. *(See appendix for accompanying worksheet -- can be uploaded and shared into google drive to avoid consuming paper.) (The first three segments center around increasing our awareness to the amount of foods we consume.) A student version of the reponse questions can be found in the appendix.*

   Part one: http://www.youtube.com/watch?v=ZQdejn_RxBQ

   *Questions:*

   #1) What are some of the ways infants in the U.S. consume the natural resources? (milk/diapers

   Part two: http://www.youtube.com/watch?v=CoLjkTb81rA

   *Questions:*

   #1) How do "convenience foods" impact the environment? (all the packaging/ingredients)

   #2) What's the significance of eating animal products? (meat/eggs)

   #3) What are the kinds of carbs the video discusses us eating? (potatoes and bread)

   Part three: http://www.youtube.com/watch?v=y6IpHjQfcvs

   *Questions:*

   #1) Approximately how many loaves of bread will you consume in your lifetime? (lifetime being averaged at 77.9)(4,376)

   #2) How much candy will you eat on average in one year? (25 pounds)

   #3) Why does it matter if we eat fruits/vegetables that are out of season?

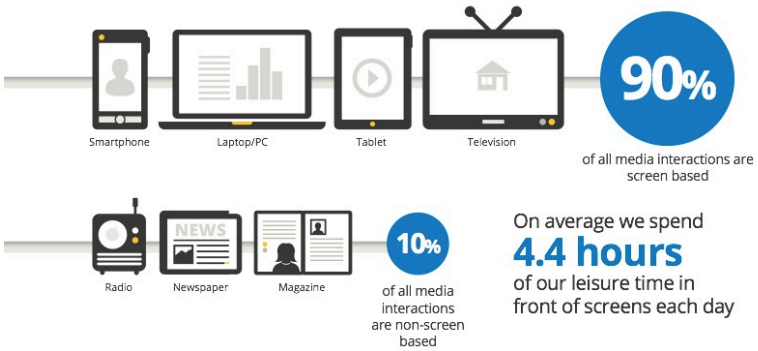
   #4) How much trash does one person create in our lifetime? (29,700 pounds)

   #5) How many cans of soda will the average American consume in their life? (43,371 cans)

**DAYS TWO - ONE WEEK**

3. Class Research: Tell Students that they are going to collect their recyclable trash for a week.
4. Students should only bring in “clean” trash -- meaning, all containers should be rinsed and dried as needd.
5. (Optional) Consider putting parameters on the experiment by specifying the trash must be from lunch at school only, only from home, etc
6. After one week, have students measure and weigh the accumulated trash.
7. Have students calculate how that amount would translate to one month, one year, etc.

8. Extension (optional/for older students): Once class experiment has been completed, have students set-up an addtional science experiment to test just how much of the item they are actually using (as individuals, a class, a school) and measure/collect the data over a 1-3 month period. Students should follow the basic steps of scientific inquiry and be very intentional about isolating their variable so that their data is accurate. Some items will be more difficult to measure than others. (have class select one or more of these to track -- can be done as individuals, small groups or as a whole class depending on the interest and ability levels of the students) You might also consider tracking one as a class and having the students track other consumer goods afterwards). Potential items to track (as shared by the film) include:
    - waste (trash)
    - sugar consumption
    - bananas / oranges
    - milk
    - carbs
    - meat
9. After competion of experiments, have students analyze and graph their data. Introduce concept of computer generated infrographics and encourage students to apply their findings and extrapolate them into inforgraphics like the examples below:



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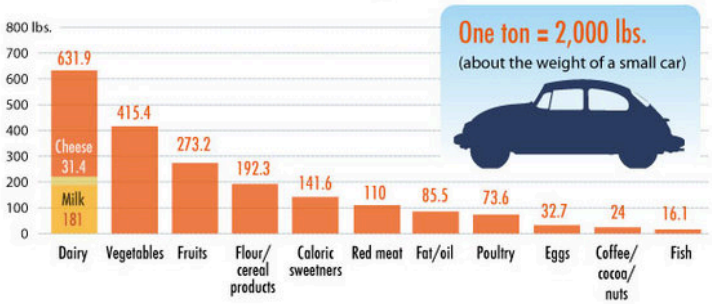
## Eating a Ton of Food

GoFigure!

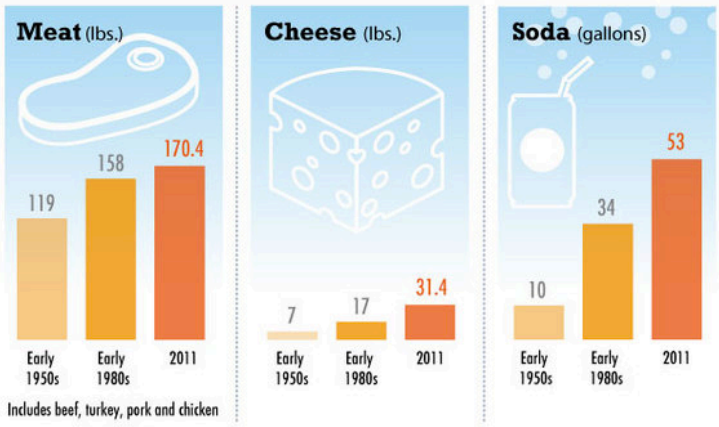
The average American ate 1,966.3 lbs. of food in 2011, nearly a ton, according to USDA's Economic Research Service.

Credit: Dreamstime.com

### Breakdown of food consumption in the US in 2011




### Increases in consumption per year




SOURCES: MENSHEALTH.COM, UNITED STATES DEPARTMENT OF AGRICULTURE

R. TORO / © LiveScience.com

## Procedures - Part Two (*Adapted from National Geographic's "Perils of Plastic" Activity)*

1. Introduce students to the lesson by explaining that over our lifetime, each of us (as United States citizens) throws away nearly 15 tons of packaging. Much of this packaging ends up in the ocean, and much of it is plastic. As plastic ages, it breaks into pieces (called "nurdles" or "mermaid tears"). Unfortunately, many of these pieces get consumed by sealife resulting in sickness and death which weakens the ocean's ecosystem.
2. Distribute "Perils of Plastic" handout
3. Allow student groups time to read (or read aloud together)
4. Watch David de Rothschild in action on this (4 minute) TEDx video: http://www.youtube.com/watch?v=IjcUT1LjOgk
5. Following their completion of the "Perils of Plastic" activity, ask students to share what they learned from the reading, activity, and video:
   a. Why is plastic harmful to the environment?
   b. What could people do to produce less trash?
   c. What was the point of the Plastiki?
   d. What is David de Rothschild's opinion about what it take to make a difference in the world?
   e. What does it mean that "nobody is as smart as everybody"?
6. Visit http://theplastiki.com/
7. Brainstorm possible idea of what we can do to make a difference?

## Assessment:

- Participation in collection and "weigh-in of recyclable trash
- Extrapolation one week's worth of recycled trash to a year and ten years
- Made a personal connection between personal consumption and how the waste we generate can have a negative impact on the environment

## Learning on Display:

- Student created infographics of human consumption/wastes, measured over a two month span, projected to a year, five years, etc.
- Creation of public art from non-recyclable trash (as visual reminder of weekly wastes)
- Potential beginnings of new project (designed by students) to reduce wastes and make a positive environmental impact

# Endangered Earth: Human Impacts on the Environment

## Related Key Terms:

- Human Footprint: the mark we all leave on the world just by living in it
- Consumer: someone who buys/uses goods/services for their own use
- Infographic: a visual image such as a chart or diagram used to represent information or data
- Ecosystem: a biological community of interacting organisms and their physical environment

## Cross-Curricular Extensions:

- **Geography**: Make connections between human impact and geographic factors: http://education.nationalgeographic.com/education/activity/mapping-our-human-footprint/?ar_a=1
- **Technology/Math:** Take an online quiz to assess your carbon footprint (requires calculations): http://www.myfootprint.org/
- **Conservation:** Green Classroom Audit: http://www.melodyshaw.com/files/student-info-sheet_1_.pdf
- **Visual Arts:** creation of public art from non-recyclable trash (as visual reminder of weekly wastes) Here are some examples:

Eco-systems, Energy Flow, and Education:

## Endangered Earth: Human Impacts on the Environment

# SIXTH - TWELVETH GRADE

(Ecosystems & Adaptations)

## "Bodacious Bioindicators"

**Description:** Students will observe, study, and chart lichen populations on trees located on their school campus (or on-site at Selby Gardens) to monitor air quality. Data will be incorporated into a geographical information systems (GIS) database to demonstrate how it can be used to map communities' environmental health. Student teams will count the number of each lichen type within a grid placed on each tree trunk sampled and enter the information into a GIS database. Once data is collected, students will create maps of lichen populations at each sample site and write abstracts about their research.

**Driving Question:**

"What can lichen health tell us about our environment?"

**Objectives:**

- Students will construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations. *(MS-LS2-4)*
- Students will evaluate competing design solutions for maintaining biodiversity and ecosystem services. *(MS-LS2-5)*
- Students will apply scientific principles to design a method for monitoring and minimizing a human impact on the environment. *(MS-ESS3-3)*
- Students will use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity. *(HS-ESS3-6)*
- Students will use mathematical representations to support explanations of factors that affect carrying capacity of ecosystems at different scales. *(HS-LS2-1)*

## Additional Background Information:

*(taken from the JOURNAL OF MICROBIOLOGY & BIOLOGY EDUCATION, May 2009)*

Lichen Classification:

The Greek philosopher Theophrastus first coined the word lichen in about 300 B.C. to describe the plant-like outgrowths that he observed on olive trees (5). These outgrowths are actually mutualistic associations between two very distinct organisms, an ascomycete fungus (mycobiont) and a microscopic green alga or cyanobacterium (photobiont) (5, 6). The two symbionts come together to form a structure called a thallus that looks completely different from either the fungus or the alga growing independently. The thallus functions as a single organism with the fungus providing most of the physical structure and living off the carbohydrates produced by the alga's photosynthesis.

Three major categories of lichens typify most environments, namely crustose, foliose, and fruticose (1). Crustose lichens adhere closely to the surface to which they are attached and appear "crusty" in nature, as if they are painted on the surface. Foliose lichens are leafy and have an upper and lower fungal surface, attaching loosely to surfaces. Fruticose lichens appear string-like or may have hollow, upright stalks.


***a foliose lichen***

***a crustose lichen***

***a fruticose lichen***

Importance of Lichens: Lichens have important ecological and beneficial roles in local environments (1, 12). Lichens are used as sources of dye, food, and medicine. They are the primary colonizers of rocks, producing acids to break down the rocks to form soil. It is their sensitivity to air pollution, though, which is often capitalized upon in ecological studies.

Lichens are sensitive to a variety of air pollutants, including sulfur dioxide, nitrogen dioxide, and ozone (4). Lichens also accumulate heavy metals and radionuclides, making them useful bioindicators of industrial and urban pollution. Sulfur dioxide concentrations as low as 13 μg/$m^3$ have been shown to inhibit or kill some lichen species (10). Vokou et al. (17) monitored lichen vegetation around Thessaloniki, northern Greece over 10 years and found that lichen populations decreased in 70% of the sites observed. This decrease was attributed to high levels of air pollution in the study area. Sigal (13) pointed out that studies like this have become a routine measure of the biological impact of air pollution.

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(See also: http://www.nps.gov/ever/naturescience/lichens.htm for Florida-specific lichen information)

## Materials:

- grid/graph paper
- transparency sheets
- marking tape / string
- GPS enabled devices (optional)
- pencil/paper
- computer/internet access

## Procedures:

**DAY ONE**

1. Introduce lichens and what they look like, take a nature walk outside and see if you can spot any lichen on your school campus. Encourage students to count the different lichens (without worrying yet about species or growth forms) around their homes and then consider whether the lichen counts reflect their setting (urban, suburban, farm, countryside,woods.) What is growing in the same area and might, or might not, be a lichen? What kind of substrates (type of trees, rocks, soil) do your lichens grow upon? The artists of the class could help out by drawing or photographing the lichens.
2. Perhaps the class would like to make a scrapbook, with a drawing of a lichen matched to a brief paragraph describing where it grew and when it was observed.
3. When students have gained confidence in lichen sighting, they are ready to begin a more systematic collection of data. Consult http://www.discoverlife.org/mp/20q?guide=Lichens_USGA to identify specific types of lichens, or at least the forms closest to those in Florida.

**DAY TWO**

4. Begin with an introductory discussion on the importance of lichens and their classification (see information above) and the use of GIS to map environmental data.
5. Students should learn how to identify the three major types of lichens and use of GPS units, if available. *(cell phones and other GPS enabled devices can also be used) In the absence of GPS devices, students can plot the location on a map using descriptions to aid location.*
6. Student teams will then review knowledge through assessment of graphing lichen populations on a sample trees using the following method:
    1. Use 6 inch squares of graph paper *or* create a 6 inch square grid made up of 1/8th inch circles, laid out 10 by 10. Photocopy the grid onto a transparency.
    2. Locate lichen bearing trees and circle them with a tape at chest height.
    3. Mark North, South, East, West and place the transparency (North, then South, then East, West) so its lower edge touches the tape. Count the number of circles showing lichens. (You can also count moss and bare bark.) Advanced: Note the different type/species of lichens.
    4. Note related variables such as light, humidity, wind direction, direction towards town, any known pollution.
    5. Discuss any differences they observe in trees sides and in the aforementioned related variables.

**DAY THREE**

6. In student groups, record and chart the lichen data for your school campus or the Selby Gardens campus. In order to observe environmental changes, we will compare your data to previous years and study the changes.

## Assessment / Learning on Display:

- Students will submit a scientific abstract that summarized the project and analyzed and interpreted the data that they collected. These abstracts can be graded using a rubric like the one below:

| Section (purpose) | Explanation of indicated no. of points | | |
|---|---|---|---|
| | 4 or 5 (fully meets all requirements and expectations) | 2 or 3 (partially meets requirements and expectations) | 1 (minimal effort made to meet requirements) |
| Introduction (briefly states subject and purpose of project) | Provides concise, thorough introduction to lichens as well as statement of purpose | Fails to define key terms or to use them correctly, give enough introductory information, or provide a logical statement of purpose | Provides little introductory information |
| Materials and methods (identifies how the problem was studied and defines all jargon, abbreviations, or acronyms) | Briefly discusses what tests and procedures were used to measure lichen populations in an organized, clear, and concise manner | Discusses methods but is disorganized, vague, or verbose | Provides little explanation of methods used |
| Results (abstract provides brief, specific description of data collected and explains what was discovered) | Provides thorough, numerical description of data collected and mapped and connects these results to the methods and conclusions | Merely states results with little explanation and comparison | Provides little description of results |
| Conclusions (abstract interprets results and evaluates what they mean to the project) | Logically connects results into a reasonable argument and provides meaning and context to work | Either reflects the purpose or fails to provide context and meaning to the work | Little effort made to provide meaningful conclusions |

## Related Key Terms:

- Bioindicator: an organism whose status in an ecosystem is analyzed as an indication of the ecosystem's heath
- Lichen: an organism comprised of a mutualistic relationship between a fungi and an algae a bacteria
- Substrate:  the medium on which something grows -- under (sub) layer (stratum) *latin*
- Symbiotic mutualism: a relationship between two organisms where both benfit from the relationship

## Cross-Curricular Extensions:

- **Science**: Take your lichen study a step further with this transection activity http://staff.concord.org/~btinker/gaiamatters/investigations/lichens/transect.html

- **Math**: Graph the changes in Lichen health over the course of time the experiment has been running (comparing different types of lichens -- fruticose is the most susceptible to environmental pollutants)

## TEACHER INFO. RESOURCES

- National Geographic: Eye in the Sky Maps: Human Impact: http://www.nationalgeographic.com/eye/impact.html
- EPA Overview of HIE: http://www.epa.gov/owow_keep/estuaries/pivot/overview/cf.htm
- Local Sarasota County Conservation Organization http://www.conservationfoundation.com/
- Using Bioindicator's to Measure HIE: http://www.nature.com/scitable/knowledge/library/bioindicators-using-organisms-to-measure-environmental-impacts-16821310
- http://jmbe.asm.org/index.php/jmbe/article/view/94/html_2
- Article referencing new study showing humans directly responsible for Ice Age animal extinction: http://www.iflscience.com/plants-and-animals/humans-not-climate-change-blame-ice-age-animal-extinction
- Article about teaching elementary students HIE: http://www.classroomscience.org/human-impacts-human-solutions-engaging-elementary-school-children-in-solution-based-science
- Measuring Carbon Dioxide in the Environment: http://www.bbc.co.uk/schools/gcsebitesize/geography/climate_change/carbon_footprints_rev1.sht
- HIE Slideshow (6-12): http://www.slideshare.net/biovictor/human-impact-on-the-natural-environment
- Research-driven HIE LP: http://questgarden.com/127/12/2/110602181225/process.htm
- The Earth Transformed: An Introduction to Human Impacts on the Environment http://www.wiley.com/WileyCDA/WileyTitle/productCd-0631194657.html
- National Geographic “Human Footprint” Lesson Plans (3-8):http://www.nationalgeographic.com/xpeditions/lessons/14/g68/HumanFootprint.pdf
- Lichen Graphing Sample: http://jmbe.asm.org/index.php/jmbe/article/view/94/html_2

## STUDENT INFO. RESOURCES

- EPA Breakdown of HIE into categories: http://water.epa.gov/type/wetlands/mangrove.cfm
- Measuring Carbon Dioxide in the Environment (6-12): http://www.bbc.co.uk/schools/gcsebitesize/geography/climate_change/carbon_footprints_rev1.sht
- HIE information (3-5): http://www.ecokids.ca/pub/eco_info/topics/biodiversity/human_activities.cfm
- American Museum of Natural History Science Website for Kids (includes topics: climate change, water, and biodiversity): http://www.amnh.org/explore/logy

**STUDENT INFO. RESOURCES (CONTINUED)**

- Sample company (Timberland) actively involved in Environmental Responsibility (for student analysis of effectiveness): http://responsibility.timberland.com/
- HIE Overview from "Skwirk," an Australian Online Learning Company: http://www.skwirk.com/p-c_s-57_u-520_t-1393_c-5363/qld/sose-geography/a-question-of-balance-australian-environments/civilisation-and-the-ecosystem/human-impacts-on-the-environment
- HIE in the Wetlands (6-12): http://www.coastal.ca.gov/publiced/UNBweb/human.pdf
- Biodiversity (3-5): http://www.ecokids.ca/pub/eco_info/topics/biodiversity/food.cfm

**STUDENT ACTIVITY RESOURCES**

- *Water, Water Everywhere* by Mark J Rauzon and Cynthia Overbeck Bix, Sierra Club Books for Children, 1994. ISBN0-87156-383-5
- *Come Back, Salmon* by Molly Cone, Sierra Club Books, 1992. ISBN 0-87156-489-0
- *River Story* by Meredith Hooper, Candlewick Press, 2000. ISBN 0-7636-0792-4
- *Water Dance* by Thomas Locker, Harcourt Brace & Company, 1997. ISBN 0-15-201284-2

**VIDEO RESOURCES:**

- Crash Course Ecology: 5 Human Impacts HIE Video (11 minutes) (7-12) http://www.youtube.com/watch?v=5eTCZ9L834s
- Edgy, yet Fully Engaging Video Intro. *(4 min. 26 sec.)* Regarding Human Role and Beliefs about Climate Change (9-12 - Contains adult language): http://www.iflscience.com/environment/john-oliver-does-science-communication-right
- The "Human Footprint" National Geographic (10 minutes) (4-12) http://www.youtube.com/watch?v=ZQdejn_RxBQ

# Appendix

1. “Fred the Fish” Script
2. “Fred the Fish” illustration with word bubble
3. Invasive Species List
4. Human Footprint Video Notes Sheet
5. “Perils of Plastic” Student Handout (available below and at this address: http://www.nationalgeographic.com/xpeditions/lessons/14/g68/HumanFootprintPlastic.pdf)

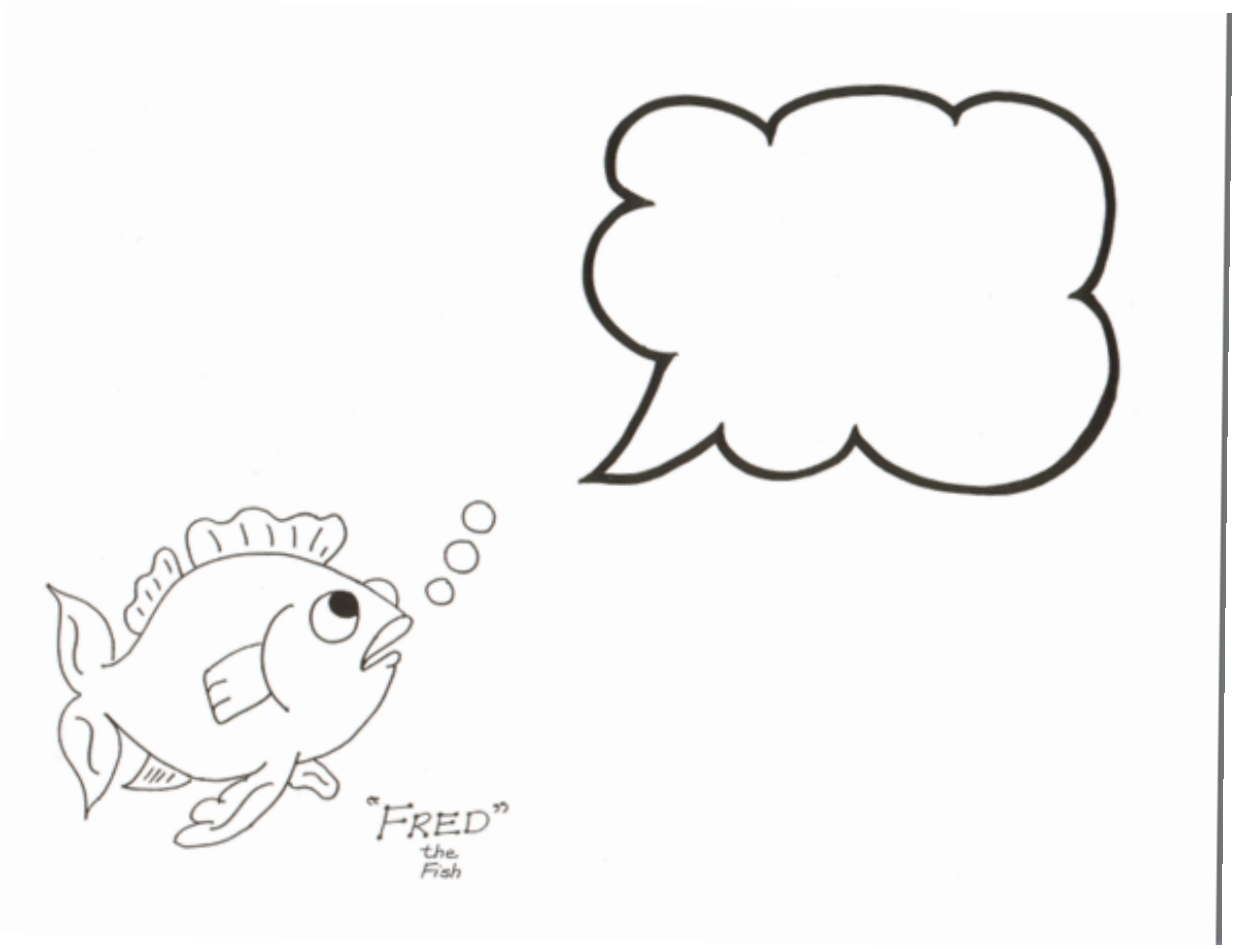
Eco-systems, Energy Flow, and Education:

# Endangered Earth: Human Impacts on the Environment

## "Fred the Fish Script"

| | |
|---|---|
| **1** | **Imagine a clean stream, as it meanders from a mountaintop lake through protected wilderness. Meet Fred. HOW IS FRED? He has lived here all of his life, but now he is going on an adventure downstream.** |
| | |
| **2** | **Fred swims into some farm country. He passes a freshly plowed riverbank. It begins to rain and some soil erodes into the river. (Dump some soil into Fred's habitat.) HOW IS FRED?** |
| | |
| **3** | **Fred nears a suburban housing development. Some fertilizer and pesticides from the nearby farms and lawns washed into the river awhile back. (Place the powered milk into Fred's habitat.) The fertilizer made the plants in the river grow very fast and thick. Eventually the river couldn't furnish the plants with the nutrients they needed, and so they died and are starting to decay. Their decomposition is using Fred's oxygen. HOW IS FRED?** |
| | |
| **4** | **Fred swims under a highway bridge that goes over the river and a dirt road. To keep the dust from the dirt road under control, the residents spread oil on the road. (Pour the oil into Fred's habitat.) At spots, the oil ran into the river. It also seeped in to the ground water and ended up in the river. HOW IS FRED?** |
| | |
| **5** | **As Fred continues on his journey, he passes under another bridge. During a recent cold spell, ice formed on the bridge. The county trucks spread salt on the bridge to prevent accidents. Rain is now washing salty slush into the river. (Put salt into Fred's habitat.) HOW IS FRED?** |
| | |
| **6** | **Fred swims past a city park. Some picnickers didn't throw their trash into the garbage can. The wind is blowing the trash into the river. (Sprinkle trash into Fred's habitat.) HOW IS FRED?** |
| | |
| **7** | **Several factories are located downstream from the city. Although regulations limit the amount of pollution the factories are allowed to dump into the river, the factory owners don't always abide by them. (Pour laundry detergent into Fred's environment.) HOW IS FRED?** |
| | |
| **8** | **The city's sewage treatment plant is also located along this stretch of the river. The pollution regulations for the plant aren't as strict as they should be. Also a section of the plant has broken down, allowing untreated sewage to run into the river. (Squirt two drops of red food coloring into Fred's habitat.) HOW IS FRED?** |
| | |
| **9** | **Fred swims past a hazardous waste dump located on the bank of the river. Several rusty barrels of toxic chemicals are leaking. The rain is washing these poisons into the river. (For each leaking barrel, squeeze one drop of green food coloring into Fred's habitat.) HOW IS FRED?** |
| | |
| **10** | **HOW IS FRED? Fred feels weak. He can't breath. He can't see through the water. His fins will barely move. WHAT SHOULD FRED DO? WHAT IS THE FATE OF FRED, THE FISH???? WHAT IS OUR FATE????** |

# "FRED THE FISH"



Eco-systems, Energy Flow, and Education:

# Endangered Earth: Human Impacts on the Environment

## Invasive Species - Suggested Species List

1. Brown rat: http://www.arkive.org/brown-rat/rattus-norvegicus/
2. Black rat: http://www.arkive.org/black-rat/rattus-rattus/
3. Grey squirrel: http://www.arkive.org/grey-squirrel/sciurus-carolinensis/
4. House mouse: http://www.arkive.org/house-mouse/mus-musculus/
5. Lionfish: http://www.arkive.org/common-lionfish/pterois-volitans/
6. Harlequin ladybird: http://www.arkive.org/harlequin-ladybird/harmonia-axyridis/
7. Himalayan balsam: http://www.arkive.org/himalayan-balsam/impatiens-glandulifera/
8. American mink: http://www.arkive.org/american-mink/mustela-vison/
9. Rabbit: http://www.arkive.org/rabbit/oryctolagus-cuniculus/
10. European starling: http://www.arkive.org/european-starling/sturnus-vulgaris/
11. Giant African land snail: http://www.arkive.org/giant-african-snail/achatina-fulica/
12. Common mynah: http://www.arkive.org/common-myna/acridotheres-tristis/
13. Red deer: http://www.arkive.org/red-deer/cervus-elaphus/
14. Crab-eating macaque: http://www.arkive.org/crab-eating-macaque/macaca-fascicularis/
15. Stoat: http://www.arkive.org/stoat/mustela-erminea/
16. Wild boar: http://www.arkive.org/wild-boar/sus-scrofa/
17. Red fox: http://www.arkive.org/red-fox/vulpes-vulpes/
18. American bullfrog: http://www.arkive.org/american-bullfrog/lithobates-catesbeiana/
19. Sika deer: http://www.arkive.org/sika-deer/cervus-nippon/
20. Canada goose: http://www.arkive.org/canada-goose/branta-canadensis/
21. Racoon: http://www.arkive.org/northern-raccoon/procyon-lotor/
22. Cuban treefrog: http://www.arkive.org/cuban-treefrog/osteopilus-septentrionalis/

Eco-systems, Energy Flow, and Education:

# Endangered Earth: Human Impacts on the Environment

NAME:
TEACHER:
CLASS:
DATE:

## National Geographic's

# "The Human Footprint"

## Video Notes Sheet

*<u>Directions</u>: Preview the questions below. Next, watch each of the video clips listed below. You can select/retype the hyperlink into your browser, or search "nation geographic Human footer" into the youtube browser. Feel free to pause and rewatch portions of the segments.*

**Part I:** http://www.youtube.com/watch?v=ZQdejn_RxBQ *(10 minutes)*

1) What are some of the ways infants in the U.S. consume natural resources?

_____

_____

**Part II:** http://www.youtube.com/watch?v=CoLjkTb81rA *(10 minutes)*

1) How do "convenience foods" impact the environment?

_____

_____

2) What's the significance of eating animal products?

_____

_____

3) What are the kinds of carbs (carbohydrates) the video discusses us eating?

_____

Eco-systems, Energy Flow, and Education:

# Endangered Earth: Human Impacts on the Environment

**Part III**: http://www.youtube.com/watch?v=y6IpHjQfcvs *(10 minutes)*

1) Approximately how many loaves of bread will you consume in your lifetime?

_____

2) How much candy will you eat on average in one year? _____

3) Why does it matter if we eat fruits/vegetables that are out of season?

_____

_____

4) How much trash does one person create in our lifetime? _____

5) How many cans of soda will the average american consume over his or her lifetime?

_____