CARRYING  CAPACITY  AND  ECOLOGICAL  FOOTPRINT

Question 2-1: Select one of the items in the following list and write a few sentences arguing that it is a carrying capacity issue, and then argue that it is not.

a.  Die-offs of squirrels on your campus
b.  The loss of 70,000 km$^2$ of cropland each year due to nutrient depletion
c.  Increasing vehicular traffic and “road rage” incidents
d.  Record high prices for heating oil and natural gas in recent winters in the northeast United States and elsewhere

This question is designed to encourage students to look at events whose causes might be easily explained from a carrying capacity viewpoint. Some students will resist and argue that each item has a logical explanation that has nothing to do with carrying capacity.

Question 2-2: What indicators, environmental or otherwise, would support the assertion that the United States had exceeded its carrying capacity? One possible example: export of hazardous waste to developing countries.

Several indicators support the assertion that the United States has exceeded its carrying capacity: long-term record of topsoil loss; conversion of forest to urban use; long-term degradation of air and water; long-term species loss; loss of agricultural land; traffic gridlock and road rage; homelessness; loss of open space and wetlands; export of municipal solid waste; and riots in inner cities.

Question 2-3: It has been stated that everyone in the United States could fit comfortably inside the state of Texas. The mid-2012 U.S. population was 312 million. The area of Texas is 261,914 square miles (67,835,000 ha). Calculate how many acres and hectares each person would occupy if all U.S. residents (in 2012) lived in Texas (1 mi$^2$ = 640 acres; 1 acre = 0.4 ha).

$$312 \times 10^6 \text{ people} / 261,914 \text{ mi}^2 = 1,191.2 \text{ people per square mile}$$
1,191.2 people/mi$^2 \times 1 \text{ mi}^2/640 \text{ ac} = 1.86 \text{ people per acre}

1.86 \text{ people/ae} \times 1 \text{ ac}/0.4 \text{ ha} = 4.65 \text{ people per hectare}

Thus, each person in the U.S. could have over 23,000 ft$^2$ of space if we all lived in Texas.

Question 2-4: How many times larger would Texas need to be, assuming all Americans lived there and each American required 8 hectares?

$$312 \times 10^6 \text{ people} \times 8 \text{ ha/person} \approx 2.5 \times 10^9 \text{ hectares}$$

The area of Texas is 6,780,000 hectares. As the calculation below shows, Texas would need to be 354.6 times larger:

$$\frac{2.5 \times 10^9}{7.05 \times 10^6} = 354.6.$$

Question 2-5: The surface area of the Earth is 15 billion hectares. Now assume all 7.05 billion people on Earth in 2012 lived like Americans. How much area would be needed, assuming all lived with the ecological footprint of Americans? Report your answer in hectares and acres. How many more planets with the surface area of Earth would be required?

Here is how much area would be needed:

$$7.05 \times 10^9 \text{ people} \times 8 \text{ ha/person} = 56.4 \times 10^9 \text{ ha}$$

$$56.4 \times 10^9 \text{ ha} \times 1 \text{ ac}/0.4 \text{ ha} = 141.0 \times 10^9 \text{ ac}$$

$$141.0 \times 10^9 \text{ ac} \times 1 \text{ mi}^2/640 \text{ ac} = 220.3 \times 10^6 \text{ mi}^2$$

Here is how many more planets would be required:

$$(56.4 \times 10^9 \text{ ha})/(15 \times 10^9 \text{ ha}) = 3.76 \text{ more planets}$$

Note: this answer is misleading because the current population of the planet is not living sustainably now on the 15 billion hectares.

Question 2-6: Summarize the major points of this Issue.

An outline is one way to have students begin to answer this question. It will be interesting to see the variations in students’ perceptions of what points are important in regards to carrying capacity and ecological footprint.

Question 2-7: Evaluate the carrying capacity of the United States from the standpoint of sustainability.
Students may conclude that the current U.S. population is fundamentally unsustainable. You might raise issues regarding problems posed by an ageing population, like in Italy. Some students may assert that resource efficiencies and renewable energy can allow a large population to live sustainably. Those students who make this point should be encouraged to provide specific examples.

FOR FURTHER THOUGHT (ANSWERS TO SELECTED QUESTIONS)

Question 2-8: Americans use a disproportionate portion of the Earth’s resources. Discuss reasons why this is so.

Possible reasons include the following: America’s high economic production requires a greater use of raw materials; Americans are more influenced by or exposed to advertising than are people in other countries; America needs to produce more to provide its citizens with a high standard of living; Americans waste more than people in other countries; America’s access to cheap raw materials encourages waste; the rest of the world lends America money to encourage imports; and America exports a lot of products.

Question 2-9: Discuss whether the use of resources by Americans is a fair allocation of the planet’s resources.

Many economists say we can infinitely substitute when resources decline; in other words, human ingenuity can compensate for scarcity. Examples of such human ingenuity might include substituting plastic for wood or aluminum for copper. But how far are we willing to go to alter the natural environment to provide for our wants?

Also, there is the issue of wasted heat. Since energy production from combustion is relatively inefficient, we produce ever-increasing amounts of wasted heat when we burn fossil fuels. A typical gasoline engine wastes 90 percent of the fuel’s energy, for example. The use of renewable resources and fuel cells in the future could help to eliminate this waste.

Soil loss (also a big problem) may determine sustainability in the long run.

Finally, is it essential, important, desirable, or irrelevant to preserve natural systems? To what extent?

Question 2-10: Is our use of resources sustainable? Why or why not? Cite specific examples and document your assertions with evidence.

Our current use of resources is not sustainable, particularly if we wish to protect natural environments. In this context, Brazil’s use of sugarcane to produce transport fuels is a good topic to introduce to students.

Question 2-11: Because estimating an area’s human carrying capacity is inexact and difficult, some would argue that the concept is useless. Do you agree or disagree? Explain and justify your answer.
Some people argue that the uniqueness of humanity—our ingenuity—can solve anything. Thus, carrying capacity has no value to them. Other people are more troubled by racial and ethnic conflicts, inequalities and conflicts over resources, the state of our environment, and our overall quality of life. For them, carrying capacity is central to our stewardship of Earth.

**Question 2-12:** Conduct a search on the web using the key words “ecological footprint.” Once you have accessed a suitable site, calculate your footprint. How does your ecological footprint compare to others? What actions could you take to reduce your footprint?

A wide spectrum of responses is to be expected here. Instructors should ensure responses are based on fact and logic, reflect critical thinking skills, and identify assumptions.