Your ECOLOGICAL *footprint*

Comparing National Ecological Footprints

Thus far we have focused on individual ecological footprints—the amount of natural resources you use or the amount of wastes you generate. This principle can be scaled up to calculate national ecological footprints and ultimately a global ecological footprint for humanity.

Go to http://www.ecologicalfootprint.org/ and download the spreadsheet "World Footprint Data (Excel)." This spreadsheet contains data for the ecological footprint of individual nations. The ecological footprint is a measure of how much biologically productive land and water area an individual, a city, a country, a region, or humanity uses to produce the resources it consumes and to absorb the waste it generates, using prevailing technology and resource management schemes. This land and water area can be anywhere in the world. This includes land used in other nations to supply food, fiber, or energy consumed domestically. (For example, the land in Costa Rica used to grow exported bananas shows up in the footprint for nations that import those bananas.)

The footprint for each nation is the sum of six categories of use of biologically productive areas. *Cropland* is land that is, or has the potential to be, cultivated for the production of food, animal feed, fiber, and oil. *Pasture land* is grassland and pasture area used to raise animals for meat, hides, wool, and milk. *Forest area* refers to natural or plantation forests that are harvested for timber, papermaking, and fuel. *Fisheries* are the area of ocean required to support fish populations that humans harvest. *Built space* includes infrastructure for housing, transportation, industrial production, and capturing hydroelectric power. *Energy land* is the biologically productive area needed to sequester enough CO_2 to avoid an increase in atmospheric CO_2 concentration. *Other land* is the land not included in any of the other categories.

The spreadsheet also contains data about the biological capacity (biocapacity) of nations. Biocapacity is the total usable biological production capacity in a given year of a biologically productive area—for example, within a country. Biologically productive area is land and sea area with significant photosynthetic activity and production of biomass. Marginal areas with patchy vegetation and nonproductive areas are not included. There are about 11.3 billion hectares of biologically productive area, corresponding to roughly a quarter of the planet's surface. These 11.3 billion hectares include 2.3 billion hectares of water (ocean shelves and inland water) and 9.0 billion hectares of land. The land area includes 1.5 billion hectares of cropland, 3.5 billion hectares of grazing land, 3.9 billion hectares of forest land, and 0.2 billion hectares of built-up land.

The remaining three-quarters of Earth's surface, including deserts, ice caps, and deep oceans, support comparatively low levels of bioproductivity that are too dispersed to be harvested. Bioproductivity (biological productivity) is equal to the biological production per hectare per year. Biological productivity is typically measured in terms of annual biomass accumulation. Both the biocapacity and ecological footprint data are expressed in units of hectares per person.

Use these data to calculate the ecological deficit or surplus for each nation. This is the difference between what a nation uses (the footprint) and what it has available (the biocapacity). Rank the nations in order of decreasing surplus and increasing deficit. What patterns emerge from this ranking in terms of geographic area, developed versus developing nations, population size, and so on? Calculate the global ecological deficit or surplus. What does that number suggest about the sustainability of our current way of life on the planet?

ADDITIONAL READING

WWF International. Living Planet Report 2004. *WWF Gland, Switzerland: UNEP World Conservation Monitoring Centre, Global Footprint Network, 2004.*

STUDENT LEARNING OUTCOME

- Students will be able to describe the components of a nation's ecological footprint.

renewable fuels such as fuel wood and animal feed. One kilogram of gasoline contains 11,228 kcals compared to only 3,822 kcals in one kilogram of animal feed. This means a kilogram of gasoline has the potential to do three times more economic work than animal feed. New machines and methods of production were developed to use fossil fuels. These included the internal combustion engine (used in automobiles), electric motors, the gas turbine (used in aircraft), and the steam turbine (used in electric power plants). The jet engine on a commercial aircraft can generate 100,000 times more horsepower than a draft animal (Table 10.3).

We can summarize these changes with the observation that the percentage of total work done in industrial economies by labor and draft animals has declined steadily since 1850. These animals have been replaced by more powerful energy converters—machines that use energy—that burn large amounts of fossil and nuclear fuels. The increase in the energy use per worker enabled GDP to increase faster than the number of laborers. This, in turn, increased labor productivity and per capita GDP.

The effect of a larger energy subsidy for labor is illustrated by the changes that took place in agriculture (Figure 10.14). Using only a hoe a single farmer may need 400 hours to till one hectare (2.5 acres). By hitching oxen to a plow a single farmer can prepare the same hectare in about 65 hours. This change represents a sixfold increase in the farmer's productivity. When attached to a tractor, a 50 horsepower internal combustion engine allows a farmer to prepare the same hectare in just 4 hours, a hundredfold increase in productivity. Similar improvements in productivity have occurred in every other sector of the economy when technologies capable of using fossil fuels have become widely available.