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AS I SEE IT

You and Earth's resources

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The illusion of freedom will continue as long as it's profitable to continue the illusion. At the point where the illusion becomes too expensive to maintain, they will just take down the scenery, pull back the curtains, and you'll see the brick wall at the back of the theater. Frank Zappa

The planet's human population, now at over 6 billion, is expected to increase to 10 billion by 2050. Earth is a finite planet with finite resources, so the decisions humankind makes in the first part of the twenty-first century will affect the lives of posterity as well as current generations. A major problem is that human society now considers exponential growth as normal. In the past, evolutionary selection, both biological and societal, has favored 'ecological fitness', which includes success in acquiring resources. Persuasive evidence indicates that some cultures have lived sustainably for many generations; however, equally persuasive evidence shows that cultures with too many unsustainable practices have collapsed.

Sustainable use of the planet is closely linked to individual behavior and societal practices. In the past, cultures lacking appropriate behaviors and practices collapsed without taking any, or only a few, other cultures with them. Now globalization has increased the probability that excessive individualism and modest levels of cooperation will fail on a finite planet with a finite carrying capacity. Hardin's (1968) classic article noted that individuals will exploit anything that is free in order to maximize their own advantage, which entails a cost to society as a whole. Hardin (1993) used a lifeboat as a metaphor to illustrate the concept of carrying capacity. A lifeboat has a finite capacity before it sinks. Hardin stressed that nations have carrying capacities as well. Catton (1980) asserts that exceeding or overshooting carrying capacity will result in a crash; however, an ecological understanding of the causes of the crash might halt a total loss of humanity. In addition, using reason coupled with intelligence and knowledge might make the crash avoidable.

During the twentieth century, life span and material affluence increased, but with concomitant massive ecological damage. The *ecological footprint* approach shows that humankind can live a fulfilled life in harmony with natural systems. 'The ecological footprint is a measure of the "load" imposed by a given population on nature. It represents the land area necessary to sustain current levels of resource consumption and waste discharge by that population' (Wackernagel & Rees 1996). The concept of the ecological footprint is a superb means of determining the disparity in the distribution of Earth's resources to both individuals and nations.

Arguably, the best way to approach the ethical issues involving humankind and Earth's resources is the calculation of an individual's ecological footprint (e.g. www.lead.org/leadnet/footprint/food.cfm, www.earthday.net/footprint/quiz.asp). In addition, factors that are most important in estimating the size of an ecological footprint are useful (www.redefiningprogress.org/programs/sustainabilityindicators/ef/faq/). The weighting of factors produces somewhat different footprint sizes. Calculation programs for estimating ecological footprint size are also available for communities, nations, and so on.

Most affluent individuals, especially those in wealthy nations, are shocked at what a large ecological footprint they have. The term *affluent* is relative. Middle-class Americans would deny being affluent, but even a casual perusal of the superbly illustrated book *Material World* (Menzel 1994) will quickly disabuse them of this illusion.

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The book's photographs show the material possessions of a cross section of families around the globe. For an American, these photographs are disturbing, especially the two on the book's cover. The text and statistics that accompany the pictures are equally revealing but lack the emotional impact of the photographs.

Rees (1996, his figure 2) provides another view of this critical situation. Essentially, the Netherlands depends on the ecological productivity of an area nearly 15 times larger than the country itself. In short, ecological footprint size is not determined by the area occupied, but by the area required to maintain the present consumption of resources.

Societal action on the ecological footprint information requires both ethics and science. In the middle of the twentieth century, the established dogma was that ethics and science should not commingle. I encountered this belief when I began research on water pollution in 1948. Those scientists with the temerity to deviate from 'pure science' were regarded with contempt by some, with amusement and pity by others. However, enough support was available to encourage us. Gradually over the next half century mainstream science increasingly accepted science and ethics as a construct. The crucial relationship between ethics and science began to be recognized, even applauded. However, the elation I felt was brief.

In some departments of American universities and colleges, science then began to be regarded as just another value judgment. The consilience (literally, leaping together) of ethics and science had been impaired. In addition, in the US, political efforts surfaced to disrupt the scientific process, including peer review; 'junk science' was given major attention. This situation has resulted in critical responses from such groups as the Union of Concerned Scientists (Meyer 2004) and the graduate students and faculty of Stanford University (see www.scienceinpolicy.org/, a document signed by a number of scientists worldwide and discussed in the news media [e.g. Revkin 2004]). The dangers of disrupting and denigrating the scientific process are already apparent. Fortunately, individuals can make ethical decisions based on the verifiable information used in determining ecological footprint size and by using voting and purchasing power to influence both political and corporate positions.

Some illustrative issues involving ecological footprint size follow.

1. If one's ecological footprint is significantly larger than the world average, what action should one take? (For the twentieth century, the available per capita ecological space has decreased from 5–6 hectares to approximately 1.5 hectares; the world average is about 1.8 hectares/person [Wackernagel & Rees 1996, pp. 85, their Table 3.4].)

2. Should all products and services be labeled to indicate how much they will increase one's ecological footprint size?

3. On a finite planet with finite resources, should there be a limit on ecological footprint size?

4. How can individuals, corporations, and nations with no conscience be limited in ecological footprint size?

5. Should ecological footprint size be regulated for transportation and other energy intensive activities?

6. The ecological footprint size of India is approximately 0.4 hectares/person. What should the response of nations with large ecological footprints (e.g. 5.1 hectares/person in the US) be if India's population continues to grow and the present tenuous carrying capacity is exceeded?

7. How should ecological deficits (the level of resource consumption and waste discharge by a defined economy or population in excess of locally/regionally sustainable natural production and assimilative capacity [Rees 1996]) be eliminated?

8. Since resources are finite on a finite planet and humankind is either approaching or has exceeded global carrying capacity, how can equity and fairness in resource distribution be achieved?

9. How can global consensus be reached on whether the goal is maximum number of people (lower quality life) or optimal number of people (higher quality life)?

10. What is the equitable and fair distribution of resources between one species (*Homo sapiens*) and the other 30+ million species with which humans share the planet?

11. If humankind overshoots global carrying capacity and causes a major ecological catastrophe resulting in decreased carrying capacity, how should this issue be addressed in terms of ecological footprint size?

12. Since some nations and cultures will live more sustainably than others because their population is more stable and more concerned about the size of their ecological footprint, what should they do when environmental refugees attempt to move into their ecosystem? Additionally, how will these comparatively prosperous, attractive countries avoid threats of resource wars and terrorism?

Excessive faith in technology and economics has fostered a belief that the planet's carrying capacity for humans is infinitely expandable. If this belief were true, the ecological footprint size would be a matter of academic interest, rather than a valuable concept for understanding sustainable use of the planet. However, the human population is still growing, as are expectations of more material goods per capita. Earth's resource base is simply not keeping up with expectations, and the present level of affluence is only possible because natural capital is being consumed at a greater

than replacement rate. Even if the new technology does increase the resource base, the human population will expand to utilize the newly available resources, thus ensuring only a temporary increase in resources per capita.

In addition, new technologies may have undesirable side effects. For example, genetically modified potatoes may be able to immunize humans against hepatitis B and cholera, but uncertainty exists about the containment of the modified genes. In March 2004, voters in Mendocino County, California, US attempted to ban the propagation, cultivation, raising, and growing of genetically modified organisms. Whatever the outcome of this battle between concerned citizens and the biotechnological industry, this battle will probably be fought globally for many years to come. Whatever the outcome, a long-term increase of resources per capita is doubtful.

The twenty-first century represents a defining moment for humankind. This globally dangerous period of human history has two major threats: (1) overshooting global carrying capacity for humans and (2) major damage to Earth's ecological life support system as well as natural capital and the ecosystem services it provides. Should humankind fail to replace unsustainable practices with sustainable practices before the middle of the twenty-first century, this irresponsibility and lack of concern for posterity will probably result in global catastrophe. Humankind must repudiate some beliefs and alter its attitude towards technology and exponential economic growth. Technology can be extremely useful, but it cannot develop ethics or values — humankind can. No robust evidence is available that technology can replace natural capital or that the remaining store of natural capital is adequate to meet indefinitely the demands placed upon it. Arguably, reduction of Earth's carrying capacity for humans may be the major problem of the twenty-first century.

Lotka (1925) remarked: 'It is not so much the organism or the species that evolves, but the entire system, species and environment. The two are inseparable.' All individuals are dependent upon this entire system, so it is prudent not to damage its processes for individual short-term gain.

LITERATURE CITED

Catton WR (1980) Overshoot: the ecological basis of revolutionary change. University of Illinois Press, Urbana, IL

Hardin G (1968) The tragedy of the commons. Science 162: 1243–1248

Hardin G (1993) Living within limits. Oxford University Press, New York

Lotka A (1925) Elements of physical biology. Williams and Wilkins, Baltimore, MD

Menzel P (1994) Material world: a global family portrait. Sierra Club Books, San Francisco, CA

Meyer A (2004) Bringing science back to the people. Catalyst 3(1):2–4

Rees WE (1996) Revisiting carrying capacity: area-based indicators of sustainability. Popul Environ 17(3):1–22

Revkin AC (2004) Bush climate plan rated somewhat improved. New York Times 19Feb

Wackernagel M, Rees W (1996) Our ecological footprint. New Society Publishers, Gabriola Island, British Columbia

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