

ENERGY-WATER NEXUS STEM INVESTIGATIONS

Calculating Your Personal Ecological Footprint

KEY LEARNING OBJECTIVES

Students will be able to:

- **Assess** their lifestyle to **estimate** their consumption of energy use and production of waste.
- **Analyze** data to determine how many biologically productive hectares they would require supporting their current lifestyle.
- **Compare** the total number of hectares needed for their lifestyle to the number of hectares per person the Earth can support.

OVERVIEW

In this activity, students will begin to understand the food-energy-water nexus and how their decisions impact the Earth. Students will take a quiz to estimate how many natural resources or nature their lifestyle requires. This quiz allows students to consider and estimate their consumption of energy used in the home, transportation, food, housing, and for goods and services, while estimating the amount of waste they generate. After completing the quiz, students will compare their score with others and identify ways they can reduce the impact that they have on Earth.

CONNECTION TO THE ENERGY-WATER NEXUS

- It is important to analyze data to determine whether an individual is consuming more resources and producing more waste than the planet can regenerate or absorb in the atmosphere.
- Looking at energy use on a global scale can help us determine where conservation efforts are needed and monitor the use of both non-renewable to renewable energy resources.

NATIONAL STANDARDS

Next Generation Science Standards

- MS-LS2-1 Ecosystems: Interactions, Energy, and Dynamics
Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organism in an ecosystem.
- MS-ESS3-4 Earth and Human Activity
Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.

- MS-ESS3-3 Earth and Human Impact

Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

BACKGROUND

An ecological footprint is a quantitative measurement of how much ecologically productive land and water an individual, population, or activity requires to produce all the resources it consumes and to absorb the wastes it generates. An ecological footprint is usually measured in global hectares. A global hectare is a biologically productive hectare with world average biological productivity for a given year. Biologically productive land and water are areas that support significant photosynthetic activity and the accumulation of biomass used by humans. Non-productive areas are not included. Biomass that is not of use to humans is also not included. The total biologically productive area on land and water in 2014 was approximately 12 billion hectares. Dividing by the world population in 2014 (7 billion) provides 1.7 global hectares per person.

An ecological deficit occurs when the footprint of a population exceeds the biocapacity of the area available to that population. Conversely, an ecological reserve exists when the biocapacity of a region exceeds its population's footprint. The footprint for the United States is approximately 9.57 global hectares per person. If everyone on the planet was to live like an average American, we would need 5 planets to sustain everyone. Our planet's biocapacity would only be able to support 1.2 billion people, far less than the 7 billion we have on Earth.

KEY VOCABULARY

- Ecological footprint
- Biocapacity
- Global hectare
- Biologically productive land and water

MATERIALS

- *Calculating My Personal Footprint*
- White boards or poster paper
- Images of a rain forest and coral reef
- Calculator

TEACHER PREPARATION

- Copies of *Calculating My Personal Footprint* for each student

PROCEDURE

1. To determine prior knowledge, open the lesson by asking the class to construct a definition of an ecological footprint. Allow students to share their ideas and develop a list on the board. Share the actual definition of an ecological footprint on the board and compare it to the ideas the class generated.
2. In small groups of three, have students trace a large footprint and a small footprint on a white board or poster paper. Challenge each group to construct a list of activities that could increase their country's footprint. Those activities will be written inside the large footprint they traced. Each group should also generate a list of activities that could decrease their country's footprint. Those activities should be written in the small footprint. Provide each group an opportunity to share activities they brainstormed with the class.
3. Ask students to predict if they would have a large or small ecological footprint. Display images of a rain forest and coral reef (or other biologically productive areas) on the board. Biologically productive land and sea includes cropland, forest, and fishing grounds. They do not include deserts, glaciers, and the open ocean. Discuss with students that the total amount of biologically productive land and water on Earth in 2014 was 12 billion hectares providing 1.7 hectares per person on Earth. (A hectare is about the size of a soccer field)
4. Distribute the *Calculating My Personal Footprint* worksheet to each student and state that they will be calculating their personal footprint to determine if their prediction was accurate.
5. Allow students to work in small groups of three to complete the quiz. The teacher should walk around the room to answer questions that students may have. Students will most likely have questions with the transportation and energy use sections depending upon their knowledge of automobiles and appliances. Students may also need help calculating the hectares per person after the quiz.
6. Provide students the opportunity to compare their footprint with other students in the class by inviting the students to write their hectare per person calculation on the board. Calculate the class average and compare it to the averages of other countries.
7. To close the activity, have students outline a plan to reduce their ecological footprint.

EXTENSION

As an extension of this activity, students can discuss, develop, and implement a school plan to reduce wasted resources.

Sources: <http://www.worldcentric.org/conscious-living/expanding-eco-footprint>

CALCULATING MY PERSONAL FOOTPRINT

How many planets would we need if everyone lived like you?

Directions: For each question, circle the answer that represents the most accurate description for a typical day in your home. At the end of each section, add the total points that were circled. The grand total of all sections will be used to calculate your personal footprint.

Food

1. ___ of my food has packaging

All (100) Most (75) Half (50) Some (25) None (0)

2. On a typical day, I waste ___ of my food

All (100) Most (75) Half (50) Some (25) None (0)

3. ___ of my food is processed

All (100) Most (75) Half (50) Some (25) None (0)

4. I compost my vegetables and fruits.

No (60) Yes (-30)

5. ___ of my food is grown locally

All (100) Most (75) Half (50) Some (25) None (0)

6. Daily, I eat ___

Meat more than once a day (600) Meat once per day (400) Meat a few times a week (300) No meat, but do eat dairy & eggs (200) No animal products (150)

Food Total

Transportation

1. **We have ___ of cars**

> 2 per driver (200) > 1 per driver (100) 1 per driver (50) < 1 per driver (0) No car (-25)

2. **The time I spend in a vehicle per day is ___**

> 1 hour (200) 30–60 minutes (100) < 30 minutes (50) No time (0)

3. **I travel to school by ___**

Driving myself (200) Driving with others (100) Bus or Public Transit (25) Walking/Biking (0)

4. **The size of the car I typically travel in is ___**

Full size (200) Mid-Size (100) Compact (50) No car (-25)

5. **Each year, I take ___ flights**

> 2 (400) 1–2 (200) No (0)

Transportation Total

Shelter

1. **My home is ___**

Single House with large yard (50) Single House with small yard (25) Townhouse/Attached House (0) Apartment/Condo (-50)

2. **We own a second home that is often empty**

No (0) Others use the home (200) Yes (400)

3. **In our primary home, excluding bathrooms, there are**

More than 3 rooms per person (200) 2–3 rooms per person (100) 1–2 rooms per person (0) 1 room per person (-50)

Shelter Total

Water Use

1. **I typically shower or bathe _____**

More than once
per day (100)

Once a day,
< 10 minutes (50)

3-4 times per
week (25)

No shower
or bath (0)

2. **I flush the toilet**

Every time I use it (50) Half the time (25)

3. **When I brush my teeth**

I let the water run (50)

Sometimes the water
is on (25)

4. **We use water saving toilets and low-flush shower heads. (-50)**

Water Total

Energy Use

1. **In colder months, our house temperature is _____**

More than 72° F (150)

68-71° F (100)

Less than 68° F (-25)

2. **We use a dishwasher _____**

> Once a day (100)

Every day (50)

Never (-50)

3. **We use compact fluorescent or LED light bulbs in**

No lights (50)

Some lights (25)

All lights (-50)

4. **We use _____ energy efficient appliances**

No (50)

Some (25)

All (-50)

5. **I turn off lights and the television when not in the room.**

Never (50)

Sometimes (25)

Always (0)

Energy Total

Goods & Services

1. **I change my outfit ____ a day and put it in the laundry.**

Several times (100) Once (50) I don't wash my clothes every time I wear them (0)

2. **I wear clothes that have been mended.**

No (0) Yes (-20)

3. **Most of my clothes are purchased new.**

Yes (200) No (-50)

4. **I donate clothes I do not wear.**

No (100) Yes (-50)

5. **I don't wear ____% of the clothes in my closet.**

75% (100) 50% (75) 25% (50) <25% (25)

6. **I buy ____ new pairs of shoes each year.**

> 7 (100) 4-6 (75) 2-3 (25) 0-1 (0)

7. **We have ____ number or electronics at home.**

> 15 (200) 10-15 (100) 5-10 (75) < 5 (25)

Goods & Services Total

Waste

1. **All my garbage today could fit into a**

Large garbage can (100)	Small garbage can (50)	Shoe box (25)	No trash today (-50)
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2. **I recycle ___ of my paper, cans, glass, and plastic.**

None (200)	Some (100)	Half (50)	Most (25)	All (-100)
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3. **I reuse items before placing them in the trash.**

No (25)	Yes (-25)
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5. **I repair items before placing them in the trash.**

No (25)	Yes (-25)
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6. **I use my own bags instead of ones provided by stores.**

No (25)	Yes (-25)
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7. **I shop online ___ times a year.**

> 15 (200)	10-15 (100)	5-10 (50)	< 5 (25)	Zero (0)
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Waste Total

Calculating Your Footprint

1. Add the totals for each of the 7 sections and place the grand total here.

2. How many **Earths** would be required to support your lifestyle?
Grand total ÷ 300 = _____

3. How many **hectares** would be required to support your lifestyle?
Number of Earths X 11.6 = _____

4. Which country's average hectare per person most closely matches yours?

USA	9.57	Ireland	4.97	Mexico	2.59
Canada	8.56	UK	4.72	Costa Rica	1.91
Kuwait	8.01	Japan	3.91	China	1.36
Finland	7.00	Poland	3.40	Kenya	1.08
France	5.74	Chile	3.04	Nepal	0.57

5. There were approximately 12 billion hectares of biologically productive land and water areas on Earth in 2014. Dividing by the number of people alive in that year (7 billion) gives 1.72 global hectares per person. This area also needs to accommodate the wild species that compete for the same biological material and spaces as humans.

If your footprint is greater than 1.72 hectares, outline a plan to reduce your footprint.