

## WHAT'S IN A FOOTPRINT: ECOLOGICAL FOOTPRINT ANALYSIS

### Background and Context

In the 1970s, the American ecologist, Paul Ehrlich, in dialogue with his peers, developed a formula to assess human impact on the environment. That formula is the well known IPAT equation, where  $I$  (Impact) =  $P$  (Population)  $\times$   $A$  (Affluence)  $\times$   $T$  (Technology). Applying this formula, it is easy to show that an increase in population,  $P$ , yields an increase in the human impact,  $I$ , on the environment. Similarly, a breakthrough in technology,  $T$ , (e.g., increasing fuel-use efficiency in cars) will reduce that same impact,  $I$ . Or, an increase in the affluence of a population,  $A$ —which has often been equated to an increase in consumption—yields an increase in impact,  $I$ . Although this equation is functional with respect to its relationships—that is, how  $I$ ,  $P$ ,  $A$ , and  $T$  relate to each other—its quantitative rigor leaves something to be desired. Enter Ecological Footprint Analysis (EFA), a tool created in 1992 by Canadian William Rees, and since developed by the policy institute, Redefining Progress.

Here are some background points for understanding the ecological footprint concept: 1) Earth is a closed system, which is to say that everything we consume comes from Earth and goes back to Earth; 2) Earth is finite in size, which is to say that there are limits in terms of what Earth can produce (i.e., Earth's productive capacity) and how much waste Earth can absorb; and 3) Earth's production capacity and waste-absorption capacity can be measured as can human consumption and waste production. Taking these three points together, it is possible to express an individual human being's (or the entire human population's) consumption and waste production on an area basis—i.e., to calculate the bioproductive area of Earth necessary to support humans at a given level of consumption and waste production.

It is this metric of ecological footprint analysis which permits us to tell whether we are living within Earth's supply limits. This takes us to the heart of the matter—the most important question—namely: Does Earth have the capacity to accommodate humanity's burgeoning numbers and resource demands?

In practice, calculating an ecological footprint is an accounting exercise: Consider the common hamburger that you might order at a fast-food joint (ignoring for the time being the burger's bun and condiments). The beef patty came from a steer. During its early life this steer required land to graze on and later, when it was being fattened in a feed lot, land was needed to grow the steer's feed. This steer was killed and processed at a meat-packing plant and this required both space (for the facility) and energy (to power the plant). Next, the processed beef patty was transported to your local fast-food restaurant. Here, too, land (for roads, parking, etc.) and energy (for transportation) were required. Still more energy was needed in the restaurant for both refrigeration and cooking. Expressing the various components of your hamburger's ecological history in terms of land area and then summing these components would give the ecological footprint of this burger.

### Check In

If you could live in any culture at any time in history, where and when would you live, and in what role, and why? After all have had the chance to comment, reflect on this: Given your choice, what would be your relation to and impact upon the earth?

## **Activity One: A Taste of Footprinting: The Daily Paper**

Let's calculate the amount of land necessary to supply an individual with his/her daily newspaper over the course of a year. Even if you are not too hot with numbers, you will be able to follow along because we will just be employing straightforward arithmetic.

1) **Amount of Paper Needed:** Let's start with the amount of land needed to grow the pulp wood for the newspaper. Given a daily newspaper weighing 0.66 pounds on average, total newspaper consumption over the course of a year would amount to 241 pounds.

$$0.66 \text{ pounds} \times 365 \text{ days} = 241 \text{ pounds/year}$$

2) **Land to Produce Paper:** Next, knowing that in one year one acre of natural (i.e., non-plantation) temperate forest produces enough pulp to make approximately 1,200 pounds of paper, it follows that 0.2 acres of forest is necessary to supply the pulp for the newspaper.

$$241 \text{ pounds of newspaper} \times 1 \text{ acre} / 1,200 \text{ pounds paper} = 0.20 \text{ acres.}$$

Commonly, half the fiber in newspaper comes from recycled sources, so the actual forest area necessary to produce virgin pulp for one year's supply of newspaper would be 0.1 acre.

$$0.20 \text{ acres} \times 0.5 = 0.1 \text{ acre}$$

3) **Amount of Energy to Produce Paper:** Given that 6,600 Kcal of energy are necessary to manufacture a pound of paper, then 1,590,600 Kcal of energy would be required to manufacture one person's annual consumption of newspaper.

$$6,600 \text{ Kcal/pound} \times 241 \text{ pounds of newspaper} = 1,590,600 \text{ Kcal.}$$

4) **Land to Produce That Energy:** Next, given that one acre of land can produce 10,000,000 kcal of energy/year, an estimated 0.16 acres would be required to produce the energy necessary to manufacture a year's supply of newspaper.

$$1,590,600 \text{ Kcal of energy to manufacture newspaper} \times 1 \text{ acre} / 10,000,000 \text{ Kcal} = 0.16 \text{ acres}$$

5) **Total:** Summing the virgin pulp acres (0.1) and the energy for paper manufacturing acres (0.16), gives one person's newspaper footprint—0.26 acres. **Think of it as an area of forest, roughly 100 feet on a side**, "working" day after day in order to supply a person with his daily newspaper.

$$0.1 \text{ acre for paper} + 0.16 \text{ acres for energy} = 0.26 \text{ acres for the daily paper.}$$

6) **Fair Earth Share:** If one were to divide all the bioproductive land and sea available on Earth by the number of humans seeking to use it, you would arrive at the, "fair earth share." That is, you would arrive at the land it would be fair for you to take if you assumed that each person deserved the same amount. That number (during the first decade of the 21<sup>st</sup> Century) is 4.5 acres. Thus, everyone on earth—including you—has 4.5 acres with which to handle all energy, material, and waste needs. One can then show that the 0.26 acres for the daily paper requires 6% of this Fair Earth Share.

$$0.26 \text{ acres} / 4.5 \text{ acres} \times 100\% = 6\%$$

**Discussion:**

Newspaper is just one part of a person's footprint. Each of us also needs land for food, housing, roads, energy, and so forth. Energy comprises the lion's share of the human footprint in most countries. Researchers take two different, yet related, approaches when calculating energy footprints. One is to determine the land area necessary to grow biofuels. For example, in Brazil huge expanses of land are planted to sugarcane which is distilled to produce ethanol which then goes to power vehicles. Crops can also be grown for fuel in the U.S., and in the footprint example above, it was assumed that the energy to manufacture newspaper would come from biofuels. It is also possible to calculate footprints when fossil fuels are the energy source of choice. In this case, analysts determine the energy footprint by calculating the forest land area necessary to assimilate the carbon dioxide released in the burning of the fossil fuels that would go into producing a certain product (e.g., newspaper). This approach is taken because the unrestricted release of carbon dioxide into the atmosphere has begun to destabilize Earth's climate. Hence, to create a sustainable world, land must be set aside to assimilate the carbon released in the burning of fossil fuels.

Insofar as consumption levels vary from country to country, it should come as no surprise that footprint sizes also vary. The footprint for the average U.S. citizen is 24 acres; the average Chinese citizen, 3.5 acres; the average United Kingdom citizen, 12 acres. People in countries with similar standards of living (e.g., U.S. and U.K.) can have very different ecological footprints (24 acres vs. 12 acres). Given this background, we invite you to reflect on these questions:

1. Is your daily newspaper worth 6% of your footprint? After thinking this through and responding, you should note that though the newspaper is 6% of a sustainable lifestyle, at 0.26 acres, it comprises only 1% of the current American lifestyle ( $0.26 \text{ ac} / 24 \text{ ac} \times 100\% = 1\%$ )
2. Our calculation, though beneficial in understanding the environmental impact of daily newspaper usage, is not exhaustive. What is it missing? (e.g.: footprint of disposal, transportation, ink, conducting research and writing the actual NP stories...).
3. If 6% seems a little steep for the daily paper, what could be done to reduce the newspaper footprint?
4. How does a free newspaper (USA today, NY Times, CDT) program such as that adopted by PSU affect newspaper consumption/footprint?
5. Why do you suppose it is that the U.S.'s per capita environmental impact is twice as large as the U.K.'s?

**Activity Two: The Footprint of Movement****Introduction**

Another way to work with the numbers is to ask how many people the Earth could support if everybody had a U.S. average footprint of 24 acres. The answer: 1.2 billion people (28.4 billion bioproductive acres on Earth/24 acres per person = 1.2 billion people). A different way of saying this is that five Earths would be necessary to support the world's current population at U.S. standards. Calculations like these reveal the fallacy of imagining that, given current technologies and consumption patterns, the Earth's growing human population could ever come close to enacting U.S. lifestyles.

Performed at the global level, the most recent Footprint analysis shows that the world's human population requires 1.39 Earths to maintain the current instantaneous use of earth's

resources. That is, we are all overshooting the Earth's sustainable supply of resources by 39%. You might be wondering, How is it possible to exceed 100%? The same way it is possible to spend 139% of your monthly income. There is a supply in the bank (just as there is on Earth). In the case of the bank account, we all know what happens if the overspending of resources stays too long above 100%. It will be no different for Earth.

Thus, there arises the question, how can we reduce the impact of the human species on the only presently known inhabitable planet, Earth, so that we can continue to live on this planet, and so, too, can the millions of other species who call it home? Let us take ONE point of entry into this nut of a problem. Let's consider Transportation, just one of several major "systems" of our civilization (others of which include, energy production, waste disposal, food production, etc.).

### ***The Problem***

Take the time, as a group, to determine all the information you would need to calculate the ecological footprint of "transportation." That is, if you want to know how transportation does or could impact the environment, at both the individual and regional scales, what do you need to know? What figures do you need to have? What are the various methods of transportation? Where is energy being utilized? What wastes or toxins are being produced? What materials are required, how far must they travel, what is necessary to process them?

After you have brainstormed, discuss. Can you make any rough comparisons between the footprints of various transportation methods? Can you make a guess as to the difference between the ecological footprint of driving a car versus riding a bike?

### ***An Example: The Power Footprint of Transportation:***

**Car:** The average direct gas consumption by American cars is about 19 miles per gallon (MPG); indirect energy consumption for car manufacturing and road maintenance adds 45 percent. Each gallon of gasoline contains about 31,700 Calories (kcal) of energy. Land can supply approximately 9.675 million Calories per acre per year (kcal/ac/yr). Therefore, the fossil fuel Footprint of a 6 mile auto commute (3 miles each way) over the course of a year is:

$$\frac{1.45 * 6 \text{ [mi]} * 31,700 \text{ [kcal/gallon]} * 230 \text{ [trips/yr]}}{19 \text{ [mi/gallon]} * 9,675,000 \text{ [kcal/a/yr]}}$$

$$= 0.35 \text{ acres} = 1,400 \text{ square meters of land}$$

**Bicycle:** Let's assume that the bicycle rider requires an extra 40 Calories per mile (kcal/mi) for each mile that s/he rides to "fuel" his/her body. We assume that this extra energy is supplied by breakfast cereals. These cereals need land to grow and energy for processing. The land equivalent of the commercial energy needed for agricultural production and for food processing of plant crops is typically the same as the crop area; hence, the total land area for the growing and processing of the food is double the growing area. Cereals have a nutritional content of about 1410 Calories per pound (kcal/lb). The world average in agricultural production is 2320 pounds of cereals per acre per year (lbs/ac/yr). Thus, for a 6 mile round-trip bicycle commute, one requires:

$$2 * 40 \text{ [kcal/mi]} * 6 \text{ [mi]} * 230 \text{ [trips/yr]}$$

$$1410 \text{ [kcal/lb]} * 2320 \text{ [lb/ac/yr]}$$

$$= 0.034 \text{ acres} = 136 \text{ square meters of land}$$

Thus, from the perspective of energy utilization, the bicyclist's footprint is 10 times less than the car driver's footprint. Or, whenever one drove, one would always have to drive a minivan with 9 other passengers in it in order to equal the same size footprint of a person bicycling that same distance.

If you compare this to the prior example, you can see that the 0.26 acre footprint for the daily newspaper is 75% the footprint of a 6 mile daily car ride ( $0.26\text{ac} / 0.35\text{ac} \times 100\% = 75\%$ ). Of course, this is where attention to details becomes important. Most people drive far more than 3 miles to get to work.

### ***Discussion***

1) Though we have asked you to determine the environmental impact of various methods of transportation, what else could or should we consider when we compare transportation options? As you consider this question, peruse the chart below:

<b>Method of Transportation</b>	<b>Deaths per billion passenger miles</b>
Car	9.2
Air	0.4
Bus	0.1
Train	0.1

2) How old are you going to be in 2040? If you are still a student in high school or college, you won't be too old, right? Maybe not even married, still kicking around as a bachelor or bachelorette? It will be right around that time, the U.S. Census Bureau predicts, that the planet's population will pass 9 billion people. We just learned that the earth can only support 1.2 billion people if everybody lives with the same "affluence" of American society. For sure, over the next 30 years, no one will be working to keep the whole of China, India, and Africa in the same "affluence"-deprived condition they are now in. In fact, many people may be working to improve that condition—houses with electricity, roads, cars, supermarkets, even non-essential goods such as extra shoes, shirts, televisions. This is the reality of the situation: our population is approaching 9 billion people, and no one wants any one of these 9 billion people to go hungry or be without shelter. Nor does anyone really want to slaughter the remainder of non-human life on earth in an attempt to maintain the presence of human life. If that is our reality, what are we to do? Take several minutes—and some space in your journal—to ponder and answer this question.

### **Check Out**

An innocent pleasure: For sure, we all have environmentally guilty pleasures, things we do that we know are bad for the environment, yet continue to do anyway. What, though, is one of your innocent pleasures? What is something you do that not only treads lightly (or more lightly) on the earth but also brings you joy?

## OUT-OF-CLASS FIELD STUDY: ECOLOGICAL FOOTPRINT

### Option 1—Paying Attention to Self and Culture:

Over the next few days, observe: 1) your culture and 2) your self, with a back-of-your-mind focus on the ecological impact of all that we do. Do not be judgmental, be merely "observational." Write down everything that strikes you.

#### *The Challenge, in Two Parts:*

1) After you have had this time to observe your self and your culture, determine one way in which you could reduce *your* ecological footprint. How would this impact your life, your money, your time, your health, your mind, your heart? The change that you choose should be significant in at least one of these realms, including its environmental impact. Then, for just one day, *change*. That is, for just one day, you have the challenge of realizing this potential for change and a reduction in your ecological footprint. **Compose a response piece to this experience**, including notes upon how you arrived at considering this change, why you chose to do what you chose, how you thought it would impact your life, money, etc., how it really did influence you for that one day, and, of course, what questions it raises for you. If you are having trouble, contemplate the non-fiction author, Colin Beaver's, "No Impact Man," experiment:

*For one year, my wife, my 2-year-old daughter, my dog and I, while living in the middle of New York City, are attempting to live without making any net impact on the environment. In other words, no trash, no carbon emissions, no toxins in the water, no elevators, no subway, no products in packaging, no plastics, no air conditioning, no TV, no toilet paper...*

*What would it be like to try to live a no-impact lifestyle? Is it possible? Could it catch on? Is living this way more fun or less fun? More satisfying or less satisfying? Harder or easier? Is it worthwhile or senseless? Are we all doomed or is there hope? These are the questions at the heart of this whole crazy-assed endeavor.*

*-<http://noimpactman.typepad.com/>*

2) You have now had the time to observe our culture. Here is the second challenge: What is one way our local culture can reduce its ecological footprint? To be sure, there is a circular dynamic between our culture and our civilization, where a change in one can lead to a change in another, thus, what would our culture be—who would we be—if we enacted this change? Could we do it? Why or why not, do you think? **Compose a response piece to these questions.**

## Option 2: Necessities vs. Wants

**Part 1—Calculate your Ecological Footprint:** Go to: [www.earthday.net/footprint](http://www.earthday.net/footprint) and when the map comes up, move your cursor to the “United States” and then on English. Then respond to the 14 questions. For the “city with most similar climate to ours,” put New York City. For population of State College put between “10,000-100,000.” When you get to the end, **print out** the quiz results.

Next, take the quiz again, this time changing your answers (i.e., changing your answers) so that your ecological footprint is reduced by half or more. For example, imagine for yourself a lifestyle where you didn’t own a car, you didn’t fly, you were living with more people or your living space was smaller, your food was locally produced and largely free of meat, and so forth. Print out the results of this second footprint survey.

Finally, study your two printouts with an eye to “discerning” how your footprint is distributed among the various categories (i.e., food, mobility, shelter, goods/services) and what personal challenges you would face in cutting your “footprint” in half. Lastly, **summarize your findings in one page** and **attach the two print-outs.**

**Part 2—Distinguishing Between Necessities and Wants:** Draw a line lengthwise down the middle of a sheet of paper. On the left side list your basic necessities—i.e., the BASIC needs of every human being. Write “Basic Necessities” as the heading for this column. In the right column of your paper list the things you want for your own lifestyle but that you could, if you had to, survive without. For example, you may want a hot shower each day but you would survive without it. Likewise, you may want to sleep on a bed but you would survive without a “bed” to sleep on. Label this right column, “My Wants” and list at least 15-20 items in your “Wants” column. To the right of each item in this “Wants” column name the principle resources needed to produce that item in so far as you can know this.

Next, select three items from your “Wants” list that you would be able to give up if you had to without too much difficulty. Cross these three items off your list and put the letter ‘a’ next to each. Now, select another three items that you could remove if you had to (though living without these items would cause some hardship) and cross these off, placing the letter ‘b’ next to these items. Do this one more time, this time using the letter ‘c’ next to three items that **really feel like “necessities” to you** (i.e., that you can barely imagine giving up) but that, in fact, you could eliminate if you had no other choice.

Now, sit back and think about the table you have just constructed. When you are ready, compose a 1 page reflection describing any thoughts/feelings/insights gained from doing this “necessities/wants” exercise. If you are having trouble getting started, you might consider questions such as: Which items did you eliminate first (those with an ‘a’ next to them)? Why those items? Which “wants” were you not willing to cross out? Why? What do you think accounts for the bulk of your personal ecological footprint—your “necessities” or your “wants?” How do you think giving up *certain* of your “wants” would affect your happiness? What is it that makes you genuinely happy, anyway? Would you be willing to lower your consumption levels if it meant that people who currently lack the **basic necessities of life** could simply survive?

**Part 3—The Footprint Reduction Fast:** Now, pick a “Want” in the “c” category. Specifically, pick something that really feels like a “necessity” to you even though it is simply a very strong “want.” Once you have selected the item, commit to giving it up for three

consecutive days. That's right, live without it and, as you live without this imagined necessity, pay close attention to your reactions. For each day of this three-day period compose a short summary of your experience and, in particular, the difficulties you experience. In this vein, note that psychologist, Chellis Glendinning, maintains that many of us are literally addicted to the modern conveniences that we surround ourselves with. If Glendinning is right, you should experience "withdrawal" (i.e., pain, upset, confusion, anger, unbalance) when you suddenly deny yourself of your daily "fix" to your chosen Category 'c' Want. To evaluate if this is true for you, carefully observe your mental, emotional, and physical state, day-by-day, as you engage in this "footprint reduction fast." In addition, pay attention to how your perception of things around you changes. Note the ways that eliminating this one thing from your life either separates you from OR brings you into fuller relationship with yourself, others, and Earth.

Based on these summary notes, write a 1-page reflection summarizing what you learned in doing this "footprint reduction fast."