The Future Eaters: Metaphors and Aphorisms as Environmental Teaching Tools

John Cairns, Jr.

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A collection of papers by
John Cairns, Jr.

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met·a·phor
Pronunciation: \ me-tə- fo*r̓ also* -fər\
Function: *noun*
Etymology: Middle English *methaphor,* from Middle French or Latin; Middle French *metaphore,* from Latin *metaphora,* from Greek, from *metapherein* to transfer, from *meta-* + *pherein* to bear — more at bear
Date: 15th century
1 : a figure of speech in which a word or phrase literally denoting one kind of object or idea is used in place of another to suggest a likeness or analogy between them (as in *drowning in money*); *broadly* **:** figurative language — compare simile
2 : an object, activity, or idea treated as a metaphor

aph·o·rism
Pronunciation: \ a-fə- ri-zəm\
Function: *noun*
Etymology: Middle French *aphorisme,* from Late Latin *aphorismus,* from Greek *aphorismos* definition, aphorism, from *aphorizein* to define, from *apo-* + *horizein* to bound — more at horizon
Date: 1528
1 : a concise statement of a principle
2 : a terse formulation of a truth or sentiment **:** adage

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FOREWORD

I take it as axiomatic that metaphors are essential to communicating complex topics. In 1995, I began explicit introduction of activities to focus student awareness of metaphors in communication. In 2002, I received a small grant to investigate and develop materials for the applications of metaphors in science education. Among many other findings, two really stand out: authors Miller (*The Body In Question* 1978) and Bronowski (*Science and Human Values* 1965) clearly illustrate the utility, if not the necessity, of using metaphors and alternative approaches to communications in and about science. At any level of discourse, access to adequate shared or explicit metaphors facilitates meaningful communication. So important are they that a wide body of technical literature (such as *Women, Fire and Dangerous Things: What Categories Reveal about the Mind*, Lakoff 1987 and *Metaphor and Thought*, Ortony1993), among others) goes far in stimulating conversation and thought on their applications.

I teach high school science. Specifically, I teach high school biology, chemistry, anatomy, and physiology, and, from time to time, advanced placement biology. In the past, I have also taught physics. I teach these classes with a deliberate awareness of the symbolic, metaphorical, analogic, or aphoristic approaches to communicating with my students about the topics. In the past, I have engaged my students in extensive self study of explicit and implicit metaphors that influence their school experiences. Postman's (1995) *The End of Education: Redefining the Value of School* contains an excellent introduction to this approach in the chapter "The Word Weavers/The World Makers." So, not only have I tried to engage students in the impact of metaphors on their lives (if we see them as seedlings to be nurtured, we treat them differently than if we see them as resources to be honed into a finished product), but I also try to give them ample opportunities to become aware of their own needs and applications of metaphors in their own understanding of the scientific topics they study.

These activities have led to assignments in which students make their applications of metaphors explicit to such subjects as atomic structure, cell anatomy and physiology, DNA transcription and translation, and various other topics. I also, from time to time, point out to them the limits of metaphorical descriptions and the pitfalls of sticking to a metaphor beyond its useful applications. This work has led to my involvement in more technical research studies of the applications of metaphor, such as in the work of Reese (2003).

I write all this by way of showing that the use of metaphors is not something that I enter into casually. I have given it explicit thought in preparation of materials and activities for my students and have paid attention to their engagement of the application of and study of metaphors over the years. I am always on the lookout for additional information about metaphors and more metaphors for them to apply. This collection of writings by John Cairns are among some of the more useful ones I have encountered.

Several years ago, when I was developing materials for my students to use in studying the concepts associated with "sustainability," I came across the works of Cairns. I was immediately taken by several aspects of his work. First, of course, was the extensive and elaborate scientific background that he has. His meaningful contributions to the field of ecology and associated areas, in his own research and his sponsorship of graduate students, are without question. Anyone interested in the extent of these contributions can examine his vitae at his web site (http://www.johncairns.net). I wanted to be sure my students were accessing a sound scientific foundation. However, his articulate way of expressing complex and complicated interdisciplinary concepts, often with a sharp wit and pointed voice, most drew my attention to his work, and, consequently, also drew the attention of my students. Several of them completed class "final projects" in which they analyzed some of Cairns' writing – responding to and critiquing his works as they applied to the topics being studied in the sustainability sessions of our study of ecology and environmental science. One student, who had presented intelligent disagreement with some of Cairns' views while in high school, upon engaging related material her first year at the University of Virginia, wrote to say she felt that the class, and his writings, had given her a good background with which to work.

Over the years, as I continued to read Cairns' works, I began to note how he had a consistent way with words, often taking complex topics and succinctly, clearly, and, sometimes, forcefully bringing home his point – even coming across at times as very bold and an in-your-face manner in his message. These writing characteristics point out to the considerate reader that the topics on which he writes, and the message that he sends, are increasingly of urgent and important concern. One writing skill is his ability to hone a fine point with a metaphor that immediately brings home the "meat" of his message, making the content and intent clearer and memorable. The writings in this collection are exemplars of concision and clarity. Almost all, even the briefest, cite references that have been synthesized into his comments.

So, in my classes, I explicitly use metaphors to illustrate and elucidate essential meanings associated with the topics. I incorporate explicit activities to give students opportunities to study the metaphors they use

and to create/play with their own. I try to show students how the metaphors that professionals and policy makers use impact how they are treated in their schooling. I refer them to, and sometimes require that they engage, materials that present complex and complicated issues and concepts using metaphorical applications. I have found Cairns' works particularly useful at times in addressing issues in environmental science.

To bring home the point, since I want my students to be able to hit the ground running and have the tools to overcome the barriers on the path to understanding and assimilating information, transforming it into food to nourish their growing minds in this garden of learning called school, his writings present a cornucopia of meaningfully prepared nutrients to help sate their hunger. His words will help them to see the elephant in the classroom and avoid creating an alien planet while they hone the skills and develop the tools to stop, or at least slow, the future eaters.

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PREFACE

The genesis of this e-book was an invitation to act as a Special Guest contributor for the E-Conference "Climate Change and You: Putting a Face on Global Warming" (EcoRes Forum Online Conference #3, October 19-29, 2009, www.eco-res.org). Special Guests were asked to make two postings before the beginning date of the conference and to make two postings each day thereafter. From my participation in previous e-conferences, I know that short postings are most effective. I began the writings using metaphors and later moved on to aphorisms. The title of this E-book comes from an earlier publication I had based on a metaphor.

The final impetus came via an e-mail from a teacher at a local high school, with whom I had worked some years ago. He was inquiring about any books in print on the use of metaphors in teaching. Consequently, this e-book has two goals: (1) to reach as many teachers and students as possible (free for downloading should aid in this goal) and (2) to add to the e-book after its first appearance with updates).

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THE FUTURE EATERS

I don't think God is going to ask us how He created the earth, but He will ask us what we did with what He created. Rich Cizik

In times of change, learners inherit the Earth, while the learned find themselves beautifully equipped to deal with a world that no longer exists. Eric Hoffer

You're not going to get success on the environmental struggle without getting people to agree to cut back their level of consumption and reorder the planet in a way that is ecologically rational. Rabbi Michael Lerner

A visitor to a village in Russia where the inhabitants were starving noticed some stacks of grain nearby. "Why," he asked, "don't you eat that grain?" The patriarch impatiently explained that the seed was being saved for next season's planting. "We do not steal from the future," he said. The 20% ecological overshoot (discussed elsewhere at this website or at the internet site of the Global Footprint Network) in 2002 took 20% more natural resources than the planet could regenerate. The United States now has an ecological overshoot of 3.6 hectares per capita. This overshoot is a measure of how humankind is "eating" its future.

Exceeding Earth's carrying capacity will almost certainly result in societal and ecological disequilibrium that will, in turn, reduce carrying capacity. However, another situation, called phantom carrying capacity, will exacerbate present carrying capacity problems. Phantom carrying capacity is the result of exploiting the benefits of oil, natural gas, and coal. These energy sources will not be regenerated in the short (i.e., a quick fix) time frames that most people expect. Alternative sources of energy could contribute to reducing ecological footprint size. For example, biofuels produced by agribusiness are typically produced by highly mechanized practices, use fertilizers that are based on petroleum, and require processing before they are useful in engines. The amount of energy used in the production of alternative sources of energy contributes to the footprint size. Some sources, such as the Athabasca tar sands, are difficult to process and require significant amounts of energy to do so.

Solar and wind energy are good alternative energy sources, but they do not have zero footprint size (e.g., they involve solar panels and windmills). Reestablishing public transportation in those countries that have permitted, even encouraged, its decline will take one or more decades. Major reductions in urban sprawl will take longer, even if adequate public transportation becomes available. Eliminating ecological overshoot is closely linked with population stabilization, but could begin immediately if humankind is truly concerned about future generations.

Only those humans alive after 1980 can be described as "future eaters" or people who consume "grain"/resources that are meant for future generations—future eaters are stealing from the future. Individual future eaters have probably always existed because numerous cultures have depleted natural resources faster than they were being regenerated (e.g., Ehrlich and Ehrlich 2004, Diamond 2005). However, economic globalization and population growth have increased humankind's ability to deplete natural resources. As usual, exponential growth ensured that the problem materialized quickly, long before social evolution had developed behaviors and practices to cope with this dangerous situation.

No justification can be given for not addressing this problem immediately!

Step 1. Calculate individual ecological footprint sizes. Many programs are available on the internet for calculating an individual's ecological footprint size and can be rapidly completed (a more detailed reference is Rees 1996). The result may be shocking, especially if the calculation is for a person who considers him/herself environmentally literate and who could not possibly be a future eater.

Step 2. Identify the major factor that determines an individual's ecological footprint size. Both the ecological footprint size and control of the footprint size will vary at different stages of an individual's life. Individuals have least control when they are very young or very old. My own life (I am 82 years old) illustrates this point.

I was born in the small factory town of Conshohocken, Pennsylvania, USA, in 1923. I grew up during the time of the Great Depression in the United States. My family's house was small, semi-detached (one wall shared with an adjacent house), and heated with coal. In those days, most houses were kept much cooler than they are today and had far fewer energy consuming appliances. I walked to school and used public transportation for longer trips. I could ride my bicycle to go fishing or to visit natural systems. The family automobile was mostly used on weekends to visit relatives (20 miles or less). Food was obtained from a nearby small grocery store and was mostly produced locally. Most summers included a vacation (two weeks) near Ocean City, New Jersey (about 80 miles distance). When I became a student at Pennsylvania State University in 1940, all my clothing fit in one suitcase and I carried a winter overcoat over my arm. Once there, all my travel was by foot. Although I had little control over it, my ecological footprint was quite small. For most of my education after World War II, I commuted by public transportation but did have a car for a significant amount of time that was adequate for short trips.

My ecological footprint size increased markedly, mostly due to energy used for travel, when I became a staff member at the Academy of Natural Sciences, Philadelphia, Pennsylvania. Professional field trips were frequent, as were trips to give seminars, present papers at professional meetings, complete service for professional societies, and the like. The twenty years between 1980 and 2000 was the peak time for traveling to present professional talks. My hope is that this travel helped reduce environmental problems; however, in view of the present ecological overshoot, I fervently wish an alternative had been available. The fact that those trips and many others were by invitation does not appreciably diminish my regret.

In the late 1990s, my wife's Alzheimer's (and, later, also Parkinson's) reached a stage where leaving her to present professional talks, even briefly, was not an option. In July, 2005, my website was set up—it has been a joy to have, and it enables me to share my thoughts with others. In March 2000, my wife and I moved into a townhouse in Warm Hearth Retirement Village. We had considerable control over our ecological footprint size, and we were not future eaters. However, in June 2001, my wife was moved to a nursing home, and, in September 2002, I moved to an assisted living center where I was close to her in the same retirement village. My wife had little or no control over her ecological footprint size, and my current control has been greatly reduced. However, I can control energy use, which has been minimal. I have an automobile, but I drive it less than 1, 200 miles per year. The communal dining room produces a small ecological footprint because of the economy of scale. In short, social norms have a significant effect upon my present ecological footprint size.

Step 3. Attempt to influence social norms so that group ecological footprint size is reduced. Influencing social norms is not an easy task, but economics (e.g., increased energy costs) has a significant influence on social norms. Europe has made commendable progress in this area and has developed many practices suitable for sustainable use of the planet. However, some recalcitrant individuals may require substantial peer pressure to even begin reducing ecological footprint size. If the resistance is substantial, perhaps only a major catastrophe will persuade people to adopt sustainable practices. Alternatively, strict laws on resource use similar to those existing during World War II may be necessary. Of course, a black market will almost certainly arise for scarce resources. As usual, powerful political leaders may manage to circumvent the rules that apply to the average citizen. The "reasoning" of non-conformists is difficult to understand. Globalization has leveled the "playing field" to a substantial degree, but adjustment to this new era will initially be slow.

Step 4. Adjust politically to the reduction of the power of nation-states and concomitant regionalization of power. Ecological overshoot may not result in the decline of powerful nation-states that, because of diseconomies of scale, lose power as resource wars continue nor will resource scarcity result in regionalization of power. Terrorism and vulnerability of societal infrastructure may ultimately favor regionalization, but the waste of resources and life might be substantial.

Cognitive Dissonance

Cognitive dissonance is anxiety that results from simultaneously holding contradictory or otherwise incompatible attitudes or beliefs. An individual may have a bumper sticker that reads "STOP GLOBAL WARMING" on a sports utility vehicle (SUV) that consumes very large amounts of gasoline or diesel fuel per mile. Since fossil fuel is a major source of carbon dioxide – a major factor in global warming – one owner justified owing a SUV by stating that ownership of such a vehicle might not be possible in the future.

Cognitive dissonance is also apparent at the national level. For example, both Zhenhua (2006), Director, State Environmental Protection Agency, China, and Narain (2006), Director, Center for Science and Environment, India, made statements that clearly espoused environmental protection, yet both India and China are increasing the use of fossil fuel. China has begun to gear its international strategy to its energy needs, and India has energy guzzling congestion at airports and on city streets (Editorial 2006). Of course, my previous travels to present talks about environmental protection are another good example of cognitive dissonance, all

too frequently shared by other speakers. Many freedoms will suffer (e.g., freedom to breed) due to ecological overshoot and exceeding the planet's carrying capacity for humans. Yet these issues are rarely discussed in depth because a free and open exchange of ideas is a threat to cognitive dissonance. This situation is particularly evident during political elections when promises are made (1) to reduce taxes, (2) to increase benefits, and (3) to continue wars (a rose by any other name, etc.). The result of this cognitive dissonance is increased financial and ecological deficits and societal disequilibrium. Without cognitive dissonance, "future eating" would be greatly diminished or even disappear.

Who Ate the Future?

All humankind is responsible for consuming (i.e., "eating") natural resources essential to the maintenance of a habitable planet. A global 20% ecological overshoot (in 2002), which has worsened for decades, is the responsibility of the entire human species.

One would expect the world's religions to have a major role in establishing humankind's moral responsibility to posterity. The United States has a large ecological deficit and an excessive ecological footprint, both as a nation and for most individual citizens. How can this situation be explained when a nation that claims to be religious is taking far more than its share of the world's resources?

The world's leaders have, with some notable exceptions, espoused exponential economic growth with dangerous diseconomies, which threaten both global and national security. However, in countries with democracies, the people voted for these leaders but are not holding them accountable for their actions. In far too many cases, American citizens did not even trouble themselves to vote. The world badly needs leaders who have policies to correct the present dangerous situation and are not afraid to tell their constituents about the difficult road ahead (short-term) or the consequences of not making a mid-course correction. The candidate who does so would probably not get elected but would be doing (long-term) a great service to society.

Warnings

Although the news media and the scientific community could have greatly improved communications with the general public about the rapidly developing environmental crises, no literate person should have missed the message. Hansen (2006), a climate scientist in the US National Aeronautics and Space Administration (NASA) has attempted to alert both the scientific community and the general public that the huge Greenland ice cap is melting far faster than scientists had estimated. Twice as much ice is going into the ocean as was going in five years ago. Just sea level rise alone is a major cause for concern, but many others exist also. However, Hansen's recommendations for reduction of greenhouse gases did not meet the approval of NASA's public affairs team (staffed by political appointees), who tried to stop him from communicating this information. Gilbert and Sullivan would have loved this scenario – a research scientist in a US government agency who is attempting to inform the general public but is being opposed by public affairs personnel in the same agency. How about "I am the very model of a public affairs officer" to the tune of "I am the very model of a modern major-general"?

James Zachos, professor of Earth Sciences at the University of California at Santa Cruz, gave a talk on greenhouse gas emissions at the meeting of the American Association for the Advancement of Sciences (AAAS), February 17, 2006 (Paul R. Ehrlich, personal communication). He noted that human activities are releasing greenhouse gases more than 30 times faster than the rate of emissions that triggered a period of extreme global warming in Earth's past. At the same AAAS meeting, David Baltimore, Nobel Prize recipient and president of the California Institute of Technology, stated, "It's no accident that we are seeing such an extensive suppression of scientific freedom. It's part of the theory of government now, and it's a theory we need to vociferously oppose" (Dean 2006). Baltimore remarked that instead of twisting science to suit its own needs, government should be the guardian of intellectual freedom.

Despite these concerns about the Bush administration's political interference with science, the US Environmental Protection Agency (USEPA) is requiring prior headquarters approval for all communications by its scientists with the media (Environmental News Service 2006). The news director for USEPA's Office of Research and Development (ORD) sent a February 9, 2006, email to all staff: "We are asked to remind all employees that EPA's standard media procedure is to refer all media queries regarding ORD to Ann Brown, ORD News Director, prior to agreeing to or conducting any interviews. ... Support for this policy also will allow reasonable time for appropriate management response." In contrast, NOAA Administrator Conrad Lautenbacher told the *Washington Post*, "I encourage scientists to conduct peer-reviewed research and provide honest results of these findings" (Environmental News Service 2006).

Almost without exception, public statements made by scientists are based on research that has passed peer review in professional journals or at professional meetings, such as the AAAS meeting just mentioned.

Thus, the information is already in the public domain and would not be improved by comments from public relations personnel with no formal scientific credentials. If permission is required for scientists to meet with the media, the public's right to acquire valid scientific evidence has been seriously impaired, if not destroyed. American tax dollars are used to maintain this political interference in the scientific process. If this unscientific procedure is continued, then an organization, such as the US National Research Council, with credentialed scientists, should be set up to evaluate the effect of public relations staff on the communication of scientific information to the general public and the media.

Some reporters claim they find science journals harder to trust and not easy to verify (Bosman 2006). The incident that prompted this comment was the fabrication of evidence on human cell cloning by Dr. Hwang Woo Suk, a South Korean scientist. The prestigious journal *Science* retracted two papers of Dr. Hwang's when they received much publicity from the news media. The scientific peer-review system typically works very well, but failures inevitably occur. In this instance, the scientific process did identify the problem, and relatively quickly. To place this particular situation in perspective, the violations of ethics in the US Congress, corporations, and the news media itself can be cited. In contrast, the scientific process worked swiftly and conclusively. More personnel with some scientific credentials would be helpful to newspapers, news magazines, wire services, and television networks. One could then reasonably expect the same level of expertise that exists in sports, fashion, and movies.

Somebody Do Something

Individual environmental catastrophes make the news almost daily. Both individual scientists (including Nobel Prize recipients) and prestigious scientific organizations are alarmed at the rate of change in global warming, environmental pollution, and the like. Many promises have been made, but the unsustainable practices that created these problems continue and even increase. These unsustainable practices harm humankind, numerous other life forms, and the prospects of any descendents. Just to satisfy my curiosity, I carried out an informal survey of a variety of people of different ages, economic status, and level of formal education. Some illustrative examples I received for justifying inaction follow.

"What can one person possibly do to correct problems of this magnitude?"

This statement ignores the cumulative impact of large numbers of small, seemingly insignificant decisions. For example, traffic jams occur almost continually in large metropolitan areas when large numbers of people drive automobiles to attend a sporting event or to drive to and from their place of employment. If a large number of people decided to adopt sustainable practices, use less energy, or stabilize the human population, very significant environmental benefits would result. However, until sustainable practices become a social norm, an adequate number of people must be willing to lead. "Leaders" in government, industry, and society would probably have a dramatic impact if, instead of telling people what to do, they actually practiced what they preached.

"I don't have time to be bothered with these things (i.e., environmental problems)."

What? Not enough time to leave a habitable planet for their descendents? Not enough time to prevent a global food shortage due to global warming, an energy crisis, and a 20% ecological overshoot? Not enough time to give millions of people now living in misery and starvation a modestly better life? SHAME!!! SHAME!!! How can any compassionate individual make such statements without feeling remorse?

"If you are on the Titanic, you might as well go first class."

The unsinkable ship mindset has faith that technology shields humankind from natural laws. An alternative mindset is to use credit to "improve" one's lifestyle instead of purchasing durable goods. Three quarters of American households carry debt. Basically, American citizens have a collective psychology that asks, "What are others doing and what can I get for myself?" (Gardner 2006). Surely, the crew of Spaceship Earth should have a more future-oriented mindset.

"How do I know other people will do their share?"

No one can know if others will do their fair share, or even a small part of it; the situation is similar to being in a leaky lifeboat with a group of strangers. If everybody bails, the lifeboat will float until rescue boats arrive. If not enough people bail, the lifeboat will sink and everybody, bailers and non-bailers, will be at far greater risk than they were before. At present, I am confident that the number of bailers is not adequate. This situation is an interesting test of what humankind calls intelligence!

Concluding Remarks

The 20% ecological overshoot is positive proof that humankind has too many future eaters. Anyone with a large ecological footprint is a future eater. Resource consumption and resource generation must be balanced now and kept in balance. In addition, if, as projected, 3 billion more people are added to the human

population by 2050, per capita resource consumption must be reduced to maintain the balance between resource generation and consumption. The biospheric life support system must get a sufficient share of global resources in order to maintain the conditions favorable to the human species. A major change in the biospheric life support system is unlikely to result in conditions as favorable to humans as the present conditions are and, most likely, will be far less favorable. May humans cease being future eaters and become future guardians!

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The Tyranny[1] of Tipping Points[2]

[1]I hesitate to use the term *tyranny* because of its political overtones. My colleague Joyce Akerman suggested using the term *force majeure* or *overwhelming force* as an alternative. I decided to mention this alternative since politicians the world over ignore natural law or minimize its impact. The *force majeure* of natural law can, and has, destroyed societies and their economics many times. Mother Nature does not negotiate or bargain. Violation of natural law carries severe penalties for which no court of appeals exists.

[2]This posting is a simultaneous submission for "Climate Change and You: Putting a Face on Global Warming," EcoRes Forum Online E-Conference #3, October 19-29, 2009. Further information available at www.eco-res.org.

Complex, multivariate systems (both ecological and societal) have one or more tipping points (breaking points) beyond which the state of the system changes. Often in ecological systems, no warning is given until the system changes. These changes are essentially irreversible in time frames of interest to humans. Tipping points may be global (e.g., pH of oceans) or regional (e.g., droughts in Australia, Argentina, and Kenya). Mother Nature (or natural law) has absolute power – in short, negotiations are not possible.

Even if a region has not passed a tipping point, the lives in that area may still be affected. For example, Australia and Argentina previously exported grain (wheat) and meat, but now they do not; this situation affects prices. If the new, post-tipping point conditions are particularly bad, environmental refugees are almost certainly an outcome, and they could end up on anyone's doorstep. Even if they do not, social systems will be disrupted elsewhere, and that result will affect everyone.

A major climate conference is scheduled for December 2009 in Copenhagen, Denmark. Sovereign nations will proclaim what they will or will not do on such issues as anthropogenic greenhouse gas emissions. However, they cannot negotiate with Mother Nature. If natural laws have been violated, severe consequences will ensue, even if the delegates have agreed to substantial reductions in anthropogenic greenhouse gas emissions by 2050.

If anthropogenic carbon dioxide emissions are kept within Earth's assimilative capacity for them, the concentration in the atmosphere should not increase unless positive feedback loops become worse. Much carbon is stored in frozen permafrost, wetlands, and frozen hydrated methane on the ocean floor. Global heating will cause release of methane and carbon dioxide, thus creating a positive feedback loop. Positive feedback loops can accelerate the process of global climate change and, at worst, can negate all the negotiations between sovereign nations. Once a tipping point has been passed and the situation is irreversible, adjustment to the new circumstances is the best and, in fact, the only course of action.

The concept of tipping points is covered in the scientific literature, although the term *irreversible damage* is often used to denote the same idea.

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Cast Changes on the Ecological Stage of Earth's Evolutionary Theater

The most notable feature of the history of life on Earth for the past 4 billion years has been change, which is why I used the theater metaphor for this commentary. Earth has had a comparatively stable climate for the past 10,000 years; however, it is changing mostly because of human practices.

Earth has already passed two ecological tipping points – acidification of the oceans and melting of glaciers and ice sheets – both caused by anthropogenic emissions of carbon dioxide resulting from the combustion of fossil fuels. The actions and the results are a Faustian bargain – *Homo sapiens* has accessed more energy than any other of Earth's species, but has not used it wisely. Unwise use has produced unprecedented economic growth and exponential growth of the human population, both of which have had deleterious consequences for the human species and the other life forms with which it shares the planet. Politicians and the general public have considered remedial actions, but no effective remedial actions have emerged to date. Even charismatic species, such as the polar bear, may become extinct or reduced to relic populations of little ecological significance within a single human life span.

Although I once believed in sustainable use of the planet, I no longer do. However, under circumstances far different from those characteristic of the early 21st century, I still believe sustainable use might be possible. How should humankind respond if present conditions persist until the middle of the 21st century?

If the human species is truly a part of nature – not apart from it – it should remember that species extinction is a continual process, although impressive species losses did occur during the five great extinctions, followed by dramatic rediversification over evolutionary time. Humans have greatly exceeded Earth's carrying capacity for them, and severe consequences unrelentingly have occurred for any species that exceeded its carrying capacity.

I mourn the loss of ecosystems that I enjoyed throughout the 20th century. The fossil records show that these ecosystems will probably be replaced over evolutionary time by other, quite different, but ecologically unique, ecosystems. Even so, humankind has a moral and ethical responsibility to protect the biosphere in every way possible. If humankind does indeed have a reverence for life, then acting morally and responsibly is the only possible course of action. However, if humankind fails, as E. O. Wilson states it, the result will be another roll of Darwin's dice. In short, humankind should neither hasten evolutionary processes nor impede them.

Earth as a Dynamic, Pulsing System

Even humans with an above average life span have only witnessed a minuscule fragment of life's ecological play. Most of humanity has not acquired a global perspective, and, in the United States, a Gallup Poll taken on the anniversary of Charles Darwin's birthday found fewer than 4 in 10 Americans believe in evolution (Gilgoff 2009). The numbers shrink further when Americans are asked if they believe in Darwin's theory of natural selection – Gallup puts that number at 14%, while the Pew Research Center puts it at 26% (Gilgoff 2009). Evolution is the primary unifying concept in the biological sciences and a central concept for all the sciences. Gilgoff (2009) notes that the strongest predictor of respondents' views on evolution is church attendance. Pitting religious beliefs against science is not healthy for either religion or science, and it distorts the objectivity in using scientific information to make decisions on avoiding ecological catastrophes.

Critics of Charles Darwin miss the excitement of the drama continually unfolding in the metaphor of the ecological stage in Earth's evolutionary theater. Humankind is not spectators but part of the cast, even though it acts more like a spectator than part of the evolutionary play.

Ehrlich and Ehrlich (2009, p. 64) remark: "Four decades of largely ignored population growth and related issues – especially patterns of rising consumption and their environmental effects – . . . make collapse now seem ever more likely and possibly sooner than even many pessimists think." Some prestigious organizations and people have examined the basic drawbacks of exponential population growth. They note that the most serious flaw has been too much optimism about the future. Of course, global heating has not received much attention in the past nor were endocrine disruptors even on the horizon.

Two factors make the situation worse than it was 40 years ago: (1) all global problems are interactive, making simultaneous multiple tipping points a real possibility, (2) events are moving much faster than even scientists expected. Exponential growth and positive feedback loops could easily account for changes in rate processes. Many scientists (e.g., James Hansen 2009) and some political figures (e.g., Britain's Prince Charles,

Agence France-Presse 2009) are deeply concerned about Earth's fate. Prince Charles, the heir to the British throne, has "warned that today's consumer society comes at an enormous cost to the planet and we must 'face up to the fact' that it was no longer sustainable" (Agence France-Presse 2009). Hansen (2009) remarks: "Failure to achieve the actions needed to stabilize global climate will result in great intergenerational injustice. The young and unborn in both developed and developing countries would bear full consequences of the actions of prior generations. We need to help young people draw attention to this great injustice."

The dynamic, pulsing system that is Earth has had a huge number of species on the ecological stage of the evolutionary theater. Most of them are now extinct (as many as 99%). Extinction is an ongoing process and large numbers of species go extinct between the great extinctions. In short, extinction is the norm, although some species survive for exceptional periods of time. This comment is not intended to justify driving species to an early extinction, but to note that extinctions were the norm before *Homo sapiens* appeared on the "ecological stage."

The numerous global crises should be sounding intellectual alarms almost continuously, but "business as usual" seems to be the common response. The news media obsessively pay major attention to political figures, the death of rock stars, the latest infidelities of politicians, and so on. Attention should be placed on many complex global issues: Is society immune to the ecological stress that other species bear? Does technology protect humankind from endocrine disruptors? Can humankind be confident that all climate change will be benign? Will ocean acidification be reversed by natural forces? Will the processes of evolution be suspended for *Homo sapiens*? Can the damage already done to the biospheric life support system be reversed?

Clear the Stage for Another Act

Suppose the sixth great extinction continues and *Homo sapiens* is one of the unlucky species. An unlucky species may just be reduced to a relic population (James Lovelock speculates a remaining population of about 250 million located somewhere near the Arctic Circle). Paleontology records show that, following a great extinction, the process of evolution produces a new level of biodiversity, sometimes matching the level of species biodiversity that preceded the present one. These species are the components of the new biosphere and, since they are different from their predecessors, they will not function in an identical fashion. Predicting what the next components will be like individually or how favorable they will be to humankind (e.g., atmospheric gas balance) is impossible. Furthermore, most climate change (i.e., post tipping point) is essentially irreversible (Solomon et al. 2009). How incredible that humankind would take such risks!

Reacting to These New Circumstances

From a homocentric viewpoint, horror and despair seem to be probable responses to human extinction. How can these consequences happen to a creative, intelligent species like *Homo sapiens*? It is the dominant species and suddenly seems weak and helpless. Perhaps it lacks perspective to envision 4 billion years of evolution (Ruse and Travis 2009). However, if the human species could envision the consequences, it would be more cautious and respectful of the biosphere. Wilson (as quoted in Ruse and Travis 2009, p. vii) states: "It [*On the Origin of Species* by Charles Darwin] is the masterpiece that first addressed the living world and (with *The Descent of Man* following) humanity's place within it, without reference to any religion or ideology and upon massive scientific evidence provided across successive decades. Its arguments have grown continuously in esteem as the best foundation for human self-understanding and the philosophical guide for human action. . . . The great questions – 'Who are we?' 'Where did we come from?' and 'Why are we here?' – can be answered only, if ever, in the light of scientifically based evolutionary thought."

The history of life on Earth is vast, complex, and intimidating. Still, some points deserve highlighting.
(1) Life on Earth has existed for 4 billion years – *Homo sapiens* has only been present for 160,000-200,000 years.
(2) Natural laws (e.g., limiting factors, carrying capacity) apply to all species – humans are not exempt.
(3) Some species persisted for long periods of time; others did not.
(4) After each great extinction, the process of evolution produced a great diversity of new species, most of which differed considerably from their predecessors.
(5) The process of evolution, as is life itself, is influenced by many random (stochastic) events.
(6) Six of the seven species of the genus *Homo* are now extinct – *Homo sapiens* is the sole surviving species of this genus. Is this situation due to conflicts within the genus or other factors?
(7) *Homo sapiens* has enjoyed many creative accomplishments, such as music, poetry, languages, social organization, literature, technology, and so on. However, other species have many accomplishments, such as

migrating immense distances, complex social systems, extraordinary resource partitioning, adaptation to a wide variety of climate conditions, and so on.

Life Will Continue

Will *Homo sapiens* be one of the many species lost in the sixth great extinction? Lovelock (as quoted by Zaitchik 2009) believes that humans will persist even though billions will suffer and die. Lovelock (2009) believes that humankind has overstressed *Gaia* (his name for the biospheric life support system) and pushed it beyond the point of no return, which will result in a drastic reduction in Earth's carrying capacity for humans. Nevertheless, he hopes that several hundred million humans will survive and preserve a low-carbon civilization and, presumably, a society that nurtures *Gaia*.

My speculations on the future are less optimistic than Lovelock's. Resource wars seem probable, especially if climate change decreases regeneration of natural resources. Add a pandemic disease to the resource wars and millions of refugees, and the social stability needed to preserve the technological components of civilization will be endangered. Of course, if the negotiations in Copenhagen in December 2009 fail to achieve enforceable major reduction in greenhouse gas emissions and if the positive carbon feedback loops worsen, climatic and social disequilibrium seems to be a likely outcome. If this happened, a 3°-6°C increase in global mean temperature appears probable – humankind could probably not cope with this increase. In this case, small tribes of hunter/gatherers are the best outcome to hope for.

Since humankind is the primary cause of the global problems (i.e., climate change, overpopulation, ecological overshoot/excessive consumption, ocean acidification, toxic chemicals), it might have regret but should not weep or wail about its fate. Humans should be pleased, even if life goes on without them. One great satisfaction would be the survival of the human species and another opportunity to develop a harmonious relationship with *Gaia*. If *Homo sapiens* does not survive, it may be that intelligence (as humans define it) does not provide much survival value. *Homo sapiens* was not essential for most of the 4 billion years of life on Earth, and, presumably, life can continue for more billions of years without it.

What to Do Now

Establishing guilt and blame seems to be an unsatisfactory way to spend the remainder of the 21st century. Surely, something can be done to benefit the soon to evolve "cast members" on the ecological stage of the evolutionary theater. By reducing the forcing factors causing the cast change, life could be made easier for the species that will be ancestral to the next cast. "Although Darwinian evolution rejected the Linnaean view of the Great Chain of Being, in which all living organisms were ranged in a God-ordained hierarchy, for Darwin evolution was still progressive, with lower organisms giving way to higher ones. . . . Today's Darwinists prefer the metaphor of the bush, with all currently extant species equally 'evolved.'" (Rose and Rose 2009). From this group, Mother Nature (i.e., natural selection) will determine those species that will form the next biosphere (i.e., *Gaia*). In this case, humankind should not interfere with evolutionary processes. Humans have no idea what future conditions on Earth will be like and are unlikely to choose the "fittest" species for the new conditions. If humankind wishes to preserve "civilization" as human society now defines it, then *Homo sapiens* would have to be given preferential treatment. Have humans done anything to deserve this? The question is rhetorical since Mother Nature (i.e., natural law) selects the fittest.

Conclusions

If human society effectively addresses all five global crises and restricts the global temperature increase to 2°C, civilization may be preserved if a few hundred million humans survive this level of climate change. An increase of 3°C or more will create conditions in which the survival of *Homo sapiens* is problematic. In either case, a new cast will emerge on the ecological stage of the evolutionary theater. That pronouncement should be of some comfort to those with an ecocentric viewpoint, but almost certainly not comforting to those with a homocentric point of view.

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Phantom Land and Ghost Slaves: Humankind's Addiction to Fossil Energy

Abstract : Humankind uses vast amounts of fossil energy accumulated millions of years ago. The rate of use is many orders of magnitude greater than the replacement rate. Peak oil is the most immediate problem, and replacing this rate of energy use with biofuels is problematic. Coal is an alternative but produces more severe environment problems than petroleum and is less suitable for some forms of transportation such as airplanes. Nuclear energy does not reduce greenhouse gases, but does generate troublesome waste disposal problems (e.g., one-million year storage for some components). Solar and wind power are proven alternatives, but are not likely to generate sufficient energy to replace the petroleum no longer available. The prudent course of action, then, is reduced energy consumption per capita. As the Marks et al. (2006) report illustrates, high energy and material goods consumption is not highly correlated with happiness (i.e., satisfaction). Even if high consumption were related to happiness, continued extremely high energy consumption would probably not be justified. The approximately 100-200 years of the petroleum era are a brief, aberrant period of human history, and breaking this addiction will be painful, but not fatal.

Key words : Peak oil, Petroleum era, Reduced energy consumption, Carrying capacity, Environmental refugees, Energy return on investment.

Conquer thyself, till thou hast done this, thou art but a slave. **Sir Richard Francis Burton**

It is evident that the fortunes of the world's human population, for better or for worse, are inextricably interrelated with the use that is made of energy resources. **M. King Hubbert**

There is no substitute for energy. The whole edifice of modern society is built upon it … It is not "just another commodity" but the precondition of all commodities, a basic factor equal with air, water, and earth.
E. F. Schumacher

Power tends to corrupt and absolute power corrupts absolutely.
(Lord Acton was referring to political power,
but might equally well apply to energy use since
the latter has led humans to believe they are
immune to natural law.) **Lord Acton**

An attempt by any outside force to gain control of the Persian Gulf region will beregarded as an assault on the vital interests of the United States of America. **US President Jimmy Carter in a 1980 address to US Congress**

Thus there may be no solution to the problem of oil depletion, if by "solution" we mean a strategy that will enable us to continue living as we are. **Richard Heinberg**

As Catton (1982) notes, humans increase Earth's carrying capacity for themselves by "diverting some fraction of the earth's life-supporting capacity from supporting other kinds of life to supporting one kind." For example, during the Agricultural Revolution about 10,000 years ago, humans began taking over land occupied by other species to produce food for human consumption. In many areas, this acquisition resulted in extinction of other life forms. In some cases (e.g., Australian Aboriginals), humans learned the necessity of stabilizing their own population levels through extended lactation, use of contraceptive herbs, or infanticide in order to co-exist successfully with other species. Regrettably, at present, sharing resources, including energy and other natural resources, with other life forms is not the norm.

Fossil Fuels

Approximately three decades ago, I heard a jest (possibly from H. T. Odum) that humans had a purpose on Earth - to get rid of all fossil fuels. When the easily obtained fossil fuels were gone, humans could depart. At present, this prophecy is no longer a jest - Earth's fossil fuels, oil and coal, which accumulated for hundreds of millions of years, are now being burnt in a few centuries. Moreover, released carbon dioxide is causing global heating. Coal burning also releases mercury and other pollutants. Tainter (1988) views human society as an energy processing system that tends to collapse when its strategy for energy use is subject to the law of diminishing return. Recent studies (e.g., Homer-Dixon, 2006) have indicated that the energy return on investment (EROI) has diminished in the United States from 25 to 1 in the early 1970s to 15 to 1 at present. Black (2006) notes that the global network of agricultural research centers warns that famines lie ahead unless new crop strains adapted to a warmer future are developed. The Consultative Group on International Agricultural Research notes that yields of existing varieties will fail. New forecasts indicate that global heating will shrink South Asia's wheat area by half.

Coping with these crises will not succeed unless a consensus on standard of proof is reached in the law and in science. One case on global heating before the US Supreme Court (Dean, 2006) is not reassuring, at least in the early stages of this case. Typically, scientists do not accept a finding unless, statistically, the odds are less than 1 in 20 that it occurred by chance (Dean, 2006). This standard is higher than the typical standard of proof in civil trials (preponderance of evidence) and lower than the standard for criminal trials (beyond a reasonable doubt) (Dean, 2006). As Dean (2006) notes, the justices may also consider that, when scientists confront a problem, they collect all the information they can about it and then draw conclusions; however, lawyers use a different strategy. They know the desired outcome at the outset, so they gather arguments to support it. Scientists face peer review and cannot omit publications uncovered in their research that do not fit their hypothesis. This case before the US Supreme Court is crucial since mainstream science agrees that the planet's climate is changing and human activities (e.g., greenhouse gases) are major components of this change. At present, voluntary reduction of greenhouse gases is not working for most individuals or corporations, so effective legislation and enforcement are essential. Reduction is a matter of utmost urgency since humankind may be approaching a global tipping point on both global heating and energy availability.

Phantom Carrying Capacity

Borgstrom (1972) devotes an entire chapter of his book to the concept of "ghost acreage." This concept explains why countries, such as The Netherlands, appear to be living well with a large population on relatively little land. The explanation is that the space they occupy supplies only $1/14^{th}$ of their needs. The remainder comes from outside the country. Arguably, two even more important problems also exist:

(1) The scientific process is not designed to study global-level phenomena. The reductionist scientific method of isolating an important variable and studying it under carefully controlled conditions simply is not suitable for complex, multivariate global-level studies.

(2) Humankind is carrying out a massive global experiment on global heating with no control planet to document the differences between treatment (*i.e.*, human-produced greenhouse gases) and no treatment.

As a consequence, prudence dictates reduction in the release of human-produced greenhouse gases from the use of fossil fuels, which would also conserve unused fuel for future use. Excessive use of fossil fuels has already endangered crop production through drought, floods, and other types of climate change.

Energy Use

The average Canadian uses an amount of energy equivalent to what 200 men would expend while working 24-hour days continuously (Campbell, 2000). These hypothetical "individuals" are "energy slaves." What will humankind do as availability diminishes after peak oil has been passed (e.g., Bériault, 2005 ? The food humans eat results from a huge amount of energy from production, to processing, to delivery, to cooking, to dishwashing (e.g., food travels an average of 2080 km from farm to plate) (Heinberg, 2005). Because of inexpensive oil, one farmer can feed 100 people. However, this advantage will substantially diminish when the peak oil threshold has been passed and the end of readily available cheap oil has passed.

The Transition to Low Per Capita Energy

Some illustrative components follow:

(1) Earth's carrying capacity for humans will markedly diminish. Since the ecological overshoot is already 24%, population stabilization is mandatory, as is reduction of population size to suit the new carrying capacity.

Adjusting society to meet the needs of natural systems will not be easy, despite the fact that they constitute the biospheric life support system.
(2) Travel, especially by aeroplanes, will be greatly reduced due to decreased availability of petroleum and increased costs to reduce greenhouse gas emissions. Humankind will mourn the loss of a significant number of ghost slaves, but the era of cheap energy is approaching its end.
(3) Stop being delusional! Humankind simply can not continue to use the amounts of energy that all too many consider normal. Biofuels must be grown on real land, not phantom land, so humans must be prepared to use fewer ghost slaves. Coal is a dirty source of energy and nuclear power produces long-term radioactive wastes.
(4) Attacks on science, when robust scientific evidence conflicts with political ideology, are endangering billions of lives by delaying for many years the effective control of greenhouse gas emissions. Harvard Professor Daniel P. Schrag (2006) claims that US Senator James Imhof, then Chair of the Senate Committee on Environment and Public Works, issued an erroneous press release that claims that Schrag agreed with him that the Kyoto Protocol would have almost no impact on the climate.

Vidal (2006) describes 2006 as the year humankind woke up to the adverse effects of global heating. However, the dangers of perpetual economic growth on a finite planet and the adverse effect (e.g., global heating) of the technologies that power it are not well appreciated. Heilbroner and Thurow (1987) define economic growth as an increase in the production and consumption of goods and services; it is a function of population size and per capita consumption. The human population continues to grow and consume resources at an ever increasing rate. These and other factors accelerate the depletion of finite fossil fuel reserves, especially oil. Czech (2001) remarked "The United States is a bellwether nation with respect to democratic politics, economic development, and environmental policy. At the beginning of 2007, much of this ethical and moral leadership has been lost. The United States has approximately 5% of the planet's population and contributes nearly 30% of anthropogenic greenhouse gases*".*

In an era when resources (e.g., oil and food stuffs) have probably peaked and may soon suffer declines in production, the kind of excessive consumerism flaunted by the ultra-rich is becoming both archaic and immoral. In short, an individual may be able to afford large quantities of material goods and energy, but the planet cannot afford such purchases. However, in the United States, many consumers are going deeply into debt to increase their material possessions. In many cases, large storage spaces are rented by the year to store the overflow (i.e., beyond the capacity of their dwelling[s]). Very probably, these possessions will not be used by the original owners after storage. Fewer possessions per capita would reduce and might even eliminate the 24% ecological overshoot. An economic system that produces a 24% ecological overshoot is clearly not sustainable. Yet, exponential economic growth is still worshipped globally, and most people and their leaders are either unaware of the ecological overshoot or uncertain about it.

The Elephant in the Room

The present "joke" is that population is like an elephant in the room. Everyone sees the elephant, but no one is willing to talk about it. The World Population Growth Chart (http://www.atmos.umd.edu/~owen/CHPI/IMAGES/pop.html) projects that an additional 1 billion people will be added to the planet between 1998 and 2009 (*i.e.*, 11 years). Heinberg (2005, p. 31) estimates that world population will drop from 7 billion in the early 21st century to less than 4 billion in 2200 due to a decrease in oil availability. However, even as the population rises, Australia, an exporter of meat and grain, has a dramatically decreased supply of mutton and grain as a result of a drought that has lasted 5 years already (Mercer, 2006). The drought could break in 2007 or 2008, but might not break until 2050. China is also experiencing a reduction in grain supply due to global heating (Buckley and Aizhu, 2006). Climate change and water shortages exacerbate these problems. Lou Yong, a deputy director of China's National Climate Centre, stated: "The most direct impact of climate change will be on China's grain production."

However, at present, the human population continues to grow (Motavalli, 2006). In Niger, Salamatow said "I am exhausted" as she struggled through labor with child number 13. She is a 37-year old widow. In some countries, such as Russia, the "birth dearth" (births less than deaths) is definitely real, but it is far from universal. For example, the United States (a leading consumer of energy and resources), which has a fertility level just above replacement, has just reached the 300-million population mark, primarily due to legal and illegal immigration. The United Nations projects a world population of 9.1 billion (as the middle of three possible scenarios) in 2050 (Motavalli, 2006). Given all the bad news about droughts and the food supply, loss of arable land due to desertification, and sea level rise, clearly present unsustainable practices cannot continue (*e.g.,* Markowitz and Rosner, 2002). The much publicized fertility decline has not halted global human population growth and ignores the fact that the human population has more than doubled between 1950 and 2000. In fact, many countries (*e.g.*, Saudi Arabia) have a very young citizenry (*i.e.*, nearly half under age 15).

This youth increases population growth momentum since a huge percentage of the population is at or soon will enter the breeding age.

Segelken (2004) quotes agricultural ecologist David Pimentel: "Every trend – from decreasing per capita availability of food and cropland to population growth - shows the predicament becoming even more dire." Pimentel also notes that the present level of malnutrition among nearly half the world's population of 6.3 billion is unprecedented in human history. Despite this evidence, corn to ethanol production continues. Pimentel (2007) reports that 18% of the US corn crop and the same fraction of the corn crop land produced less than 1% of the total automotive fuel used in the United States. If 100% of the corn crop were dedicated to ethanol production, it would only satisfy about 5% of US energy needs. Since humankind is already using Earth's resources 24% faster than that of their regeneration (ecological overshoot), a major catastrophe would be inevitable if current rates of resource consumption continue, even if population growth ceased. However, it has not ceased, so an even greater catastrophe lies in the near future unless major changes in human behavior are made immediately.

Humankind's exponential growth should be accompanied by comparable growth in all the factors now associated with civilization - schools, health care facilities, etc. The remedy to this situation is not readily apparent since the planet is finite. In addition, present resources are distributed very unevenly. The richest 2% of the world's adults own more than half the world's wealth (Glantz, 2006). The wealth gap has increased dramatically in recent years, which is likely to produce social instability, just when stability is needed to cope with the concomitant crisis in population, energy, food production, and climate change.

Even in a relatively new country, the United States, the original inhabitants were deprived of the buffalo so they would move to reservations established by the US government. However, the relationship of the human to the animal community that supplied its food, clothing, and housing (e.g., teepees) had been the central, pivotal concern of the rigorously maintained social order (Campbell, 1972, p. 89). As a consequence, the loss of the buffalo meant the loss of the binding symbol. In the 21st century, the loss of energy (e.g., phantom land and ghost slaves) will almost certainly have a more dramatic impact because the effects will be global. As Campbell (1972, p. 89) notes, the first and most important effect of a living mythological symbol is to waken and give guidance to the energies of life. The symbol requires functioning in a certain way, which will be conducive to participation in the life and purposes of a functioning social group. Campbell further notes that, when the symbols provided by the social group no longer work and the symbols that do work are no longer of the group, the individual cracks away, becomes dissociated and disoriented, and is confronted with what can only be named the pathology of the symbol. Humankind is embedded in natural systems but is assaulting nature (e.g., greenhouse gases) as if its dependence on natural systems were not true. Humans have made energy a central unifying symbol and are acquiring and using energy in ways that affect nature adversely.

Moral and Ethical Leadership

In many cultures, especially in the United States, many people believe in a conflict between science and religion. As Campbell (1972, p. 90) notes "the famous conflict of science and religion has actually nothing to do with religion, but is simply of two sciences: that of 4000 BC and that of AD 2000." The driving sources of human society (the computer, cheap energy, the automobile, television, airlines, nation sates, space exploration, fast food, global heating and globalization) are drastically different from the forces that drove the early societies in which religions developed. Given this perspective, the perception of a conflict between science and religion is not surprising.

What does this perceived conflict have to do with the present situation? The solution often given for the problems of overpopulation, diminished energy, global heating, resource wars, ethnic conflict, and religious confrontations is that some deity will solve the problems. However, the people who state this solution are usually not among the approximately 3 billion humans who are malnourished. Presumably, the same deity provided brains and intelligence, so one wonders why those humans feel no responsibility to use their brains and intelligence to solve the many problems. One also wonders why the intelligence is not used to live harmoniously with other life forms that collectively constitute humankind's biospheric life support system.

Three of the myths humankind lives by in the 21st century are: (1) a technological solution exists to every problem humans have caused, (2) the rising tide of economic growth will "raise all boats," (3) the status quo will endure forever - exponential population growth can continue indefinitely on a finite planet, the automobile culture will endure, pollutants harmful to the environment will not affect humans. If the first myth is true, why are peak oil, environmental pollution, AIDS, and global heating major problems? If the second myth is true, why is disparity in the distribution of wealth increasing so dramatically? The third myth is really a denial of reality, which can be very powerful.

Much cognitive dissonance is present in humankind's response to present problems. The Calvert Group, Ltd., an investment rating service, endorses 52 of the largest 100 US companies based on market capitalization, but flags the other 48 for transgressions against social responsibility (Piller et al., 2007). For example, the Gates Foundation assets total more than the gross domestic products of 70% of the world's nations. The Gates Foundation awards grants in support of public education in the United States and for social welfare programs in the US Pacific Northwest. In contrast, the Gates Foundation has major holdings in:

• companies ranked among the worst US and Canadian polluters, including Conoco Phillips, Dow Chemical Company, and Tyco International, Ltd.

• many of the world's other major polluters, including companies that own an oil refinery and one that owns a paper mill; both of these types of companies can sicken children at the same time that the Foundation is trying to save their parents from AIDS

• pharmaceutical companies that price drugs beyond the reach of AIDS patients.

Paul Hawken, who directs the Natural Capital Institute, notes that, while foundations fund groups trying to benefit posterity, their investments steal from the future. This type of "blind-eye" investing rewards bad behavior. However, anyone who has tried to achieve ethical investment (even by one's personal standards), using overall good or bad performance of the majority of corporate operations, has found this task incredibly difficult. Clearly, foundations, corporations, political leaders, and the general public must develop a more holistic perspective on environmental ethics and morals, particularly with the energy crisis and all of its manifestations.

On Monday, January 6, 2007, with wars in Iraq and Afghanistan and an air attack on a suspected terrorist site in Somalia, worsening global heating, and an unsettling national debt, the US Congress suspended its activities so that some members could fly to the US State of Arizona to watch the football game between Ohio State University (ranked #1) and the University of Florida (ranked #2), thus increasing the global supply of greenhouse gases. Not to be outdone, Prime Minister Tony Blair (UK) stated: "I would frankly be reluctant to give up my holiday abroad" (Etchingham, 2007). However, he does recycle and uses energy efficient light bulbs. Do these two conservative activities offset vacations in the US and Caribbean? Blair has labeled as "impractical" any personal sacrifices to cut greenhouse gas emissions (Watt, 2007). In contrast, the Prince of Wales declared that he will cut back on domestic and international flying. Blair made an unpersuasive effort to offset British fury over his personal flight policy by using carbon emissions offsets, but at least some newspaper columnists are not persuaded (e.g., Grice, 2007). Street-Porter (2007) feels Blair should set an example and holiday in Britain. Monbiot (2007) calls attention to US President George Bush's six years of obfuscation and denial of climate change, which was followed by a memo to the Intergovernmental Panel on Climate Change that advocated "modifying solar radiance" rather than advocating cutting greenhouse gas emissions.

Energy and Nation-States

Fossil fuels have provided humankind with incredible amounts of energy. However, this extra energy enables nation-states to flourish and extend, economically and militarily, their power far beyond their borders. The United States has fought wars, and is still doing so, in Iraq and Afghanistan. Initially, much of the US part of each war involved aircraft carriers far from the field of battle. However, the period of abundant, cheap energy ends with peak oil or soon thereafter. Presumably, then, the power of nation-states will diminish.

At present, with a major global crisis in heating and other types of climate change, humankind needs a universal ethic for survival. Failure to develop such an ethic will make the probable outcome one of severe stress upon humans, possibly extinction. Since the biota of the planet has survived five great extinctions, it is probable it will survive a sixth. However, a major reduction of human potential is a violation of humankind's sacred obligation to posterity. Humankind has a second ethical responsibility also to other life forms, not only because they constitute the planetary life support system but primarily because desecration of other life forms is a sacrilege. However, if one listens to what most societies and their leaders profess, endangering or actually harming economic growth is of greater concern than the survival of polar bears and other megafauna, including non-human mammals. A global ethic for all life forms is essential for sustainable use of the planet and development of a harmonious relationship between humans and other life forms.

With approximately half the world's population living in urban areas and the other half living primarily in humanized landscapes, development of an eco-ethic will be difficult, especially since phantom land and ghost slaves will decrease each year. Internet based organizations should be most helpful in this situation. Also, loss of both phantom land and ghost slaves should diminish humankind's deleterious environmental impact, which is primarily, but not entirely, technology based. Technology can also adversely affect humans by producing greenhouse gases. As John Holdren (2007), President of the American Association for the Advancement of Science, remarked, in conjunction with the 2007 Annual Meeting, on the problem of energy:

> Well-being has environmental, sociopolitical, and cultural dimensions as well as economic ones, and the goal of
> sustainable well-being entails improving all of these dimensions in ways and to end points that are consistent with maintaining the improvement indefinitely. This challenge includes not only improving substantially the
> standard of living in developing countries, but also converting to a sustainable basis the currently unsustainable practices supporting the standard of living in industrialized ones.

And, one might add, stabilizing the human population so that it does not exceed Earth's carrying capacity. Very little progress is being made in any of the important categories just mentioned. Greenhouse gas emissions are increasing - dramatically in some cases, such as China and the United States. The world population continues to increase at the rate of 91 million per year. All too often the daily news has some unpleasant new surprise. For example, the long-term stability of the massive Antarctic ice sheets, which have the potential to raise sea levels substantially, has been called into question with the discovery of fast-moving rivers of water sliding beneath their base (Connor, 2007). Other findings show substantial subglacial lakes under ice that is moving a couple of meters per day. Most of the plans to address global heating and other types of climate change have end dates such as 2020 and 2050. It is probable that within that time frame, one or more critical ecological and societal thresholds will be passed. For many disequilibrium situations caused by exceeding a threshold, remedial action may not be possible within time frames of interest to human society.

Despite the clear connection between combustion of fuels and anthropogenic carbon dioxide, Americans (and other automobile cultures) continue to search for ways to replace petroleum, despite the warning to US lawmakers not to rely on biofuels for energy security (Seba, 2007). Of course, these executives also recommended opening up more offshore areas to drilling. The era of cheap, abundant fuel is over but few people accept this fact.

Small Group Species vs Large Group Species

Abundant, cheap energy has made it possible for *Homo sapiens* to evolve from a small to a large group species in an extremely short period in evolutionary time. However, this abundant, cheap energy has also made it possible for humankind to seriously damage the biospheric life support system. If this damage continues at the present rate, the result will probably be a precipitous decline in human numbers, especially if resource wars involve nuclear and/or biological/chemical weaponry. Sagan's (2006) posthumous book predicted part of this scenario - he warned of the danger that a leader under the sway of religious fundamentalism might not try too hard to avoid a nuclear Armageddon, reasoning that it was God's plan. The urgency with which actions are taken to reduce anthropogenic greenhouse gases will determine how severe the consequences will be for humankind and the extent of the necessary remedial actions.

At present, atmospheric carbon is markedly increasing (over 3 billion metric tons emitted in 2007; http://www.worldometers.info). Statements from political leaders of two of the biggest contributors, the United States and China, do not indicate that an emissions tax on carbon is likely soon. Of course, in the United States, California and some other states are taking substantial remedial measures on their own. However, a global problem will not be solved unless all nations, especially the largest contributors, join in effectively reducing anthropogenic greenhouse emissions. Global cooperation will be difficult to achieve since some countries, such as Bangladesh, are more at risk than others (Huggler, 2007). In addition, a truly staggering quantity of unreported carbon dioxide is emitted around the world by the top ten companies on the London Stock Exchange (Black, 2007). Presumably, this situation occurs elsewhere in the world. Finally, the ice caps may not be saved (Adam, 2007), and such melting would raise sea levels by 4 to 6 meters (Adam, 2007).

Epic Changes

Pimentel (1998) states:

> Approximately 90% of the energy in crop production is oil and natural gas. About one-third of the energy is to reduce the labor input from 500 hours per acre to 4 hours per acre in grain production. About two-thirds of the energy is for production, of which about one-third of this is for fertilizers alone.

Youngquist (1999) remarks:

> A future without oil is difficult to visualize in detail, but some aspects of the post-petroleum paradigm can be anticipated with some degree of certainty.

All possible economic energy sources will have to be used, but replacing oil in its great energy use versatility probably will not be completely possible. Replacing the role of both oil and gas in agricultural production will be the most critical problem and may not be entirely solvable.

With a still growing human population, finite agricultural land, and reserves of petroleum (a primary source of income) diminishing, a major social crisis in the first half of this century is highly probable. As Fleay (1995) noted many years ago: "A very large proportion of the world's population depends for food from high agricultural yields achieved by use of fossil fuels." Epic change will result from: (1) the end of the cheap, abundant fossil era, (2) a global freshwater crisis that will have a major impact on agriculture, (3) and severe deleterious effects of global heating and other types of climate change on agricultural productivity.

Bartlett (1994, p. 28) wrote about the general complacency about the future:

> There will always be popular and persuasive technological optimists who believe that population increases are good, and who believe the human mind has unlimited capacity to find technological solutions to all problems of crowding, environmental destruction, and resource shortages. These technological optimists are not usually biological or physical scientists. Politicians and business people tend to be eager disciples of the technological optimists.

Well over a decade later, not much has changed, although there appears to be a modest trend to abandon these thought processes and recognize the findings of science. At present, depending on unproven technology is not enough to meet the epic changes humankind faces.

Humankind has faced starvation and disease before, but never on the scale likely to occur in the 21st century because the global population is far larger than it was even a century ago. The petroleum age is nearly over. There are alternatives, but as Youngquist (1999) notes: "The inability of fuels to be easily interchangeable in their end uses is a major problem." Youngquist (1999) also makes a major additional point:

> It is important to note that the end product of many alternative energy sources such as nuclear, hydro-electric power, wind, solar, geothermal, and tides is electricity, which is not a replacement for oil or natural gas in their important roles of raw material for a host of products ranging from paints and plastics, to medicines, and inks. But probably the most vital of all uses is to make the chemicals which are the basis for modern agriculture. Electricity is no substitute.

Ethical/Moral Issues

What should humankind do when the nations of the Middle East have diminished funds to buy food because their main source of income - petroleum - is less available? Even at US$200 per barrel, adequate purchasing power for foodstuffs will not last forever. They are mostly beyond sustainable long-term carrying capacity. Anarchy, even while oil remains, would impede delivery to other parts of the world as the war in Iraq has already done. Armed conflict is not a good, or even adequate, way to resolve these issues!

The current (March, 2007), estimated population of Saudi Arabia is 27,019,731 million, of which 5,576,076 are not citizens. The freshwater supply is negligible, so food is imported and purchased primarily with funds from the sale of petroleum. In 2006, Kuwait's population was estimated at 2,014,100 million and the area had a negligible agricultural base. In 2006, Iran had an estimated population of 68,688,433 and a significant amount of water and arable land. All these countries will be affected eventually by a decreasing oil supply, even if the price per barrel rises four fold or more. Millions of individuals will be added to the high number of environmental refugees. Iraq, population estimate for 2006 of 26,783,383, has already produced millions of resource depletion refugees, and their numbers will almost certainly increase dramatically until the civil war ends and social stability is achieved. Present indications are that both British and American military forces will not be able to end the civil war, but neither the precise departure dates nor the effects the departure will have is clear.

The ethical/moral question of how to cope with more millions of refugees has not been adequately addressed. A large part of the problem is the result of mismanagement of energy use from phantom land. This has produced global heating and other types of climate change, as well as a rapid population growth based on depletion of a finite resource - petroleum. The problem must be addressed before the human/environmental crisis worsens.

Path Forward

Eric Hoffer stated: "In times of change, learners inherit the Earth, while the learned find themselves beautifully equipped to deal with a world that no longer exists" (from Future Quotes - *http://www. wisdom quotes.com/cat_future.html*). The scientific evidence on global heating increases almost daily. All too much evidence indicates the rate of environmental damage is greater than expected. However, humankind cannot adapt to the new conditions by ignoring them, nor can effective remedial measures be taken unless a realistic appraisal of the problems is undertaken. Political leaders were reluctant to accept the evidence of global heating and, at present, refuse to implement the strong remedial measures that would probably diminish the high rate of change, fearing it would damage the economy. However, protecting the economy at the expense of the biospheric life support system is not a sound strategy. Sagan (2006, pp. 53-54) has a lucid statement of the problem:

> But what is interesting is that in a number of respects the universe is very fine-tuned, so that if things were a little different, if the laws of nature were a little different, if the constants that determine these laws of nature were a little different, then the universe might be so different as to be incompatible with life.

Sagan (2006, p. 35) notes: "Now there is another tendency from the psychological or social sphere projected upon the natural world. And that is the idea of privilege. These prophetic statements describe why humans put the economy ahead of natural systems. We feel privileged and nothing bad can happen to us." The evidence of global heating and other types of climate change are causing humankind to reluctantly abandon these ideas. Will they be abandoned in time to take effective remedial action?

Phase 1 - Reducing Anthropogenic Greenhouse Gas Emissions

Many people in the United States have faith that a supreme being will step in and save them from the consequences of unsustainable practices. Others believe unproven technology will save humankind. What both groups have in common is the conviction that the status quo in energy use can be maintained without changing unsustainable lifestyles and practices. Phase 1 will begin when these delusions are abandoned and energy efficient policies and programs are embraced. Phase 1 will end when sustainable energy policies and practices are in place globally (i.e., greenhouse gas emissions maintained at a level that will not result in climate change).

A concomitant component of Phase 1 is the stabilization of the human population within the planet's long-term carrying capacity. The actual number will depend on the quality of life chosen. Most people would not choose disease and starvation as the prime limiting factors, but those will be the default factors in the absence of strong, effective population control measures.

Phase 2 - Fine-tuning Greenhouse Gas Emissions to Match Global Assimilative Capacity

Ecosystems are dynamic and, therefore, their greenhouse gas assimilative capacity varies. The assimilative capacity will vary both seasonally and regionally. This situation will require development of predictive models and biological/chemical/physical monitoring systems to validate their efficacy and make corrections when necessary. At first, this vision appears to be utopian, but is essential to sustainable use of the planet. In a period of climate disequilibrium, much work will be necessary for the experimental sciences, and enough appropriately experienced personnel may not be available. The National Research Council (1977) devotes an entire book to the problem of environmental manpower, which was difficult to resolve even before global heating and peak oil had been recognized as major problems.

Conclusions

Humankind is rapidly creating an alien planet that will probably be quite different from the hospitable planet that has nurtured humans for approximately 160,000 years. Already, global events are sufficiently unprecedented to make scientifically sound predictions of future conditions difficult. Worse yet, humankind appears unwilling to abandon the unsustainable practices that are causing an already precarious situation to worsen. Adapting to markedly altered conditions will require a continuous flow of scientific information as well as dramatic changes in individual and social behavior. Stabilizing the human population so that it is within Earth's carrying capacity and reducing greenhouse gas emissions so they are within Earth's assimilative capacity will require a higher degree of environmental literacy than is now present, as well as a willingness of individuals to sacrifice some of their perceived "needs" for the common good. The balance of life on Earth is the greatest

ethical/moral issue today. Humankind has a responsibility to other life forms as well as members of its own species. May humankind be up to the challenge!

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THE GLOBAL TOWER OF BABEL

Only in the last quarter of my life have we come to know what it means to be custodians of the future of Earth—to know that unless we care, unless we check the rapacious exploitations of our Earth and protect it, we are endangering the future of our children and our children's children. We did not know this before, except in little pieces, people knew that they had to take care of their own...but it was not until we saw the picture of the Earth, from the moon, that we realized how small and helpless this planet is—something that we must hold in our arms and care for.

Margaret Mead, March 21, 1977

I am confident that many humans would endorse Margaret Mead's message above, but most would not know precisely how to take action on this prophetic statement that will affect both the present generation and posterity. In addition, how can individuals and dedicated organizations become active and effective custodians of Earth when:

(1) the global ecological footprint exceeds the regenerative powers of Earth,
(2) humankind has many languages, cultures, ideologies, and an enormous range of per capita income,
(3) the major global paradigm is economic growth, even at the expense of natural capital,
(4) far more money is spent on destructive forces (e.g. military forces and equipment) than on environmental restoration and protection;
(5) spokespeople of special interest groups denigrate and distort science when it appears to threaten their activities,
(6) a major portion of the news industry is directly or indirectly controlled by special interest groups,
(7) many obstacles exist when attempting to visualize the world from multiple integrated perspectives,
(8) no single discipline can transcend the barriers to integrate knowledge throughout the planet, and
(9) environmental literacy is inadequate for achieving sustainable use of the planet?

I immediately thought of the Tower of Babel story in which the whole world had one language and a common speech. Humans found a plain on which they built a city with a tower that reached to the heavens and were not scattered over the face of the whole earth. The Lord said, "If as one people speaking the same language, they have begun to do this, then nothing they plan to do will be impossible for them. Come let us go down and confuse their language so they will not understand each other." So the Lord scattered them all over Earth, and they stopped building the city. (There are multiple versions of this story—from Genesis 11:1-9, available on-line in many languages at http://www.omniglat.com/babel/; details are available at http://www.idolphin.org/babel.htm/.)

Of course, the key to long-term economic and social stability is sustainable use of the planet. Arguably, the key to resolving this issue is China, which is not only a very populous country with a rapidly growing consumer economy but comparatively little natural capital. How China addresses its consumption and production might represent a clear danger to humankind or, alternatively, an unprecedented opportunity to become a model nation for sustainable use of the planet (Flavin 2005).

Natural law has been "solving" bio-capacity problems for roughly 4 billion years. Nature's ways, however, are hard on both individuals and species. Even so, evolutionary processes have survived five major extinctions and will probably survive the sixth now underway. *Homo sapiens* may not be one of the surviving species, but, even if it is, a major loss of human life may occur. A common ground for simplifying this fragmentation (including language, culture, etc.) would be a global consensus on eco-ethics and sustainability ethics, both of which:

(1) focus intently upon the ethical relationship between humankind and natural systems (Cairns 2003),
(2) deplore the folly of humankind's unsustainable course of action, which is exhausting the planet's nonrenewable resources, such as fossil fuels,
(3) deplore the over-harvesting of renewable resources, such as oceanic fisheries and old growth forests,

(4) agree that global environmental quality is being degraded by automobile emissions, pesticides, nuclear wastes, greenhouse gases, and chlorofluorocarbons, which produce environmental consequences such as biotic impoverishment, global warming, and acid rain, and
(5) are deeply concerned about the exponentially growing human population, increased per capita affluence, and the increasing disparity in per capita distribution of the planet's resources.

Both concepts are essential to the quest for sustainable use of the planet. At present, it is difficult to visualize reaching a consensus or a common ground. Yet a consilience (literally, "leaping together") must be achieved for successful implementation of sustainability, and these ethical constructs are only two of many cultures/languages in the contemporary Tower of Babel. Regrettably, one can find more than one example of language and cultural barriers to a consensus in the news each day.

One major factor in the failure to make an effort to reduce cultural and language barriers is the lack of a long-term perspective, which is essential to any effort requiring a reduction of cultural barriers. Hulbert (2005) reports that investors in the stock market are not interested in the long term. They focus instead on what a stock is likely to do over the next quarter—or just the next week. Equally distressing is that these investors do not project very far, even when they attempt to consider factors that will affect a company's long-term profitability. Since they should have a strong self-interest in the long-term results of investing their personal money and do not, one would conclude they would have even less interest in events far distant in time and space. Yet, stewardship of Earth's natural resources is essential to the quest for sustainable use of the planet, and fair and equitable resource distribution is essential among those now living.

Another major obstacle to a harmonious relationship between people in different cultures speaking different languages is the high probability of an increased frequency and intensity of resource wars. As Brown (2005) notes, competition for vital resources, such as land and water, will increase as they become scarce. Of course, these resource wars will occur among ethnic and religious groups, as well as between the poor and the wealthy in the same culture. For example, the global expansion of the human population cut the grainland area per capita in half, from 0.23 hectares in 1950 to 0.11 hectares in 2000.

Finally, the supply of fossil fuels per capita is decreasing due both to population growth and increased per capita affluence. In addition, at the Prudhoe Bay oil field in Alaska, which still pumps more oil than any other site in the United States, output has fallen nearly 85% from its peak in 1987 and is expected to continue dropping (Blum 2005).

The global Tower of Babel is such a formidable obstacle to achieving sustainable use of the planet that the barriers must be markedly diminished. However, a harmonious relationship with unique local and regional ecosystems requires that cultural diversity be maintained. In a diverse biological world, global standardization is not a viable approach. Diverse languages will be less of a problem if a global consensus can develop on eco-ethics and sustainability ethics, which requires that they be compatible. Neither biological nor social evolution has prepared humankind for this sort of resource partitioning, but, if achieved, it would be a triumph for the ethical approach, which is, in any circumstances, better than the alternative. There is hope. Humankind is, more than any other species, a product of cultural evolution (Ehrlich and Levin 2005). Continual cultural evolution may permit achieving sustainable use of the planet.

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HUMAN ALTERATION OF EVOLUTIONARY PROCESSES

ABSTRACT

Soviet climatologist Budyko has remarked: "temperature and rainfall are the two major variables of life on Earth." Human society is changing both of these phenomena markedly, along with many other key variables that affect evolutionary processes. A major risk is that the tempo (or rate of human-induced environmental change) may proceed more rapidly than the ability of scientists to understand, predict, or make any long-term changes that might reduce the severity of the consequences. Increasing evidence indicates that the general public and its leaders (i.e., policy makers and politicians) fail to grasp the full implications of a planet in which the types and rate of environmental change differ substantively from the climate records of the past 5 million years.

INTRODUCTION

Almost every human activity has some effect upon natural systems. When the human population was small and spread thinly over the planet, as it was for most of the 160,000 years the human species has inhabited the planet, adverse effects were localized and comparatively small. In short, the resilience of natural systems was not exceeded and, as a consequence, the impact on evolutionary processes was much less than it is today. Currently, however, effects are global and intense; illustrative examples follow.

(1) Human population increased fourfold in the 20th century (Speth, 2004). The doubling time occurred within the life span of a single individual—a new phenomenon.
(2) Affluence has increased even more because the global economic output has increased approximately twenty fold.
(3) Humankind has become a major evolutionary selective force.
(4) Perpetual economic growth is, arguably, the major paradigm for human society.
(5) Species impoverishment (i.e., loss of biodiversity) and the consequent loss of valuable genetic information due to invasive species and habitat destruction and alteration, together with an increase in ubiquitous persistent toxic substances, has alarmed the scientific community for decades.
(6) Over-harvesting, especially of marine fisheries, has made sustainable use of natural resources problematic.
(7) Climate change has already become a major factor that is impairing ecosystems globally.

LOVE OF NATURE AND CATASTROPHES

Two major factors may diminish or stop damage to the 30+ million other life forms with which humankind shares the planet: (a) a love for and an ethical responsibility for the well being of other life forms and (b) fear of the consequences if humankind continues unsustainable practices (Cairns, 2004*a,b*).

Concern about natural systems and the environment became widespread during the latter part of the 20th century, which resulted in the first Earth Day in 1970 and the 1972 United Nations Conference on the Human Environment (The Stockholm Conference). The latter resulted in the United Nation's Environmental Programme. However, the failure to implement any of these protective measures resulted in continued environmental degradation, although some notable successes were achieved. Even environmental catastrophes in the late 20th and early 21st centuries have resulted in a focus on symptoms rather than causes. Some ecological catastrophes (e.g., thinning and disappearance of the Artic ice shelf) receive little or no attention from the "popular" news media. Other ecological events receive significantly more attention, such as the sea level rise at the Pacific Ocean island country of Tuvalu (Brown, 2001-2002) and the displacement of the Inuits (Native Americans in Alaska) covered by US Senator John McCain's global warming hearings in the US Senate. Of course, the most dramatic catastrophe was the tsunami in late 2004, which caused massive loss of human life. Persuasive evidence indicates that the loss of protection from massive wave action increased tsunami damage substantially. This lack of protection would not have happened if the mangrove forests and coral reefs had not been damaged previously by human actions (e.g., Silverstein, 2005; Sharma, 2005). Ecological catastrophes are most likely to occur in areas or nations with significant ecological deficits (i.e., natural capital has been lost at a rate greater than the replacement rate) and will almost certainly have a major effect upon evolutionary processes, which, in turn, will have both long- and short-term effects upon human society. Finally, global warming and other human induced ecological changes that will affect evolutionary processes will result in severe consequences to human society.

One example is the suddenly warming climate, which is likely to be a serious threat to political stability (Schwartz and Randall, 2003). The "Pentagon Report" (Schwartz and Randall, 2003) describes an extreme scenario whose effects might be less than described or even worse because of interactions between subcomponents of the global systems. Effects on evolutionary processes are probable, regardless of the way the scenario unfolds.

EVIDENCE FOR HUMAN ALTERATION OF EVOLUTIONARY PROCESSES

An excellent summary of the alteration of evolutionary processes is available through the US National Academy of Sciences (Myers and Knoll, 2000), which provides abundantly referenced evidence that alterations have occurred and are likely to continue if present trends persist. Significant alteration of evolutionary processes will have major effects, mostly unfavorable, upon the dynamics of human society and humankind's quest for sustainable use of the planet. Dixon and Adams (2003) speculate on what a post-human society might entail (these two authors consulted thirteen advisors with impressive credentials on evolutionary processes). Habitat fragmentation, now a global phenomenon, is another alteration that could cause a major disruption of evolutionary processes (e.g., Templeton et al., 2000).

Attesting to evolutionary alterations with massive documentation seems superfluous. Who can contemplate the massive recent alterations humans have made in the biosphere and conclude that these alterations have no effect upon evolutionary processes? Those persons would have to deny such evidence as the development of resistance to antibiotics in some disease organisms and the continual need to develop new pesticides to control pests. Why do policy makers not regard this paucity of readily available information as major evidence of the detrimental effects to human society of altering evolutionary processes?

DENIAL, ANTI-SCIENCE, AND SPECIAL INTEREST LOBBYING

One controversial explanation of the ineffectiveness of the environmental movement in the United States is that no prominent national leader has stated publicly and forcefully the detrimental consequences of present environmental trends. Leadership may fear alarming the general public or being labeled an extreme environmentalist (e.g., Shellenberger and Nordhaus, 2005). Although many laud the efforts of pioneers in the environmental field, some (Shellenberger and Nordhaus, 2005) believe that modern environmentalism is no longer capable of coping with the serious ecological crises of the world. For example, efforts to reduce global warming over at least two decades have not resulted in unsustainable practices being replaced by sustainable practices.

In contrast, Ehrlich and Ehrlich (2005) assert that, despite their belief that *The New York Times* Science Section has led the journalistic profession in reporting the consensus of the scientific community on the issues of climate change, the seriousness of the overall environmental situation has never been adequately covered by the media. Even though *The New York Times* has printed articles (Editorial, 20 January, 2005) on the human impact on the planet, no explicit statement about the seriousness of the impact has been forthcoming.

The well-known American religious leader Martin Luther King, Jr. stated: "A time comes when silence is betrayal…. Nor does the human spirit move without great difficulty against the apathy of conformist thought, within one's own bosom and in the surrounding world" (Quote of the Week from *Sojourners* online newsletter, Wednesday, 19 January, 2005). How can the silence continue when the processes, including evolutionary, of Earth's biological life support system are being seriously disrupted by human activities? Earth's life support system has favored the human species for approximately 160,000 years, but the 30+ million species with which humans share the planet are not concerned with the fate of *Homo sapiens*. The other species are not committed to maintaining the life support system on the behalf of humans, even though conditions they produce now are beneficial to humans.

Speth (2004) believes that three factors are responsible for humankind's failure to respond to global threats: (a) the collective power of the forces that produced this situation will not be adequately changed by half-measures, (b) the far-reaching complex responses required make redirecting the global agenda inherently difficult, and (c) global politics impede the development of a suitable global agenda. However, Speth believes the transition to sustainability can be made.

Gelbspan (2004), a recipient of the Pulitzer Prize, focuses on the consequences of global warming, which he feels is causing the planet to fall apart piece by piece in the face of persistent and pathological denial. Since Gelbspan is a journalist, his charge that the media has failed to make the connection between climate change and other events, such as altered rainfall patterns, is very persuasive. Gelbspan also feels another major failure of the media is ignoring the ferocious battles between the fossil fuel industry lobby and credentialed scientists who have made the study of global warming a major part of their professional careers. He uses as an example (pp. xii, xiii) the assault on the character and scientific integrity of Dr. Benjamin Santer, a world-class climate

modeler at the US Lawrence Livermore National Laboratory. Associated Press Special Correspondent Hanley (2005) remarks that the US delegation to a global conference on disasters wanted to purge a UN action plan of its references to climate change as a potential cause of future natural calamities. Clayton (2005) describes the fate of George Zeliger, a *whistle blower* (a person who makes a public disclosure of corruption or wrongdoing). Orr (2004) has written a very disturbing analysis of the effect of politics (especially when disguised as patriotism) on the environment.

The relevance of these incidences to human alteration of evolutionary processes is that the scientific process must be allowed to flourish and must not be suppressed when it appears to conflict with political or economic ideologies or matters of faith. The scientific process, including peer review, has been very successful in discrediting faulty hypotheses, but it does so by rigorous testing of them and their supporting data.

Wiener (2005) describes a situation in which 20 of the largest chemical companies in the US have developed a campaign to discredit two historians who studied the attempts of industries to conceal links between their products and cancer. This situation is unusual in that the companies have subpoenaed and deposed (in courts of law) the five academicians who recommended that the University of California Press publish the book *Deceit and Denial: The Deadly Politics of Industrial Pollution* by David Markowitz and David Rosner. Intimidating qualified reviewers strikes at the heart of the scientific process. In another somewhat similar situation, the British Government's chief scientific advisor, Chief Scientist Sir David King, has claimed there have been attempts to discredit him because of his attempts to call attention to the threat of global warming (Conner, 2005).

In the United States, arguably one of the scientific leaders in the world, the assault on science has three major components: (a) discredit scientists whose views differ from the dominant political or economic ideology and religious faith, (b) attempt to intimidate scientists and other academicians by litigation, which is both time consuming and expensive, (c) attempt to discredit scientific theories by implying they are merely educated guesses rather than carefully constructed frameworks for understanding a substantial body of evidence (e.g., Editorial, January 23, *The New York Times*, 2005). Theories supported by mainstream science are the most useful scientific theories. Attacks on the theory of evolution in the United States are increasing and persistent and are especially significant when they are against the texts used in the school system. If science is discredited in the educational system, understanding the effects of humans upon evolutionary processes will be markedly hampered. Fortunately, many scientifically advanced countries accept evolutionary theory, and both teaching and research can proceed in a systematic way in keeping with the processes of science.

Many Christians view evolution as God's means of creation, and the theory of evolution is taught in Catholic schools and many other Christian schools. Christian fundamentalists and creationists are a very politically active sub-set of all Christians, but their energy and fervor in promoting their beliefs have made teaching evolution a major issue in the United States. Sustainable use of the planet requires that humankind have a better understanding of evolutionary processes. Achieving this goal requires that the processes of science not be disrupted, especially in the education of future scientists.

CONCLUSIONS

The quest for sustainable use of the planet by *Homo sapiens* requires a mutualistic relationship between human society and natural systems. Disrupting evolutionary processes that facilitate this relationship will almost certainly have adverse, possibly fatal, effects upon human society. Another way to envision the quest for sustainability is avoiding a post-human world (Cairns, 2005). Lest this seem too fanciful, it is well to remember that *Homo sapiens* has only inhabited Earth for approximately 160,000 years out of an estimated 4.5 billion years that the planet has probably existed. In addition, the greatest anthropogenic damage has occurred in the last 200 years.

If ecological tipping points are reached or exceeded, disequilibrium will result. Regrettably, the only certain way to find an ecological tipping point is to reach it or exceed it, because no laboratory experiments are suitable for such large temporal and spatial spans. McCarthy (2005) discusses a report that estimates the climate change tipping point at 2° centigrade above the average world temperature prevailing in 1750 (before the Industrial Revolution). Since that time, human production of greenhouse gases, such as carbon dioxide, has markedly influenced the retention of the sun's heat in the atmosphere.

Speth (2003) believes that globalization is one of the profound phenomena in the present era that has affected the environmental, economic, and social aspects of the nations of the world. Because globalization involves so many political and economic systems, mid-course corrections of these powerful trends will be exceedingly difficult, but not impossible, to alter. To achieve this goal, a mutualistic co-evolution of human society and natural systems is necessary (Cairns, in press). If humankind fails in this undertaking, evolutionary processes will continue, although many other species will probably be driven to extinction. Failure would also

suggest that intelligence, as humans define it, did not provide the long-term survival value it was thought to have. I believe if intelligence is used to select sustainable practices, it will have proven to have long-term survival value.

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COMPASSION, CATASTROPHE, AND CHANGE

The world is plunging into an energy crisis unlike any before, while geopolitical alliances are shifting quickly and to a degree not seen since the end of the Soviet era, and perhaps not seen since the end of World War II.
Richard Heinberg (2006)

Background

Modern society is based on energy, and its recent evolution has been rapid because of cheap, convenient, readily available energy. Energy availability enabled the small-group species of *Homo sapiens* to change from a few million, spread thinly over the planet, to over 6 billion individuals, mostly in large human artifacts or cities and their suburbs. The energy in an ecosystem available to its biota is one of the most important determiners of carrying capacity. Anthropological evidence shows that humans have been capable of living in a harmonious relationship with natural systems for most of the 160,000 years the species has been on the planet. This relationship does not mean that humans caused no damage; however, the damage has been small and isolated so that ecosystems could recover from it.

However, as Catton (1980) remarks, humans diverted a substantial portion of Earth's life support capacity from supporting other life forms to supporting humans. Moreover, humans have continued to usurp energy since the Agricultural Revolution (which occurred abut 10,000 years ago) so that only a few truly wild systems remain and most of the planet shows some effects of anthropogenic activities. In addition, tools (e.g., bows and arrows, knives) enabled humans to extend their domination over nature, but the tools also changed humans. In an automobile culture, such as the one in the United States, the "tool" actually separates humans from natural systems.

Domestication of wild plants and animals that supported the Agricultural Revolution also gave humans access to energy that was previously less available to them. For example, horses turned grass into transportation or work energy – cattle turned grass into food. However, climate change can result in a reduction in the energy available via these routes.

The process that has enabled humans to produce a 24% ecological overshoot is called *drawdown*. This process can use either nonrenewable resources, such as fossil fuels, or renewable resources, such as old growth forest or top soil, for which regeneration rates are slow. However, this strategy is not sustainable.

Humankind faces an unprecedented opportunity for both success and failure on a global scale. As Heinberg (2005), Diamond (2005), and Tainter (1988) note, many human societies have expanded their power and complexity to remarkable levels only to decline and revert to simpler forms of social organization. Humankind has used every means available to displace other life forms from the areas they once occupied, divert their resources to human use, and deplete natural capital that has taken many years to accumulate. Now the cheap, easily available, convenient energy that made this scenario possible is declining (Heinberg 2005). Alternative fossil sources of energy are available (e.g., coal), but come at a higher environmental cost. Wind and solar power are appealing, but are not yet widely available. Clearly, profligate energy use is rapidly becoming a relic of the past.

Humans have not shown much compassion for other life forms during the process of dominating the planet. Will compassion for other life forms increase or decrease when the era of cheap energy is over? Some foodstuffs (e.g., corn) can be converted to fuel (e.g., ethanol). Will compassion for other members of the human species place food ahead of fuel while some humans are starving or malnourished? Some catastrophes now seem probable. How will compassion for the suffering be expressed in terms of resource allocation? In short, in an era of rapid change, will the manifestations of compassion from humans be appropriate?

Resource Consumption

Concern is mounting about global warming, peak oil, environmental pollution, species impoverishment, and other trends resulting mostly from human activities. The concerns and trends continue because implementation of strategies that would improve prospects for sustainable use of the planet is minimal. Tipping points cannot be precisely predicted until they have occurred, so scientific uncertainty is being cited extensively as a justification for inaction, just as it was cited for the harmful effects of cigarettes decades earlier. However, disequilibrium of the planet's life support system will almost certainly not be reversible. Unless major changes

are made soon in humankind's relationship with the biospheric life support system, catastrophes will occur and hope for leaving a habitable planet for posterity will diminish.

Beginning around 1980, evidence showed that the use of resources by the global economy has outgrown the capacity of natural systems to regenerate them. Almost daily examples of the conflict between demand and supply are in the news media. Worse yet, resources that have taken hundreds of thousands, even millions, of years to accumulate are being consumed in a few centuries. One lesson of history is that the primary indicators of societal decline were ecological, not economic. The ecological overshoot was about 20% in 2002 and appears to be increasing about 1% per year. This situation is not sustainable.

Ecosystem Restoration

Lowering resource consumption to equal the regenerative capacity of natural systems will require monumental management changes of resource extraction and use. Restoring damaged ecosystems will require even more sacrifice, but the health of the economy and the supply of natural capital and the ecosystem services it supplies are closely coupled. Moreover, restoring damaged ecosystems to their pre-damaged condition in an era of ecological disequilibrium will be extremely difficult (Cairns 2006). In fact, anthropogenic climate change and loss of species may make restoration to predisturbance ecological conditions an impossible task. Perhaps humankind should let nature take its course and see what happens. The major risk of this approach is that the new ecosystems will probably not be as beneficial to humans as the ones that were damaged. Worse yet, new ecosystems could be a threat to human society.

Brown (2006) recommends an annual earth restoration budget of US$93 billion. This sum is tiny in view of the amount of restoration needed. At the very least, such a budget would indicate where and under what conditions ecological restoration might meet stated goals. However low the probability is of success, ecological restoration must be attempted, unless failure is virtually certain. Essential to any plan is the determination of which damaged ecosystems are irreversibly damaged, which should recover without restoration efforts, and those for which ecological restoration efforts will make a major difference.

An ecological triage decision would differ from the human medical one in an important respect: ecosystems too damaged to restore to pre-disturbance condition or to recover naturally to that state could be replaced with constructed ecosystems (e.g., Atkinson and Cairns 1993) and created ecosystems (e.g., Atkinson et al. 1993). These naturalistic systems are designed to function under new conditions, and both help accumulate natural capital and provide ecosystem services. These constructed ecosystems will require subsidies and more intensive management, but should increase Earth's carrying capacity appreciably.

Since humankind has typically ignored threats to the biospheric life support system, damaged ecosystems may also be ignored. This scenario is not a good idea since these damaged systems will be colonized by species resistant to human control (called pests). Many pests will emigrate to parts of the surrounding area and probably out-compete and displace many indigenous species, which is not conducive to achieving sustainable use of the planet. If humans have diminished natural capital and the ecosystem services it provides, both must be replaced to whatever degree possible.

These ecological restoration activities are usually accomplished best in a local setting so that citizens can both be part of the effort and protect the improved ecosystem from future damage. This approach is also helpful in developing and demonstrating compassion for other life forms. What a pity that ecological catastrophes are necessary to catalyze these ecologically benign activities.

Compassion for Other Humans

Exponential increases in both human population size and level of affluence have resulted in a global water shortage. Since 1,000 cubic meters (approximately 1,000 tons) of water are necessary to produce a ton of grain, water shortages and food shortages are closely coupled. Populous countries, such as China and India, already have large water deficits, as do Algeria, Egypt, Iran, Mexico, and Pakistan. Their citizens are fellow crew members of Spaceship Earth; surely, political differences can be resolved so that humans can help each other. If human populations are not stabilized, any efforts will be wasted. However, unsustainable practices caused the problem and compassionate help should not allow these practices to continue. Should the United States be given more cheap oil with the hope that the US Congress will develop a comprehensive, sustainable energy policy or the that drivers of automobiles will use energy efficient vehicles?

Since the beginning of my professional career in 1948, action has been postponed because "technology will save us," reason will prevail and the environmentally damaging practices will cease, politicians will fulfill their promises to protect the environment, and polluting industries will become environmentally sensitive. Instead of improving environmentally, the planet is in a precarious situation that may be irreversible. None of my hopes have been realized; many have been shattered. However, is inaction best? No; however, neither are

statements such as “I respect the interdependent web of life if it is not accompanied by major environmental deeds.” Even so, what can be done must be done to protect and restore the environment.

Nation-States in Disequilibrium

Schell (2003) notes that global warming cannot be stopped by B-52 bombers (but they contribute to it) or by nuclear proliferation (pp. 353-354). He notes that peace, social justice, and defense of the environment are a cooperative triad pitted against war, economic exploitation, and environmental degradation. Schell also adds that rejecting war is not enough; humankind must now secure survival by suppressing the menace of annihilation. Second, Schell believes in delimiting sovereignty — when power is cooperative, in the domestic sphere at least, it does not have to be indivisible but can be divided among branches of government and localities (or even eco-regions). Schell states that, if such divisions cannot occur in the international sphere, hope for sustainable use of the planet is doomed. The European Union is a good example of what might be accomplished with hybrid arrangements unimaginable if nation-states base their policies on war. Third, the old unity of state, people, and territory would be dissolved (p. 374).

Gottlieb (1993) feels that the basic components of sovereignty (the state and the nation) might possibly be separated. Given the turbulent relationship between ethnic groups, religions, and other special interest groups worldwide, this separation is unlikely, although it has existed, temporarily, in some sovereign nations. The problem is that humans remain a small-group species and are unable to cope with complex, multivariate political structures. Perhaps human resource distribution issues might be resolved more fairly and equitably if political boundaries were replaced by ecological boundaries and the primary political goal was preservation of carrying capacity based on natural capital and the ecosystem services it provides. The people responsible for the diseconomies and catastrophes would then suffer when their ecological life support system is damaged.

Developing Naturalistic Social Norms

In the 21st century, a rapid evolution of social norms is essential. For cultures such as the United States, in which social norms have been based on a cheap, convenient, readily available source of energy (i.e., petroleum), the rate and degree of change needed will be almost overwhelming. The American automobile culture has let public transportation languish, and urban sprawl has been possible because of the independence automobiles provide. Coal is a possible energy alternative, but it diminishes air quality as well as producing greenhouse gases. Ethanol is an alternative to petroleum products, but may have unattractive input/output energy ratios. Moreover, corn and other foodstuffs are serious contenders as sources of ethanol. Since most of the planet’s arable land is already in use, an “eat or drive” situation could easily develop, especially if climate change (e.g., rainfall patterns, temperatures) diminishes present agricultural productivity. If climate change occurs more rapidly than predicted, as it is in some parts of the world, the consequences will probably be catastrophic. If foodstuffs, such as corn, are diverted to alcohol production for automobiles, the increased demand could force prices well beyond the means of poor and middle-class people. If climate change diminishes the production of corn and other foodstuffs that can be converted to alcohol, prices could soar even more. At present, over a billion people are not adequately nourished, and the additional 3 billion more people who are projected to be added in the 21st century will exacerbate this troubling situation.

If compassion for the poor exists, something should be done to improve their condition. Since most of the population growth is expected in third-world countries, population stabilization at a level compatible with regional carrying capacity is an obvious solution, which means intruding on individual freedom to have large numbers of children. This intrusion would be distasteful to many people. On the other hand, in natural systems, species that exceed the regional carrying capacity simply lose large numbers of individuals to death, starvation, and disease. If humankind is unable to develop social norms that protect the biospheric life support system, should disease, starvation, and death be permitted to limit human population size as they do for other species? In the Pacific arena of World War II, the very heavy casualties resulting from capturing Iwo Jima were considered justified because they saved the lives of so many B-29 bomber crews whose damaged aircrafts would otherwise have been lost at sea. Should the same reasoning be used to protect the biospheric life support system that is essential to a habitable planet for posterity? Should this reasoning be used when the long-term carrying capacity of the planet has been exceeded?

Biospheric Life Support Systems

One colleague correctly pointed out that there is yet no robust evidence that the biospheric life support system is in disequilibrium; however, no robust evidence indicates that its health and integrity have not been impaired. The consequences of the biospheric life support system ceasing to maintain conditions so favorable to humankind are so appalling that precautionary measures to avoid stressing the biospheric life support system

beyond its tipping point are prudent. Paleontological evidence indicates that evolutionary processes eventually restored biological diversity in the past, but not the species that became extinct. Post-disequilibrium conditions may not be as favorable to humans as those at present. From a homocentric viewpoint, precautionary measures are justified even though the precise tipping point of the present biospheric life support system is not known. This tipping point can be determined by continuing present unsustainable practices; however, when the biospheric life support system is in disequilibrium, how will this new knowledge benefit humankind? Evolutionary processes will almost certainly persist (until the sun dies), but individual species, such as *Homo sapiens*, may well suffer major loss of life or even become extinct. Compassion for the other life forms that constitute the present biospheric life support system is a matter of enlightened self interest, as well as an indication of compassion for posterity.

The Limits of Compassion

The daily news is a constant reminder that catastrophes occur continuously, even though, fortunately, most are regional rather than global. Responding to each in a meaningful way would produce an emotional overload in most people. In fact, many people studiously avoid the bad news and only welcome the good news. Of course, denial of or avoidance of problems usually results in delaying the solution of the problem. However, so does taking on too many problems at once so that none gets the attention needed for solution.

With an exponentially increasing human population, increasing ecological overshoot, global warming, and other types of climate change; peak oil; and inadequate supplies of fresh water, exceeding a number of ecological and societal tipping points in the 21st century would not be astonishing. Since the exact location of these tipping points will not be known until they have been passed, each catastrophe will be a surprise. Of course, if an urgent, major global effort were made to first arrest and then reverse these unsustainable trends (remembering ecological overshoot), these thoughts could be dismissed as idle speculation. However, no credible signs indicate that this trend is happening at the global level. Worse yet, so little has been done that even inadequate measures may look good to the general public and, thus, delay effective remedial action. Some illustrative questions related to these issues follow.

1. Will compassion for the biospheric life support system be adequate to ensure its health and integrity so that conditions favor *Homo sapiens*?
2. Can humans adapt to rapidly changing social and ecological conditions so that species survival is likely?
3. Will humankind have sufficient compassion for posterity to withhold aid to populations that persist in having social norms that are unsustainable?
4. Will resource wars, both military and economic, be the primary determinant of allocation of finite resources on a finite planet?
5. Will resources be used sustainably?

In natural systems, finite resource problems are “solved” in ways repugnant to most humans — mass deaths, starvation, disease, etc. Since humankind credits itself with intelligence, creativity, and compassion, one might reasonably expect more from this species than a 24% ecological overshoot, exponential population growth, excessive anthropogenic greenhouse gases, and resource wars. The basic question is not how to meet human “needs” and expectations, but how to live sustainably so that the biospheric life support system continues to maintain conditions that are so favorable to humans. Otherwise, humans will become a transient species like those that preceded it over billions of years.

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SURPRISE, SURPRISE—HEAT MELTS ICE

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Get your facts first; then you can distort them all you please. Unknown

Globally, temperatures are rising; glaciers are melting and shrinking; scientists are predicting increased numbers of damaging hurricanes (Zollo 2005); rainfall patterns are changing; and sea levels are rising. All these events will affect the reliability of global food production. In addition, higher seas are swamping native villages in far north Alaska, and the melting of the permafrost around Fairbanks is causing some roads and other structures to buckle (Egan 2005). Climate change is also affecting bird migration, a significant source of tourist dollars for some Alaskan villages. Portage Glacier can no longer be seen from the visitors' center.

Some politicians, corporate executives, and many citizens act surprised at these changing events and emphasize the uncertainty in scientific hypotheses and information. However, Swedish scientist Svante Arrhenius predicted, in the 1890s, that the Industrial Revolution would result in global warming, and evidence supporting his theory has been accumulating for well over a century. Uncertainty will always exist in science since theories are probabilistic determinations based on verifiable evidence. Citizens invest in the stock market and vote for political candidates based on the expectation that the stock market will benefit them and politicians will fulfill their campaign promises. Obviously, considerable uncertainty exists in both these expectations, but citizens still act.

Michaels (2005), a research epidemiologist, calls attention to similarities between his research and that of those who study climate change (including global warming). Michaels cannot intentionally expose people to carcinogens and must collect data through observation only; so must climate change investigators. He notes that uncertainties are inevitable, but neither public health nor environmental protection will be effective if absolute proof is required before acting. Otherwise, action will be indefinitely postponed, which, Michaels notes, is often exactly what industry wants. As a consequence, part of industry has mastered the art of manufacturing uncertainty and demanding absolute proof.

Worse than this situation are recent disclosures that unqualified government employees are altering scientific reports. For example, the former US White House staff member (Philip Cooney) who revised government-generated scientific reports on global warming resigned his position following these disclosures and promptly acquired a position with Exxon Mobil. He was a lobbyist with no scientific credentials (Revkin 2005).

Yet another approach is used when the facts do not fit the ideology—the administration just rewrites the facts (Opinion 2005, Goodman 2005, Cart 2005). If none of the preceding strategies work as well as expected, the tactic of delay is used. For example, McNeil and Barrionuevo (2005) report that the US Department of Agriculture finally confirmed, after seven months delay, that a cow had died last year with Mad Cow disease. The result was never publicly disclosed, even though interest in this disease has been intense both nationally and internationally; many countries have banned shipments of US beef because they consider testing techniques lax.

The American Civil Liberties Union charged that the US President Bush's administration is placing science under siege by overzealously tightening restrictions on information, individuals, and technology in the name of homeland security (Associated Press 2005). Another strategy is to resist any discussions on an issue perceived as unfavorable to the government's cause. For example, Heilprin (2005) reports that the Bush administration is working on a draft report on climate and energy about the need to resist naming global warming as an urgent problem that requires aggressive action. Still another approach is to annex the news and public affairs of the US Public Broadcasting System to the larger state propaganda machine (Rich 2005).

A widely read news outlet, *USA Today*, has proclaimed that the global warming debate is over (Vergano 2005). Vergano notes that the ground has shifted on global warming since, with little fanfare, divergent groups are joining hands to deal with a problem they believe people can no longer ignore. However, there is still a long way to go. The administration of US President Bush is still trying to downplay global warming as a major problem for humankind. Many large corporations still spend huge amounts of money minimizing the importance of global warming. A large number of people are unwilling to change their life styles to diminish anthropogenic greenhouse gases, and literacy on global warming is still appallingly low. All these tactics are reflected in the reluctance of the US Congress to take a strong position on global warming. The fact that this reluctance results in deep disappointment in Europe and other areas of the world seems not to matter (e.g., Woolf and Brown 2005).

Even the Kyoto agreement, if implemented, is regarded by mainstream science as an inadequate solution, although it is widely viewed as an important first step. Global warming is now a battle between science and ideology, although a favorite delaying tactic is to call for more research. As noted previously, it is the nature of science to always have different levels of uncertainty. Gathering more scientific evidence on global warming is highly desirable, but no amount will displace ideology. Compassion for those already suffering from global warming in Europe (e.g., LaFranchi 2005), Pacific Islanders forced to leave their native lands, and the Inuits in the US State of Alaska is not very evident. Even compassion for future children, grandchildren, and their descendants is not apparent. Bustillo (2005) quotes Peter Hoppe, head of the "geo risks" division at Munich Re, the world's largest insurer of insurance companies, that his biggest worry is what global warming is already costing the $3-trillion insurance industry. The present situation is difficult because the techniques for estimating disaster risks are based on historical trends, which may no longer be reliable. Other professionals, such as Pielke (Bustillo 2005), note that the reinsurance industry has a powerful vested interest in charging the highest rates possible. A former insurance executive, Andrew Elugolecki, stated that, unless insurers could adjust their premiums to match the uncertainties they see, they might eventually stop offering some types of coverage, such as oceanfront properties (Bustillo 2005). Historic data will probably be less useful in estimating the risks of global warming than such things as fire and theft.

McCarthy (2005) wonders if the United States can prevent wealthy countries from agreeing on what to do about climate change; he concludes that the omens do not look good. Other questions concern areas such as Africa and its poverty. Many professionals note that everything that makes Africa hard to inhabit today will be made harder by global warming. Even though the United States may not endorse a Kyoto Protocol style agreement, global warming proponents may shift the approach in a new direction. The tide may be turning, but it may be turning too slowly to prevent a series of catastrophes.

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LIFEBOAT ETHICS —– TO SINK, OR NOT TO SINK: THAT IS THE QUESTION*

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No generation has viewed the problem of the survival of the human species as seriously as we have.
Garrett Hardin
(1974)

For the foreseeable future survival demands that we govern our actions by the ethics of a lifeboat. Posterity will be ill served if we do not. Garrett Hardin (1974)

Hardin (1974) used a lifeboat metaphor to simplify the issues involved in living on a finite planet with finite resources. The human species hopes to remain on Earth for many generations (i.e., sustainable use without abuse of the planet), and the use of metaphors will help humankind understand and cope with vast temporal and special scales and complex multivariate data. Further, Hardin (1974) believed that rights and responsibilities must be congruent. He asserted (Hardin 1976): "lifeboat ethics is merely a special application of the logic of the commons." He also provided some ways to avoid sinking the planetary lifeboat (Hardin 1985). Hardin's numerous publications identified the major issues humankind must resolve in the 21st century — or suffer grievously. Hardin's lifeboat metaphor is ideal for illustrating the consequences of individuals leaving (emigrate from) a sinking or badly overcrowded lifeboat to board (immigrate to) a lifeboat with more desirable conditions.

The metaphor is weak in that the lifeboats (islands and continents) cannot rise when the sea level rises. As Revkin (2004) notes, Greenland has an ice cap that is two miles thick; Revkin calls it a "freshwater Gulf of Mexico" that is frozen atop the world's largest island. Equally important is that the influx of freshwater from this melting ice cap might block currents in the North Atlantic that help moderate the weather of the North Atlantic (Revkin 2004). The lifeboat metaphor does not convey the high probability that rising water will reduce food production while crowding people on a small land surface. Changing weather would also impair agricultural productivity, probably pushing it into instability. As Hardin (1974) noted, lifeboats should not be filled to capacity so that each will maintain a safety factor.

Sachs (2004) maintains the necessity for both understanding and resolving human catastrophe security threats arising from extreme poverty. The poor are on sinking or unsafe (i.e., not sustainable) lifeboats, which they will almost certainly be tempted to leave, even at great personal risk, if their circumstances are not improved. *The Camp of the* Saints (Raspail 1973) is an apocalyptic, but believable, vision of future events if the disproportionate allocation of planetary resources worsens or if damage to natural systems reduces Earth's carrying capacity.

The quest for sustainable use of the planet is an attempt to avoid a post-human world. Many circumstances are contrary to achieving this goal; two of the most important follow. (1) An ecological "overshoot" has been caused by the human economy. Stated more directly, humankind is not living within the regenerative capacity of the biosphere (Wackernagel et al. 2002)—humankind is exceeding the long-term carrying capacity of the planet. (2) Access to the global commons is not regulated (Cairns 2003-2004). Hardin (1968) has eloquently described the tragic consequences of free access to the commons by people or organizations with little or no conscience.

Prestigious scientific groups (Union of Concerned Scientists 1992, Royal Society of London and the United States National Academy of Sciences 1992) and world-class scholars (e.g., Wilson 1993) have issued

*With apologies to William Shakespeare

warnings about the dangerous deterioration of environmental conditions. Myers (1996) has included national security as an environmental issue, and his book is not an isolated example of the connection between biospheric conditions and political conditions. Since culture has markedly shaped human evolution (e.g., Wilson 1998), humankind may be its own worst enemy. Arguably, the leaked Pentagon report that warns of climate wars (Environmental News Service, 23 February 2004, originally published by the British newspaper *The Observer*) is a dramatic force since the Pentagon is not viewed as an environmental organization.

Oddly, the Pentagon report has received little attention in the American news media even though the probability is high that global warming is almost certainly a greater threat to American security than terrorist attacks. Myers (1996) discusses why humankind chooses to ignore the environmental implications of its actions. He wisely avoids explicit policy statements (since the need for a policy on greenhouse gases and population stabilization, to mention two matters of urgency, have been evident for years), even though no remedial policies have been developed. Since world leaders respond primarily to emergencies, one or more environmental catastrophes will probably have to occur to initiate action on policies. Hanley (2004) provides an excellent summary of the views on global warming of prominent scientists and highly respected scientific organizations. As he notes, even skeptics agree that it is time to act, although research on global warming should continue.

Even the well publicized September 11 terrorist action (i.e., three hijacked planes crashed into the World Trade Center twin towers and the Pentagon in 2001) has not yet produced an effective policy to prevent such future incidents. Arguably, this inaction is due to policy makers who are addressing the symptoms rather than the underlying causes, partly because special interests protecting existing policies and practices are too formidable and their lobbyists are too entrenched. In addition, an environmental illiteracy problem exists which, when corrected, should elicit policy development from all sectors of human society. Myers (1996) does discuss failed policies on natural resources and profligate unsustainable use of these resources. What is not understood is that even moderate damage to the planet's biospheric life support system will severely impair global security and major damage might result in the final exit of *Homo sapiens*.

These thoughts are depressing, but humankind has the ability to change these circumstances by changing behavior patterns so that it neither exceeds carrying capacity nor irreversibly damages the biospheric life support system. These resolves will require leadership that can persuade and inspire the average citizen to make such changes. However, the United States, which has the world's largest ecological footprint, has carried out more than 150 impairments of environmental safeguards between January 2003 and March 2004 (National Resources Defense Council 2004). To assume that these impairments would have no interactive or cumulative effects would be madness. Globally, the probability of cascading tipping points is daunting. China has a rapidly growing economy, making it a major influence on the world grain market. The United States trade deficit with China is huge, so that much of the American grain surplus will probably go there. Since about 1,000 tons of water is needed to produce 1 ton of grain, the world shortage of freshwater will have an impact on grain production, as will desertification. Furthermore, in the United States, grain production is highly mechanized, so increases in energy prices will have a major effect on costs. Finally, global warming and other types of climate change may well have adverse effects upon grain production.

Orr (2004) describes the current crisis as political, although not in the traditional sense. He notes that American-style democracy is in tatters when trying to change unsustainable practices, since most American citizens (the majority) do not want dirty air and water; however, there is formidable opposition to changing practices that pollute and damage the environment. Ironically, as Mooney (2004) notes, there is an Orwellian aspect to any attempt to undercut scientists. Politicians who advocate "sound science" in support of their political agenda do not dare, at least at present, to call mainstream science poor, deficient, or fraudulent because they have no robust evidence to support this assertion. "Junk science" is best dealt with in professional journals by the scientific process involving credentialed scientists. A call for "sound science" is an attempt by politicians to denigrate scientific research that deviates from the dominant political ideology. The Union of Concerned Scientists (18 February 2004) released a report criticizing the Bush administration for distorting and denigrating scientific publications that differ from the administration's ideological agenda. Bartlett (2004) notes that there will be no satisfactory long-range solutions to problems of energy and the still increasing carbon dioxide emissions until population growth and sustainable energy policies have been developed. Since human society depends heavily on energy, this serious problem could destabilize human society if it is not addressed in the near future.

Orr (2004) discusses how the democratic public, on such crucial topics as climate change, hazardous chemicals, and environmental degradation, has had little or no influence on public policy in the United States. If democracy is to be established in non-democratic countries, the United States should serve as a model for sustainable use of natural resources. Orr (2004) attributes this situation to two key factors: (1) a marked

decline in public accountability and (2) a well funded campaign to denigrate alternate points of view. Both of these are acts of denial and are not limited to politics, advertising, or economics, but include politicizing of both scientific research and education. Berry (1977) discusses the perversion of the goals that led to the establishment of land-grant universities in the United States.

Ehrlich and Ehrlich (2004) discuss the belief that America can maintain its high level of affluence despite the rapidly increasing disparity between rich and poor. They believe that this situation (and other political stances) demonstrates a loss of contact with reality. Historic and archeological evidence is used to illustrate that a powerful, prosperous, and culturally advanced society (e.g., Nineveh, located in the nation-state of Assyria) can be replaced by a barren landscape if there is a marked decline in the natural resource base. Assyria had a powerful military establishment that played a major role in maintaining the flow of resources into it, and Assyrian kings used terror to deal with powerful foes. Living unsustainably globally threatens the quality of life of posterity and even its very existence.

Counter trends have surfaced (e.g., one article by Robert F. Kennedy, Jr. in the 11 December 2003 issue of *Rolling Stone* and also available at http://www.commondreams.org/views03/1120-01.htm). The United States Senate Climate Stewardship Act, S. 139 (ssi@ucsUSA.org) is a bipartisan effort to set mandatory limits on greenhouse gases from relevant sectors of the American economy. Officers of some of the largest pension funds in the United States are attempting to have the United States Securities and Exchange Commission require disclosure of financial risks involving global warming to the stocks in their pension funds (Environmental News Service, April 2004).

These situations lead to some very puzzling questions. Why is humankind continuing unsustainable practices that put posterity at risk? Why risk a worst case scenario that places the human species at unnecessary risk? Why are nation-states and corporations favoring, even subsidizing, practices that put their citizens and customers at risk? Why is science denigrated when evidence is counter to political agendas and supported when it favors them? Why, when baboons have an emerging peaceful culture, can't humans (Sapolsky and Share 2004)? Why is humankind so reluctant to have a free and open discussion about the worsening environmental crisis?

One possibility for this reluctance is that answers to these questions would expose humankind's vulnerability to the consequences of an environmental destruction unprecedented in human history. Denial of the consequences of unsustainable practices is the best way to avoid major changes in societal behavior, which should, if implemented in time, substantially reduce the risks. Anxiety has not been eliminated—just suppressed. Natural systems should generate a sense of awe in humankind because it still does not understand them fully. Instead, natural systems are labeled "resources" to be used as humans choose.

Although it borders on the heretical to reflect on the decline, even extinction, of *Homo sapiens* in an era of exponential economic growth, a few questioners have done so. Hanh (1993) remarks on the intense anxiety about what the future holds. Berry (1996) considers how the dissolution of the present components of the environmentally destructive system might affect the future. Hill (1994) asserts that ultimately no refuge from nature's laws exists. Dixon and Adams (2003) have labeled the present era the "Human Era" and speculated, with the help of a number of scientists, what might inhabit a post-human world, i.e., humankind's domineering presence will not endure. Heifetz (1994) stresses the need to endure anxiety and pain so that one can learn from these emotional challenges. Humans need to confront their fascination with their environmentally destructive society and develop what Wilson (1984) calls biophilia.

It is reassuring that both Orr (2004) and Ehrlich and Ehrlich (2004) and, of course, all who believe sustainable use of the planet might well be achieved, have suggestions for changing unsustainable to sustainable practices. Orr (2004) remarks that a conference on the "State of the World" included much on the gloomy state of the environment and the human condition; he decided to list the legitimate reasons for optimism about the future. Orr concludes that many individuals are correct in affirming better prospects: "public opinion polls show determined majorities over three decades in favor of clean air, clean water, open spaces, preservation of species, climate stability, less traffic congestion, and solar energy" (Orr 2004, p. 133).

Much of the tolerance for unsustainable practices may be due to "cognitive dissonance"—the result of situations where the pieces of information about the same subject are inconsistent (e.g., Cooper 2004). Cooper (2004) notes that the human psychological need to reduce dissonance is one of the forces that compromises rationality. Humankind is enamored of many unsustainable practices (e.g., population growth, increased material consumption, disposable containers, and the like), but there is no "away" into which to throw or dispose of waste products (i.e., everything is interconnected). Consequently, if natural systems cannot utilize the waste products as a resource, then the wastes will cause problems. Cognitive dissonance is undoubtedly a major problem for politicians, especially those facing frequent elections of 2-4 years, and also for many citizens. Unsustainable practices are not obvious when numerous supermarkets are always well stocked with a variety of

foods, large discount stores carry a wide selection of merchandise, and no long lines form at gasoline stations. All these are frequented by a substantial number of customers, indicating that prices are not beyond the capabilities of the average citizen in some parts of the world (e.g., the United States).

I am comforted by persuasive evidence that life on Earth has survived five major extinctions and that the diversity of life has increased during this period. However, the sixth great extinction, now underway, will almost certainly drive many charismatic species into extinction and compromise the biospheric life support system so favorable to humankind. In terms of evolutionary time, the diversity of life forms will probably be restored, but *Homo sapiens* is unlikely to be the dominant species it is now and could even become extinct as did many hominids of the past. I am saddened and distressed that a species capable of producing superb literature, art, music, and science may disappear. However, this regret is diminished by the knowledge that humankind has been shockingly destructive of natural systems and has already driven many species to extinction. In addition, it is difficult to sympathize with a species that is leaving a less habitable planet for its descendents. Even in this sadness, all is not yet lost—humankind could develop a mutualistic relationship with natural systems, restore damaged ecosystems, live more sustainably, and give eco-ethics a much higher priority. More emphasis should be placed on growth of social capital, including a fair and equitable allocation of resources between humans and the planet's biospheric life support system, as well as within the species. Humankind must earn the privilege of being on the ecological stage in the evolutionary theater by admitting that it is not the only species in the drama, especially since it arrived only recently on the stage. Action not preceded by thought is dangerous at worst and unsatisfactory at best. Many emotional issues are involved, especially those of conflicting loyalties. The 21st century will be a transitional era for the human species, and suffering will occur, regardless of the outcome. Hope exists for sustainability, which is the ultimate quest for the human species. Lifeboat Earth can be managed for long-term use instead of short-term gain.

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CREATING AN ALIEN PLANET

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In a sense, we're getting our first sniffs of air from an alien world.

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For approximately 160,000 years, conditions on Earth have favored humankind, thanks to the biospheric life support system. At present, anthropogenic wastes, from hazardous chemicals to carbon dioxide, are damaging the biospheric life support system at a rate unprecedented in human history. The scientific evidence on global heating, and other types of climate change, has changed from persuasive to overwhelming, as it did previously for hazardous chemicals and physical damage to natural systems. However, unsustainable practices continue and the consequences worsen. Humankind may have to suffer horrendous, appalling events before it accepts responsibility for the severe, possibly irreversible, damage to Earth's biospheric life support system.

The Pioneering Prophets

"Where there is no vision, the people perish" (Proverbs 29:18) is a quote from the Christian Bible – it is eerily applicable in 2007. Wilson (1996, p. 184) remarks: "Unlike any other creature that has lived before, we have become a geophysical force, swiftly changing the atmosphere and climate, as well as the composition of the world's fauna and flora." Ehrlich and Ehrlich (1974, p. 11) state: "Our entire society seems to suffer from a sort of mental block and may refuse to take action to correct its fatal course until it has passed the point of no return."

Carl Sagan was invited to give the Gifford Lectures on Natural Theology at Glasgow University in Scotland n 1985 for the lectureship's centennial. Fortunately, his widow and long time collaborator, Ann Druyan, found his notes and published them (Sagan 2006) on the tenth anniversary of his death. The chapter entitled "Crimes against Creation" in that Sagan volume is, regrettably, even more appropriate than when it was written. At the time the chapter was written in 1985, Sagan's concern was about the consequences of nuclear war. At present, however, crimes against creation could be nuclear war, ecological overshoot (O'Driscoll 2007), and/or global heating and other types of climate change. Sagan (2006, p. 19) states: "But when the world is changing very fast, I suggest survival may depend precisely on our ability to change rapidly in the face of changing conditions." The daily news on global heating and climate change indicates precisely such a time is now. Moreover, nuclear war is possible because of weapons built by nation-states, but global heating is the result of billions of individual decisions over which each person has control.

Throughout most of human history, change has been comparatively slow, but now the rate of change is startling. Many major changes occur in the span of a human generation. Sagan also notes (2006, p. 194) that technology that permits travel on a scale unprecedented in human history also enables humankind to destroy itself. What a pity for the human species to destroy itself and much of the life with which it shares the planet because it failed to use Earth's resources wisely or because resource wars seemed to be the most expedient alternative. Of the total number of species that have ever existed, most are now extinct, but life in some form still persists. The quest for sustainable use of the planet is based on the assumption that *Homo sapiens* might be an exception to the transient existence of most species. When writing about the catastrophe that destroyed the dinosaurs (p. 200), Sagan (2006) notes that dinosaurs were powerless to anticipate their extinction or prevent it. In contrast, humankind should be able to anticipate the dangers of nuclear war, ecological overshoot, and/or global heating.

The Metamorphosis

Humankind is already experiencing changes alien to the planet upon which it lives, but is extremely reluctant to alter its unsustainable life styles. Frantic efforts are being made to replace petroleum with ethanol. However, if half the fuel supply came from switch grass, growing this plant would compete with food agriculture (Crenson 2007). In addition, an alternative fossil fuel, coal, is receiving bad press from world class climatologist, James Hansen, as well as science circles and the business world (Little 2007). Both growing switch grass and coal surface mining in many locations displace indigenous species from their habitat. Both coal mining and use of natural systems for human benefit deprive the planet of the ecosystem services the former natural systems provided.

Persuasive evidence indicates that humans are adversely affecting ecosystems globally. In some areas, deleterious effects such as droughts, desertification, and ecosystem fragmentation have destroyed or seriously impaired ecosystem integrity and, as a consequence, reliability of ecosystem services. In addition, when biomass is removed, nutrients and other valuable ecological components are removed with inadequate requirements for replacement. This scenario is not sustainable use of the environment.

Most of the forces degrading the global environment could be substantively diminished, or perhaps, in some cases, eliminated, by changes in societal behavior and expectations of entitlement. Some illustrative examples follow.

(1) Humankind lacks compassion for the other life forms that constitute the biospheric life support system upon which human survival depends. What else can explain the systematic destruction of that system?

(2) Human society does not feel a strong sense of responsibility for posterity. What else can explain continued unsustainable practices that will result in a less habitable, or even an uninhabitable, planet for human descendants?

(3) With a human population growing (continually updated population information at http://www.worldometers.info/) about 91 million per year, millions going to bed hungry nightly, and millions more malnourished, can society justify using foodstuffs (e.g., corn) to produce fuel for automobiles?

(4) Is it justified to use arable land for switch grass production to provide more ethanol when millions of people lack an adequate diet? Is depriving other life forms of habitat in order to grow switch grass for ethanol production justified?

(5) A draft report of the Intergovernmental Panel on Climate Control, which is due to be released in June 2007, notes that hundreds of millions of Africans and tens of millions of Latin Americans who now have water will be short of water in 20 years (Associated Press 2007). The report further notes that, by 2050, more than a billion people in Asia could face water shortages. Finally, by 2080, water shortages could threaten 1.1 billion to 3.2 billion people, depending on the level of greenhouse gases that cars and industry spew into the air. Since approximately 1,000 tons of water are needed to produce a ton of corn and much water for any kind of rapidly growing biomass, prudence indicates that more thought should be given to how much water should be allocated to biomass production for conversion to ethanol.

(6) Human society has failed to grasp the enormity of exhausting the necessary physical prerequisites for the type of lifestyle it now has. Hoyle (as quoted by Duncan 1996) gives an eloquent statement on this issue:

> With coal gone, oil gone, high-grade metallic ores gone, no species however competent can make the long climb from primitive conditions to high level technology. This is a one-shot affair. If we fail, this planetary system fails so far as intelligence is concerned. The same will be true of other planetary systems. On each of them there will be one chance, and one chance only.

Present evidence indicates human society is not evolving toward sustainable use of the planet.

Time Span

The time spans for the life expectancy of the industrial civilization (Duncan 1996) vary from highs of 39-million years to about 100-million years, with the majority toward the lower end. The 39-million-year estimate was made in 1927, but more recent estimates, especially the ones involving peak oil and global heating, tend to be very short. Duncan (1996) notes that the industrial age, estimated to cover the time span of 1930-2025, has only a few years left. Life will be difficult when energy supplies diminish, so living sustainably within Earth's resource supply is essential. Profligate use of energy is reckless.

Double the Danger

Earth probably will be in orbit around the sun a billion years from now – very likely it will be in orbit 15 billion years from now when the sun dies. A dazzling succession of life forms will have probably existed, although their precise nature is impossible to predict. Moreover, how much of this time humans will be present is in serious doubt. What most proponents of perpetual economic growth seem unable to face is that economic growth, as humans define it, will also cease in the absence of humans. The world religions will also disappear. Arguably, they will disappear because they have been divisive rather than unifying on the issues that threaten the quality of human life (e.g., overpopulation, callous exploitation of other life forms, profligate use of fossil fuels), and even human survival. The quest for sustainable use of the planet is based on the assumption that humans will not destroy themselves, even though they are clearly capable of doing so with either nuclear warfare or global climate change or even, horrors!, both.

The drive to obtain ever more material possessions has produced an ecological overshoot (e.g., Wackernagel et al. 2002) of approximately 24% more natural resource use than the planet can regenerate. Obviously, this overshoot is unsustainable, especially since it appears to be increasing at about 1% per year.

Use without Abuse

In nature, organisms "use" each other as food, shelter, etc. However, in nature, abuse is uncommon, although neither enlightened use nor unenlightened abuse is carried out consciously. Surely, nuclear war qualifies as a gross abuse of natural systems, as well as abuse of the Golden Rule. Although the Golden Rule is usually attributed to Christianity, Sagan (2006) notes that, as far as he knows, not one of the 140+ nations on Earth has adopted this Christian principle. On the issue of global heating and other types of climate change, scientific evidence is being increasingly accepted, but emissions of greenhouse gas trends are expected to continue. My regional newspaper, *The Roanoke Times*, carried a front page story (Esposito 2007) on Virginia Tech's attempts to "green itself," but pointed out two columns in the Virginia Tech's student newspaper that argued against the idea of man-made global heating. The preponderance of scientific evidence should have more influence in a university town. This conflict suggests that either the people are so specialized they cannot easily absorb information outside their field or they just do not take the time to become literate on events that affect the entire planet.

Of course, denial may be the dominant motivation for the lack of emphasis. Some consequences of acting on climate change, such as lower use of fossil fuels or using fewer material goods, are so painful that most humans refuse to consider them. The original four horsemen of the apocalypse, death, disease, famine, and war, are good examples of consequences of creating an alien planet. These consequences are difficult and extremely uncomfortable to contemplate, as are the four horsemen of the 21st century – nuclear war, human overpopulation, global heating and other types of climate change, and ecological overshoot. Nuclear war and human population growth are "the elephant in the room" – everybody sees them, but nobody wants to talk about them. Due to former US Vice-President Al Gore's movie "An Inconvenient Truth," most people know something about global warming heating, but not many are even taking the simple steps (e.g., reduced driving, energy efficient light bulbs) that would not bother their lifestyle significantly.

Maintaining a Hospitable Planet

The average length of time a species persists on Earth is approximately 1 million years. If intelligence, as humans define it, has survival value, *Homo sapiens* should expect to persist more than 1 million years. However, technology has adversely affected the biospheric life support system and may push the system past a tipping point beyond which it would go into disequilibrium and, when it finally stabilized, might no longer favor humans. Intelligent beings should understand this situation and immediately take steps to reduce the probability of disequilibrium of the biospheric life support system.

Means are available to reduce greenhouse gas emissions and, thus, reduce the risks that accompany global climate changes. Ecological overshoot can be eliminated by reducing natural resource consumption to a level within the regenerative capabilities of Earth. Means (e.g., contraceptives) are also available to stabilize the human population within Earth's carrying capacity. Countries (e.g., Vanuatu) use far less energy per capita than the United States and Canada, and their citizens lead satisfying lives. An intelligent species would do something before a global catastrophe occurs, except for lack of individual and group responsibility. However, lack of individual and group responsibility is a characteristic of an unenlightened species – a species that uses war rather than reason and negotiation to resolve problems.

In his testimony before the US Congress on 21 March 2007, former US Vice-President Al Gore, who described the present situation as a "planetary emergency," recommended the following remedial measures: (1) immediate carbon freeze, followed by a program of reductions reaching 90% by 2050.

(2) reduction of taxes on employment and production and replace the difference with pollution taxes, mostly on carbon dioxide.
(3) earmark a portion of the above revenues for low-income people who will have a difficult time making the needed transition.
(4) develop a strong global treaty on greenhouse gases with a new name, since the Kyoto Treaty has been demonized.
(5) insist on a moratorium on construction of any new coal-fired power plants not compatible with carbon capture and sequestration.
(6) develop an "electranet" – a smart grid; a law that allows widely distributed energy generation to be sold into the grid, at a rate not determined by a monopoly but by regulation.
(7) raise the CAFÉ standard as a part of a comprehensive package (e.g., cars, coal, and buildings).
(8) set a date for the ban of incandescent light bulbs.
(9) create Connie Mae, a carbon-neutral mortgage association to recognize long-term benefits of sustainable activities.
(10) disclosure required by The Securities Exchange Commission of carbon emissions in corporate reporting.

Fear of relinquishing a materialistic lifestyle is a major factor in maintaining a habitable planet, especially for the super wealthy. Anger at the increasingly disproportionate distribution of wealth is also a major factor, especially for those individuals with inadequate food, health care, education, and shelter. Economic globalization causes fear in many people because countries that exploit both natural systems and people are usually most competitive. Finally, war has not proven a useful means of resource allocation. At present, in a nuclear era, visualizing any benefit from a "nuclear exchange" is impossible. Yet, the threat remains and the risks increase. Worse yet, a nuclear winter may kill more people than a nuclear war (MacKenzie 2007). In addition, a nuclear winter can do as much damage to the food supply as global heating.

On 21 March 2007, Gordon Brown, British Chancellor of the Exchequer, addressed the British House of Commons on major initiatives to reduce anthropogenic greenhouse gases (the climate change levy). In contrast, hearings in the US House of Representatives covered the gagging and rewording of reports of NASA senior scientist Dr. James Hansen by political appointees with no scientific background (e.g., Connor 2007, Revkin and Wald 2007). The contrast was shocking – Britain was making major commitments to diminish global warming heating problems while the United States was effectively censoring federal scientists who wrote and talked about the problem. During a critical stage in World War II, before the United States entered the war, the United Sates supplied destroyers and other aid to embattled Britain under a "lend-lease" program in which Britain leased certain bases for military use in return. Perhaps Britain could now send the United States their politicians and the United States could lease its politicians for the duration of the global heating emergency. Perhaps remedial action would then be taken in time.

Concluding Statement

Former Vice-President Al Gore summed up the moral issue well: "I promise you, a day will come when our children and grandchildren look back and ask one of two sets of questions. Either, what in God's name were they doing? What was wrong with them? Did they think all scientists were wrong? What were they thinking?" . . . or "How did the uncommon moral courage to rise above politics and redeem the promise of American democracy and do what some said was impossible and shake things up and tell the special interests, OK we heard you, we'll take your considerations into account, but we're going to do what's right."

Humankind has done enormous damage to Earth, but its becoming a planet not hospitable to humans may still be preventable. Surely, this possibility deserves immediate attention, coupled with drastic steps to eliminate or make major reductions in global problems. Is it possible for sufficient change to occur in the short time available when both nations and individuals are unwilling to give up high energy use, exponential economic growth, and high material goods consumption? Present lifestyles are primarily a result of cheap, abundant energy and ecological overshoot. Peak oil data indicates that the era of cheap, abundant oil is over, and resource consumption cannot exceed Earth's regenerative rate for much long. As a consequence, humankind must make major lifestyle adjustments, especially if no attempts are made to prepare for the new circumstances.

To succeed in this new endeavor, humankind's leaders will have to demonstrate much more leadership by example than they are now doing. Earth cannot continue to exist in its present circumstances if an elite group continues to practice profligate use of resources while lower classes attempt to live sustainably. The majority of citizens need moral leadership in order to make the sacrifices essential to living within Earth's carrying capacity. Both religious and political leaders must improve the relationship with the biospheric life support system before humankind's unsustainable practices turn Earth into an alien planet for humans. Surely,

continuing reckless energy use and excessive use of natural resources is not bringing the satisfaction everyone expected. In fact, Marks et al. (2006) have clearly demonstrated no close relationship between resource consumption and happiness and life satisfaction.

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DECALOGUE FOR A PLANET IN IMMINENT PERIL

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Live simply that others may simply live. Quaker Proverb

According to the *American Heritage Dictionary*, a *Decalogue* is a "fundamental set of rules having authoritative weight." This Decalogue is basically a reminder to me of the ethical/moral relationship I aspire to have with the biosphere and all its components.

(1) I will not cease efforts to protect and restore the biosphere, even in the context of bad news about its condition.
(2) I will not willingly engage in unsustainable practices, no matter how many people espouse them.
(3) I will do everything in my power to avoid contributing to either ecological overshoot or ecological deficits.
(4) Nothing relieves me of the responsibility for leaving a habitable planet for posterity and for other life forms.
(5) I must continually confront the ethical/moral question: "Which of my actions promote biospheric integrity and health- which do not?"
(6) I fear not for the future of life on Earth – at least until the sun becomes a red star. I do fear serious disruption of the planet's evolutionary processes.
(7) I fear not that present irresponsible and unethical behavior is a threat to civilization and even the human species. I affirm that I will act responsibly to the best of my ability.
(8) I pledge to use less fossil sunlight since the post-peak-oil era that humankind is now entering is a serious threat to both civilization and the planet. Coal is a dangerous substitute for petroleum. Biofuels raise the price of food (e.g., corn), endangering the over 800,000 people the United Nations reports are starving.
(9) I will seek to understand and pay attention to nature's warnings and lead a life that is harmonious with natural systems and the species that comprise them.
(10) Since the survival of humankind has depended upon the continuation of the conditions provided by the biospheric life support system (BLSS) for the 160,000 years humans have lived on Earth, I will do everything in my power to preserve the BLSS in its present form. If the effort fails, I am prepared to accept that Darwin's dice will roll again.

This is a first attempt to express what has been on my mind since the climate change, energy, and population crises made the present situation the worst emergency *Homo sapiens* has encountered. I do not think the Decalogue should be lengthy, but suggestions for improvement are welcome.

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THE END OF THE CORNUCOPIAN* DELUSION

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We don't see things as they are, we see them as we are.. Anais Nin

How long will researchers working in adjoining fields . . . abstain from expressing serious concern about the splendid isolation in which academic economies now finds itself?

Wassily Leontief, 1982
Nobel Laureate in Economics

At least half the human population has not experienced anything close to the cornucopian experience and lifestyle. However, many believe that the cornucopian dream can be theirs if they can get to a place, such as the United States, where others appear to be living the dream, even though evidence shows that the Industrial Age and all its material benefits are ending. Even the recipients of the cornucopian fulfillment of their desires may have trouble deciding whether it is a blessing or a curse. McCarthy (2007) quotes a report of the National Petroleum Council that urged cutting back on oil consumption, which should serve as the ultimate wake-up call about a looming energy crunch. Cheap oil has fueled the Industrial Revolution, which made abundance of material goods and food possible. Now that era is ending, and humankind has delayed preparing for the post-industrial world too long.

One would never come to the conclusion that the privileged component of humankind has abandoned the cornucopian delusion from listening to the "debate" about reducing greenhouse gas emissions – at least, not if economic growth is viewed from an anthropocentric viewpoint. Resistance is strong to an attempt to reduce greenhouse gas emissions that *might* adversely affect the economy. However, inadequate attempts are being made to reduce greenhouse gas emissions to protect climatic conditions that have been remarkably favorable to *Homo sapiens* for approximately 160,000 years and the genus *Homo* for about 1 million years. The species that collectively make up the biospheric life support system, which maintains these favorable conditions, are also vulnerable to climate change, and a large percentage of these favorable conditions may be lost in the 21st century. As Hansen *et al*. (2007, p. 1938) note, about one fourth of fossil fuel CO_2 emissions will remain in the air more than 500 years. No "silver bullet" (i.e., rapid fix) is available for the atmospheric gas imbalance now being created. Hansen *et al*. (2007, p. 1939) state:

> *Given the estimated size of fossil fuel reservoirs, the chief implication is that we, humanity, cannot release to the atmosphere all, or even most, fossil fuel CO_2. To do so would guarantee dramatic climate change, yielding a different planet than the one on which civilization developed and for which extensive physical infrastructure has been built.*

In short, humankind would be creating an alien planet (Cairns 2007). Hansen *et al*. (2007, p. 1939) further state that estimated oil and gas reserves, with only modest further use of coal, are sufficient to bring atmospheric CO_2

cornucopia (i.e., the horn of plenty) – the symbol of food and abundance (i.e., the property of being extremely abundant). In Greek mythology, Amalthea raised Zeus on the milk of a goat. In return, Zeus gave Amalthea the goat's horn, which had the power to give the person in possession of it whatever he or she wished.

to approximately 450-475 ppm atmospheric concentration. In addition, this scenario includes the need to phase out coal use, except where the CO_2 is captured – unlikely if present and contemplated energy uses prevail. Most important, Hansen *et al*. (2007, p. 1949) propose that Earth will be in imminent peril if initiation of dynamical and thermodynamical processes on the West Antarctic and Greenland ice sheets, which will produce a situation out of humanity's control with a devastating sea level rise, are not avoided. The authors further note that the gravest threat they foresee starts with surface melt on West Antarctica and interaction among positive feedbacks leading to catastrophic ice loss.

This information is recent and disturbing and provides evidence that Earth's abundance, in human terms, is already declining. However, the older list of climate change consequences (e.g., drought, expanded range of many diseases, reduced freshwater for both municipal and agricultural use) was already cause for concern. The words *imminent peril* add a heightened sense of urgency not previously present. Humankind should have a strong interest in preserving a planet resembling the one on which civilization developed. The present administrator of the US Environmental Protection Agency observed that humankind does not know that the present climate is optimal (ABC News 2007). This observation is true, but the climate has been satisfactory for *Homo sapiens* for 160,000 years and for the genus *Homo* for over a million years. Observed climate changes are much less satisfactory in many areas of the world, and some appear to be unsuitable. As greenhouse gas emissions increase, the rate of change will increase until humankind reaches one or more tipping points, beyond which situations will develop that humankind cannot control.

As the United States approaches an array of ecological and societal tipping points, efforts are being made to avoid reaching them. One effort was the Congressional bill to have 15% of electricity generated with renewable energy by 2020. The so-called Renewable Energy Standard (RES) was nearly undermined by Senator Pete Dominici, who wanted coal and nuclear power in the mix, but failed to get enough votes. Then, Senator James Inhofe held up the bill until it was too late for a vote on the bill and the over 100 amendments attached to it (Dorner 2007). The RES is now moribund for a time. All delays to cope with either the energy or climate crisis increase the probability of crossing one or more tipping points and/or thresholds and, thus, diminish the probability of survival for human society as it now exists and, in the worst case scenario, threaten the survival of the human species.

In contrast, in spring 2007, the US Government Accountability Office finally concluded that peak oil is real, although M. King Hubbard proposed peak oil in 1956. The GAO not only concluded that peak oil is real but also that, if it occurs soon, it could cause a worldwide recession.

Will Economic Growth Survive if the Biospheric Life Support System Fails?

One previously offered idea is that greenhouse gas emissions cannot be reduced because the course to reduction might have adverse effects upon the economy. At present, that situation is slowly beginning to change. However, Gelbspan (2007) remarks:

> *Humanity is standing at crossroads between a more just, peaceful world and an increasingly chaotic, turbulent, and authoritarian future driven by a succession of climate-driven emergencies. We could find ourselves struggling to survive a desolate era of climate hell marked not only by a degraded and fractured society but also by more authoritarian governments.*

Gelbspan makes other important points:

> *(1) The private, corporation forces that have produced the climate emergency are powerless to cure it.*
> *(2) Humanity must cut its use of coal and oil worldwide by about 80 percent in a very short time by shifting to clean energy.*
> *(3) The technical remedies favored by the big energy companies are mostly the wrong ones, such as "clean coal" and mechanical carbon sequestration.*
> *(4) What's required is significant government action, and on a global scale.*
> *(5) The United States, as the world's most disproportionate energy consumer, is in a position either to lead an energy transition, or to thwart it.*
> *(6) In 2004, the insurance industry giant, Swiss Re, noted: "There is a danger that human intervention will accelerate and intensify natural climate change to such a point that it will become impossible to adapt our socio-economic systems in time.*

> *(7) Looking at the transformative economic and political potential of a clean energy future, one can feel very optimistic. What injects a feeling of pessimism, however, is both the looming imminence of runaway climate change and the dismal lack of leadership by U.S. politicians of both parties.*

The Future of *Homo sapiens*

Focusing primarily on the health of the human economic system is clearly a "tunnel vision" approach. The biggest shift humankind must make is from an anthropocentric to an ecocentric perspective. If humankind does not focus on the health and integrity of Earth's biospheric life support system, the human race will continue to be in grave danger and may not even survive. However, Hawken (2007, p. 1) describes the groups that gathered after one of his talks as follows:

> *These people were typically working on the most salient issues of our day: climate change, poverty, deforestation, peace, water, hunger, conservation, human rights. They came from the nonprofit and nongovernmental world, also known as civil society. They looked after rivers and bays, educated consumers about sustainable agriculture, retrofitted houses with solar panels, lobbied state legislatures about pollution, fought against corporate-weighted trade policies, worked to green inner cities, and taught children about the environment. Quite simply, they had dedicated themselves to trying to safeguard nature and ensure justice.*

These people are the ones upon whom future scenarios should be based – I hope there are enough of them on the planet!

Basic Assumptions for My Future Scenario

My future scenario is based upon the following assumptions.

(1) No major remedial measures will be taken to reduce greenhouse gases until one or more climate tipping points have been passed and climate change is beyond human control.
(2) Humankind will not take drastic measures to preserve the remaining petroleum reserves until supply has become too insufficient to make a graceful transition to a low energy global society.
(3) Economic growth will continue to be humankind's primary goal until at least 2015.
(4) The human population will not be stabilized by social action but will be by natural, limiting factors (e.g., starvation and disease).
(5) Present resource wars will continue until at least 2015, using precious resources to continue fighting rather than sharing resources.
(6) The environmental refugee problem will become severe, perhaps unmanageable, because of both inaction on climate change and inadequate prior planning.
(7) Governments will, in some cases, block or delay state or regional efforts to address greenhouse gas emissions from automobiles as the US Environmental Protection Agency is now doing in the case of California and other US states that are making efforts to improve on federal standards.
(8) Since humankind is faced with a global crisis unprecedented in human history, stochastic events (random or probabilistic but with some direction; synonym of *random* and counterpart of *deterministic*) will occur. Creative groups must be assigned to remediate these events, which may require immediate attention, even though they were unexpected.
(9) A pandemic disease that disrupts global society for at least six months will probably disrupt human society including health.

This manuscript will seem both frightening and new to many people. However, although I feel a sense of horror about these distressing events, this news is not new. In November 1992, The Union of Concerned Scientists issued a "World Scientists' Warning to Humanity" (Scientist Statement 1992). I was one of the over 1670 scientists who signed the document, and the signers included 104 Nobel laureates. The primary thrust of the message was that not more than one or two decades remained before the opportunity to reduce the threats now present will be lost and the prospects for the future of humankind will be immeasurably diminished. As one of the signers from Southwest Virginia, I expected at least one phone call from the news media – none came. In fact, the warning received very little attention. Now, over a decade and a half later, events have proved that the issuance of the warning was justified, despite the lack of attention it received. Even though huge amounts of robust data have been generated since 1992, the general public still lacks the necessary sense of urgency

needed to make a major reduction of risk in the time remaining. One idea is that the more distant a problem is perceived to be in time or space, the less interest the average individual has in it. Clearly, humankind's attitude is inappropriate for the global problems that, if not corrected, will have a major deleterious influence on posterity. Starvation and inadequate health care in third world countries will probably not arouse adequate concern in a developed country that has significant numbers of starving people and inadequate health care for its own citizens.

Peak Oil and Economic Growth

As Duncan (2007) notes, the life expectancy of the industrial civilization is about 100 years. He estimates it reached a critical stage about 1930 and may end about 2030. Duncan includes an excerpt from a letter written by Walter Youngquist on March 20, 2006:

> *As the British historian, Toynbee, wrote 'The U.S. will set a record in the rate of rise and fall of an empire.' Between wide open borders and fall of the dollar and growing population against a declining resource base, the United States will be defeated from within. Mobs will rule the streets in the nation that is now the third largest in the world – right behind China and India – and unable to support its population except by taking resources from other countries.*

Campbell (2005, p. 315) states: "We will have to change the way we live as (oil) production declines toward eventual exhaustion." Since the human economic system depends on cheap oil and a stable society, things do not look promising for a system based on economic growth.

Walter Youngquist, a geologist, and Richard Duncan, Director of the Institute on Energy and Man, have made a series of ten forecasts of world oil production – one per year over ten years (Duncan 2007). One of the forecasts put the world peak at 2005; two put it at 2006, six at 2007, and one at 2008. The exact year matters short term, but long term, what matters is when advance planning to cope with this major event began. Brazil began such planning three decades ago; Europe was not far behind; and the United States has barely started, and many of its "plans" depend on unproven technologies (e.g., carbon sequestering). Deffeyes (2003) discusses the world oil shortage in some detail. In the US Congress, discussion on biofuels and more energy efficient automobiles has been plentiful; however, discussion is lacking on how roads and parking lots paved with asphalt will be maintained when oil becomes scarce (Walter Youngquist, personal communication). As Youngquist points out, asphalt is the "bottom of oil refining operations and one cannot pave roads with ethanol, biodiesel, or hydrogen." Youngquist maintains that humankind has been enjoying the "oil interval" – a brief, bright, "blip" in human history. This era will be missed. Will the fragile economic system that must be protected, even above the biospheric life support system, survive the loss of fossil sunlight (oil and coal)?

As Tainter (1996) notes: "Systems of problem solving develop greater complexity and higher costs over long periods. In time, such systems either require increased energy subsidies or they collapse." Presumably, this statement applies to both economic systems and the nation-states that protect them. Tainter (1988) remarks that the factors that cause societies to collapse take centuries to develop. Arguably, the cluster of problems (global heating and other types of climate change, exponential increase in human population size, peak oil, coal burning pollution, ecological overshoot, and oceanic acidification) is humankind's greatest challenge. Certainly, the loss of the planet's favorable (to humans) biospheric life support system is an apocalyptic threat more serious than damage to the human economy. However, Tainter (1995) notes that many aspects of human behavior appear to be complexity averse. After all, humans evolved as a small-group species and, only recently in evolutionary time, have over 50% lived in huge cities and depending on outside sources for food, energy, and housing. Since much of the world's food supply depends on a suitable climate and adequate but not excessive rainfall, climate change will threaten it. In addition, food conversion (e.g., corn) to fuel threatens the food supply of the poor. Finally, energy is essential to preserve the food and transport it from the source to the consumers. The 24% ecological overshoot is persuasive evidence that humankind has already exceeded Earth's carrying capacity. When, if ever, greenhouse gas emissions will be reduced or to what level is unknown, so estimating future climate conditions is impossible. They probably will not be as favorable to either humans or agriculture as they were for most of human history. As Kunstler (2005, p. 7-8) notes, the journey back to non-oil population homeostasis will not be pretty.

Hansen (2007) remarks that animals and plants are adapted to specific climate zones, and they can survive only in those zones. Of course, as long as cheap energy is available, *Homo sapiens* is the only species that need not adapt. However, if one regards the human species as a part of an interdependent ecosystem, this

advantage is not as attractive as it initially appears. As Flannery (2006) points out, 70% of all people alive at present will still be alive in 2050. As a caveat, I add: unless mass mortality results from a pandemic disease, starvation, or nuclear warfare, to mention a few unattractive possibilities. Flannery is hard on his country of Australia, but the United States is no model either. He notes that, some time in the 21st century, the time will arrive when human influence on the climate will overwhelm all other natural factors.

Encouraging reports indicate that animals and plants are moving into the new climate zone (i.e., isotherm), but to expect all the species of an entire interdependent ecosystem to move and flourish simultaneously is irrational. As a consequence, natural capital and the ecosystem services it provides will initially suffer a major loss. Also, since the rate of climate change driven by human activities is much greater than natural climate change, preserving both natural capital and ecosystem services will be a difficult ecological problem.

Foraging vs Traditional Agriculture

The fact that at least some species are colonizing new areas with warmer temperatures is good news. However, just as whole ecosystems cannot move as a unit to new areas, neither can agricultural systems. In addition, property lines and state and national boundaries become a problem. Added to this problem is a highly probable, global food shortage enmeshed in a conflict between the use of corn for food or fuel (e.g., Cairns, in press). A balance must be achieved between targeted compassion for motorists and multidimensional compassion for those who use grain for food (Cairns 1998). Costanza *et al.* (1996) discuss the practical issues of ecological economics, and a superb summary of the biofuels issue is presented in Runge and Senauer (2007). Holt-Giménez (2007) presents a somewhat different perspective in an overview paper. In the worst case scenario, severe food shortages will result in anarchy and resource wars, neither of which is likely to result in economic growth and which are more likely to result in a depression.

Those Blessed by the Cornucopia

Uchitelle(2007) reports that only twice before over the last century has 5% of the national income gone to families in the upper 1/100th of 1% of the income distribution – currently, the almost 15,000 families with incomes of US$9.5 million or more per year (according to an analysis of tax returns by the economists Emmanuel Saez at the University of California, Berkeley and Thomas Pikettz at the Paris School of Economics). Uchitelle (2007) compares the present era with the prosperous period before World War I and notes: "The new titans often see themselves as pillars of a similarly prosperous and expansive age, one in which their successes and the philanthropy have made government less important than it once was. He also quotes a former US Federal Reserve Board chairman, Paul A. Volcker, who said in an interview, challenging the contentions of the very rich that they are the driving force of a robust economy, that he did not see a relationship between the extremes of income now and the performance of the economy.

However, the quotation of the day in the 5 August *New York Times* provides yet another viewpoint:

> *I know people looking in from the outside will ask why someone like me keeps working so hard. But a few million doesn't go as far as it used to. Maybe in the '70s, a few million bucks meant "Lifestyles fo the Rich and Famous," or Richie Rich living in a big house with a butler. But not anymore.*
>
> Hal Steger, a Silicon Valley millionaire

In addition, the process of becoming a billionaire may be very damaging to the environment. As Hurowitz (2007) notes

> *But many of these capitalist converts need watching. While Wall Street's eco-splurge has generated a flood of financing for legitimately clean ventures like wind and solar powers, it's also spawned extremely dangerous projects that are painted green by their unscrupulous backers, but that at their core are as black as, well, coal.*

Conclusions

Bartlett (2006) remarks that the term *sustainable growth*, as used by political leaders (i.e., applied to material things), is clearly an oxymoron. He emphasizes that the idea of *sustainable* has to mean "for an unspecified long period of time." He also emphasizes that humans must acknowledge the mathematical fact

that exponential growth gives very large numbers in modest periods of time. Endless economic growth that depends on natural resources of any kind is irrational because, as Meadows et al. (1972) note, factors exist that inevitably limit growth. Hubbert (1972) has established that, for a non-renewable resource (e.g., petroleum), the expected date of the peak production of the resource can be estimated. After peak oil, the industrial society will be unable to avoid a terminal decline since it was based on cheap energy. Duncan (2007) estimates that peak oil will be reached in 2007. As McCarthy (2007) remarks: "When executives from the world's largest oil companies say we need to cut back on our consumption, it should serve as the ultimate wake-up call about a booming energy crunch."

Humankind is facing the biggest challenges in history – peak oil, global climate change, and exceeding Earth's carrying capacity for humans simultaneously. If the present, profligate fossil fuel energy use is continued, carbon dioxide levels will be approximately twice their value in the past 670,000 years. The human population expanded from between 1.6-1.7 billion in 1900 to 6,612,087 on 10 July 2007. This huge increase in population was made possible by cheap, readily available oil, useful in large scale agriculture, for fertilizer, and for long-range transport and storage. The same biospheric life support system has had to provide suitable conditions and resources for nearly four times as many people in 2007 with far more stresses and damage than it endured in 1900. Most statements that humankind should not decrease greenhouse gas emissions come from politicians with poor or no credentials in the field of economics. In contrast, a statement by 25 of the world's leading economists, including both a number of Nobel laureates in economics and former members of the US President's Council of Economic Advisors, emphasizes that the United States should move to control greenhouse gas emissions (Statement 2005). Ackerman and Stanton (2005) believe the costs of inaction could be as high as US$74 trillion. Morales (2007) quotes Sir Nicholas Stern (Select Committee on Economic Affairs 2005) as saying that the cost might be US$9.6 trillion.

Clearly, the economic costs of inaction are very high. The loss of human lives is not easily measured in dollars, but would be unacceptably high if apathy and inaction are the responses of humankind to global heating.

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THE NUMBERS OF FOREVER

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When children are asked to do some small chore, they often reply: "Oh, Mom, that will take forever." Their friends are waiting, and they must have immediate gratification of anticipated pleasures – they cannot wait "forever." In another context, people often ask how long humankind has to "solve" the problem of global heating, and then they provide the answer of 10 years, 25 years, 50 years, etc. In short, the problem is not an immediate one to them – humankind has "forever" to reduce greenhouse gas emissions.

Even the developing biofuels industry does not have specific goals or greenhouse gas emissions estimates. Wald (2007a) questions whether assessments of the energy losses and pollution releases of ethanol production will inform policy:

> *For example, a broad-based coalition of biofuels, wind and solar power advocates has formed an umbrella group calling itself "25 x '25." They want 25 percent of the nation's energy resources to come from renewable sources by 2025. Dozens of members of Congress are endorsing the group, yet at a news conference last spring in Washington, D.C., held to introduce the organization, its leaders could not even say whether wind, solar, ethanol or direct combustion of biomass would be the largest source. There was little desire to blemish the concept with arithmetic.*

Enthusiasm is not a substitute for a systematic, orderly plan to achieve a particular goal on a particular date. An uncharitable person might conclude that neither some congresspersons nor the general public wants attractive illusions to be shattered. Wald (2007a) summarizes his thoughts on ethanol as:

> *In the meantime, relying on ethanol from corn is an unsustainable strategy: agriculture will never be able to supply nearly enough crop, converting it does not combat global warming, and socially it can be seen as talking food off people's plates. Backers defend corn ethanol as a bridge technology to cellulose ethanol, but for the moment it is a bridge to nowhere.*

Pimentel (2003) has published much on energy input/output ratios and asserts that more energy is used to make a gallon of ethanol than is produced when it is burned.

The numbers of the forever charade are endless, but one important set has to do with energy efficient cars. The hearings in the US Congress on efficiency of fuel use in automobiles has very modest goals to be reached years from now, although automobiles already exist that get well over 40 miles per gallon (i.e., the Prius). Why so many years in the future? During World War II, the United States survived a terrible beating at Pearl Harbor and the Philippines and had to do something at once – not in the future, but NOW. Japan's zero fighter plane was superior to the American one, so better ones were built – at once, not in the distant future. The United States also built amphibious ships that never existed before and vast numbers of ships that could surround Iwo Jima as far as the eye could see. All this activity and much more were completed in a period of approximately 4 years! Are people supposed to believe that the United States cannot produce large numbers of fuel efficient automobiles when Richard Rusk, in the apartment next to mine, is already driving one? Has the nation that survived the Great Depression and World War II suddenly become so fearful that it can no longer function after hearing bad news for which remedial measures are at hand? Major individual conservation (i.e., use less energy per capita) and public transportation matching that in Europe and Japan (e.g., change from rails to trails to trails to rails) could be improved substantially in the short term and dramatically in a few years (i.e., not 2025, but 2015).

Why doesn't humankind address obvious problems with the urgent action they deserve? In his book *The Assault on Reason*, Gore (2007, p. 215) states:

> *In other words, reason must be separated from the "self-love" of the individuals using it, and focused instead on the pubic good – by insuring that no individual or small group can exercise power without entering into a negotiation with others who must be convinced that the proposed exercise of power meets the test of reason.*

American citizens must cease tolerating the rejection and denigration of science (e.g., global warming is a hoax perpetuated by hysterical scientists) because the science conflicts with political and corporate ideologies. More important, American citizens must understand the processes of science and reject the pseudostudies funded by special interest groups with little or no scientific credentials. For example, in the last decade, much has been made of the uncertainties in science. However, science is a probabilistic determination based on validated evidence. The general public has been persuaded that scientific theories are mere guesses instead of being told they are carefully structured statements based on the preponderance of scientific evidence. The news media has not been helpful (it has even been called *dysfunctional journalism* that fails to inform the people) in informing the public. If the public is inadequately informed, a reasoned discussion cannot occur. However, in the Internet era, apathy is the only excuse for not being informed. Since not only national but global security is threatened by the global environmental crisis, apathy is not a valid survival response. Former US President Roosevelt used leadership to control fear and anxiety at the outset of World War II: "The only thing we have to fear is fear itself." Fear of terrorists can divert attention from the global climate crisis, especially when demagogues exploit fear. Government efforts to rewrite scientific articles on climate change result in failure to curb greenhouse gas emissions when they should be dramatically reduced. Indifference is substituted for concern when the apparent magnitude of the crisis is diminished.

The estimate has been made numerous times that enough coal is available to last 250 years. This estimate is still being used, despite the fact that it was made in the 1970s and was based on the assumption that 25% of the coal that had been located was recoverable with current technology and at current prices (Wald 2007b). However, as the US Congress considers billions of dollars in subsidies to make gasoline and diesel substitutes from coal, a more robust information base is essential. A report by the US National Academy of Sciences, released in June 2007, estimated the probability of enough coal to meet US needs *at current rates of consumption for more than 100 years* (italics mine), but if Congressional policies are put in place, the rate of use will increase markedly. Worse yet, recent studies by the US Geological Survey showed that, at least in some areas, only 5% of the coal was recoverable with today's technology and at current prices (Wald 2007b). Something tells me that numbers must be more precise and the citizenry must realize that only finite resources exist on a finite planet.

The decline in petroleum availability is not new information. Klare (2004, p. xiii-xv) mentions US President Franklin D. Roosevelt's February 1945 meeting with King Abdul Aziz ibon Saud of Saudi Arabia, which produced the unprecedented oil-for-protection arrangement that has governed American ties with Saudi Arabia ever since. Clearly, President Roosevelt recognized, near the end of World War II, how essential oil was to the US economic vigor and lifestyle and that, without cheap oil, neither could endure. The President was keenly aware of the drain that World War II had placed on American oil reserves and could envision a day when the United States would need to import foreign oil. Subsequent US presidents have had a similar view, since petroleum is considered a national security matter, falling under the purview of the US Department of Defense and other administrative entities responsible for safeguarding American vital interests. In addition, the finite supply of oil was recognized globally. King Hubbard's publications of the 1950s indicated that oil was not going to last forever and that peak oil would be in the early part of the 21st century. What is astonishing is that no robust plans were made in the period after World War II for the post-petroleum era. The most discussed alternative, biofuels, seems to assume that the profligate use of energy will continue "forever."

Perhaps concern for the planet's victims of global climate change will be the forcing factor for immediate remedial action on energy use. Kristof (2007) calls attention to the fact that gas guzzling automobiles are adversely affecting the subsistence of African farmers and may well cost them their lives.

The insistence on robust numbers rather than meaningless numbers that, at best, only indicate intent is long overdue. Questioning the basis for the numbers is long overdue. May it be so!

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VOLUNTARY INCOME TAX, VOLUNTARY SPEED LIMITS

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I am proud to be paying taxes in the United States. The only thing is I could be just as proud for half the money.
Arthur Godfrey

The best measure of a man's honesty isn't his income tax return. It's the zero adjust on his bathroom scale.
Arthur C. Clarke

Where there is an income tax the just man will pay more and the unjust less on the same amount of income.
Plato

If you steal $10 from a man's wallet, you're likely to get into a fight. But if you steal billions from the commons, co-owned by him and his descendants, he may not even notice.
Walter Hickel

Recycling and speed limits are bullshit, they're like someone who quits smoking on his deathbed.
Chuck Palahniuk

I think the world is run by "C" students. Al McGuire

Broder (2007) notes that the US position on global warming and climate is still markedly apart from most of the other developed countries, although its long overdue acknowledgment that climate change is a real problem has improved the US position slightly. Many years of ignoring, even challenging, the preponderance of scientific evidence has made many nations skeptical of the somewhat more enlightened US position. However, the biggest barrier, especially for European nations, is the US administration's insistence that any plan to reduce greenhouse gas emissions be voluntary and devised by individual nations rather than as part of a worldwide treaty (Broder 2007). John Ashton, a special advisor on climate change to the British foreign secretary, called voluntary measures ineffective and remarked that dozens of nations had agreed to nonbinding goals for emission cuts in 1992; these same nations then watched pollutants linked to global heating rise at a double-digit percentile rate over the next decade. If nations believe that voluntary measures are suitable to avoid catastrophic climate change, why not have voluntary US income tax and voluntary speed limits? Any observant citizen knows the answer to this question, although many would favor these two voluntary measures. If the failure of a voluntary plan is evident, then why pursue such a hopeless cause?

The call for voluntary action on greenhouse gas emissions appears even less credible since the US House Committee on Oversight and Government Reform obtained documents that suggest the Bush administration has conducted a concerted behind-the-scenes lobbying campaign for generating opposition to California's request to regulate greenhouse gas emissions from that state's cars and trucks (Eilperin 2007). California's proposed greenhouse gas emissions standards would reduce emissions from their present levels. How can opposition to such a situation be understood?

Humankind has three urgent problems: (1) global climate change, (2) an energy crisis resulting from reaching peak oil, (3) exponential growth of the human population. No voluntary effort has arisen that appears likely to solve any of these problems before they reach major tipping points. Why obstruct any voluntary effort (California) that offers more promise than any other?

A laissez-faire solution to global climate change is very attractive to politicians because it is perceived as causing fewer short-term political problems. Many potential solutions (e.g., emissions standards and goals) seem absurd because humankind and its representatives are adept in avoiding solutions to serious long-term problems. Hardin (1993, p. 201) gives a blunt, and still appropriate, analysis of the situation:

> *Acknowledging the reality of the "greenhouse effect" and modifying human behavior to reduce its consequences will require changes in education and human economy throughout the world. We may fail; if so, we will surely be the first species to have foreseen its own demise.*

This statement was made 14 years ago – plenty of time for voluntary remedial action – however, the situation has appreciably worsened. Worse yet, humankind is nearing one or more global tipping points, beyond which events will exceed effective human control. This moment is not a time for indecision! It is a time for decisive, all out, global coordinated effort with very specific goals and time framework. Both goals and times should be based on the preponderance of scientific evidence. This situation does not need multiple, uncoordinated meetings on the same problem, especially since US Secretary of State Condoleezza Rice repeated US President George Bush's insistence "that the solution could not starve emerging economies of fuel or slow the growth of advanced nations. Every country will make its own decisions, reflecting its own needs and interests" (Broder 2007). Nature neither waits while bureaucrats are indecisive nor is it affected by human obsession with exponential growth. Hubris and technology do not make humans immune to natural law. Brown (2007) remarks: "Nature has many thresholds that we discover only when it is too late. In our fast-forward world, we learn that we have crossed them only after the fact, leaving little time to adjust."

How successful has voluntary action been in resolving some of humankind's most intractable problems?

(1) Ecological overshoot

Ecological overshoot has been evident since the early 1980s, and nothing effective has been done to diminish this problem (http://pnas.org/cgi/content/full/99/14/9266). The dominant economic world view requires that all stakeholders be well informed. Even if they were, it is by no means certain that substantive effective action would be taken to eliminate ecological overshoot.

(2) Exponential population growth

Ecological overshoot demonstrates that resource consumption and human population size are not in balance. On a finite planet with finite resources, this imbalance should be abundantly clear. However, the addition of 1.5 million persons weekly does not seem to alarm people. Malthus studied this problem over 200 years ago, and voluntary measures have not only failed but the problem has worsened over the last century. For example, Jacques Diouf, the UN Food and Agricultural Organization Chief, warned that the global rise in cereal prices could lead to "social and political troubles" in developing nations (Staff Writers 2007). According to the UN, 800,000 persons on the planet go to bed hungry each night. Consequently, an already bad situation would worsen (http://www.worldpopulationbalance.org/pop).

(3) Peak oil

Over 90% of US energy comes from fossil sunlight (Congressman John Peterson, Pennsylvania; C-Span, 3 October 2007). Kohl (2007) calls attention to how vital fossil fuels have become in meeting the planet's energy demands. Peak oil is either here or near, but the important point is that the era of "easy" oil is over and the era of "tough" oil is here. Most of the world's oil is in politically unstable areas, and the remaining untapped supplies are primarily in small pockets that are difficult to access. Earth's primary energy source is sunlight, and the "fossil sunlight" is being used very rapidly. Replacement of fossil energy will be difficult. For example, (a) 27 to 42 barrels of oil are needed to construct an average car, (b) construction of the average desktop computer requires more than 10 times its weight in fossil fuels, and (c) every calorie of food eaten in the United States requires roughly 10 calories of fossil fuels (Angel Research Staff 2007). Humankind should have already become aware of the consequences of peak oil since M. King Hubbert's now classic publication in 1956 (Hubbert 1956). More recently, Heinberg (2005) argues persuasively that human society is headed for serious trouble in the near future. In the few years since Heinberg's book was published, huge amounts of evidence have accumulated that confirm his analysis. Worse yet, humankind is still partying as if petroleum will last forever. Fortunately, some reassuring signs indicate that some parts of the world are moving in the right direction. For example, the province of Quebec enacted Canada's first carbon tax on energy companies (Associated Press 2007), but this effort is not enough to reverse greenhouse gas emissions globally.

Fatal Disconnects

Humankind has a fatal disconnect with reality. The assumption that Earth is a vast cornucopian paradise with unlimited resources is a fantasy. The belief that the human population can grow forever on a finite planet and always have adequate resources is delusional, as is the belief that global problems (e.g., global heating) can be solved by voluntary action. When these beliefs and expectations prove to be unrealistic, a period of stunned disbelief occurs, followed by a period of finding someone to blame. Finally, humankind may realize that expectations are far greater than Earth can fulfill and that everyone is responsible for letting this situation occur. One hopes that the next step will not be increasingly violent resource wars, but rather a much more austere lifestyle with limited resources shared equitably and fairly.

Probably the first amenities to disappear will be energy and water supplies. These two are closely linked problems since biofuels (e.g., corn) require 1,000 tons of water to produce a ton of grain. Recent evidence indicates that biofuels production, except with sugar cane, may be contributing to an increase in greenhouse gas emissions (Quitério 2007). Very few people have ever heard of peak oil, and many who have think biofuels will fill the gap left as petroleum become increasingly scarce. They will not abandon their carefree, high-mileage habits voluntarily, nor will they willingly limit family size to match Earth's carrying capacity. High per capita energy use is regarded as a "right." I reluctantly conclude that the default position will be brutal and effective natural law, which will limit resource use to match carrying capacity, unless humans finally use their vaunted intelligence to avoid such a catastrophic event.

A Comparison of Two Nations

China and the United States are the major emitters of greenhouse gases globally, and both have, in practice, different systems of coping with the environmental stressors that are endangering both the biospheric life support system and their citizens. Pan Yue, a vice minister of China's State Environmental Protection Administration (SEPA) warned in 2005: "The [economic] miracle will end soon because the environment can no longer keep pace. . . . China's rapid development, often touted as an economic miracle, has become an environmental disaster" (as quoted by Economy 2007). Economy (2007) further notes that "China's leaders are worried about the environment's impact upon the economy." However, Beijing has structured its environmental protection efforts in much the same way it has pursued economic growth: by granting local authorities and factory owners wide decision-making power and by actively courting the international community and Chinese non-governmental organizations for their expertise while carefully monitoring their activities. Economy (2007) also notes that SEPA operates with barely 300 full-time employees in the capitol and only a few hundred throughout the country. In contrast, the US Environmental Protection Agency has a staff of almost 9,000 in the capitol city of Washington, DC, alone. Economy (2007) remarks that China's highly decentralized system has meant limited progress: only 7 to 10% of China's more that 660 cities meet the standards required to receive the designation of "National Model Environmental City" from SEPA. Economy's (2007) superb article has many examples of other failures to control environmental pollution.

Thornton (2006) notes that, after 28 years of reform, China faces challenges of an unprecedented scale, complexity, and importance. China has already liberalized its markets, but now its leaders and people must deal with popular dissatisfaction with local government, environmental degradation, scarce natural resources, an underdeveloped financial system, an inadequate health care system, a restless rural population, urbanization on a massive scale, and increasing social inequality. In addition, the energy crisis resulting from reaching peak oil could be added.

Thornton (2006) notes that China's three decades of reform have made undertaking new reforms more difficult and further remarks that the structure of the country's bureaucracy stifles initiative and promotes mediocrity. Worse yet, he feels that many officials, from the village to the central government, are corrupt and are eroding the government's effectiveness and feeding popular discontent with the system. He concludes that only by freeing its managers and leaders from the shackles of organizational politics and old-line thinking will China be able to find a dynamic but stable path toward the democratic future aspired to by an ever-larger number Chinese citizens.

By leaving conformity up to local officials and organizations, Beijing has, de facto, made compliance with national and global (e.g., greenhouse gas emissions) pollution control goals and standards optional. In short, persons with inadequate scientific credentials are making decisions that degrade not only the local environment but also the biospheric life support system. This process is no way to address global problems already having major deleterious effects upon human society.

The United States and China share a major obsession that overrides the differences in the two nations – the dedication to and belief in exponential economic growth. During his successful election campaign, former US President Clinton proclaimed "It's the economy, stupid!" Since then, President Bush, now in office, has

stated more than once that nothing that interferes with the economy will be done in addressing climate change. In both China and the United States, citizens want the government to do more about climate change and other environmental problems. Many polls show that citizens in the United States want involvement in the civil war in Iraq to end, which would free funds for alternative energy, health care, pollution control, and a variety of other domestic issues. An excerpt from Bruce Levine's (2007) book *How to Find Morale, Energy, and Community in a World Gone Crazy* delves into the roots of depression and links the increasingly consumer-based culture and standard-practice psychiatric treatments to worsening depression, instead of solving it. In addition, political appointees with few or no scientific credentials have been altering scientific reports from government agencies, particularly those addressing human-caused components to climate change. The Intergovernmental Panel on Climate Change reports, although viewed as overly conservative by many scientists, provide much evidence for remedial and preventative action by governments. If China and the United States fail to make major changes in present policies, altering present climate change trends will have little chance of being successful.

Conclusions

The title of this commentary is intended to illustrate that some individuals will not be voluntarily socially responsible. Nations also have their particular agendas, such as the US administration's insistence that any plan to reduce greenhouse gases be voluntary. Corporations perceive that they would have to diminish their profit goals and place social responsibility before profit. Some corporations might place social responsibility first, but they might lose their competitive edge. Globalization has made corporations more influential than ever in national politics, and relentless advertising has markedly affected consumer choices. In the United States, consumers now demand protection against imported toys painted with toxic substances. Some sort of social contract that benefits all of humankind is essential, and, sad to say, too much reliance on voluntary compliance often fails.

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Wear It Out
Use It Up
Make It Do
Do Without[1]

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The era of cheap, abundant fossil energy is ending, which means that the acquisition and production of material goods will be greatly diminished. Availability per capita will depend primarily on two factors: (1) the extent to which global heating and other types of climate change affect agricultural productivity and regeneration of natural resources (e.g., forests, fisheries) and (2) the time it takes to stabilize human population and reduce it to remain within Earth's carrying capacity for humans.

Finite Resources/Finite Planet

Trainer (2007) notes: "The most serious fault in our society is the commitment to an affluent-industrial-consumer lifestyle and to an economy that must have constant and limitless growth in output." The degree to which various nations achieve this goal varies. For example, Trainer remarks that rich countries, with about one-fifth of the planet's people, are consuming about three-fourths of the planet's resource production. Clearly, production of foodstuffs is declining, due to climate change (e.g., droughts, floods, pests), while the population is increasing at about 1.5 million/week. This increase is occurring despite marked reductions in life expectancy in some regions of the world. For example, Brown (2006, p. 99) calls attention to the fact that life expectancy among the 750 million people living in sub-Saharan Africa has dropped from 61 to 48 years of age due to the spread of the HIV virus. In addition, the production of oceanic fisheries, which supplied 17 kilograms of seafood per capita worldwide in 1988, has fallen to 14 kilograms (Brown 2006, p. 91). Since fisheries are collapsing worldwide and oceans are becoming more acidic and since persuasive evidence shows that plastic is actually choking sea otters and turtles and being ingested even by krill (Weisman 2007, p. 116-118), a variety of adverse ecological effects will only become more severe. The decline in the productivity of oceanic fisheries will continue, especially since 90% of the large fish in the oceans have disappeared over the last 50 years, according to a Canadian-German science team's published study in the journal *Nature*.

Economist Boulding's Utterly Dismal Theorem

In 1798, Thomas Malthus made his famous prediction that the human population would outrun food supply, initially leading to a decrease in food per person. He has been denounced for over two centuries because cheap fossil energy (e.g., petroleum, coal, natural gas), plus agricultural technology, have provided major increases in the food supply. In 1802, just a few years after Malthus published his essay on population, the global human population was 1 billion. At present (2007), the global human population is approximately 6.6 billion. These numbers would appear to negate Malthus' prediction. However, the huge surge in human population growth in just over 200 years was made possible by two factors that are unique and temporary: (1) an abundance of cheap, readily available fossil energy (i.e., petroleum, coal, natural gas) and (2) increased productivity of a finite supply of arable land made possible by fertilizers (some from petroleum) and an infrastructure to plow, care for crops, harvest crops, and transport crops to distant markets – all facilitated by cheap fossil energy. Diminished fossil energy supplies and global heating and other types of climate change are having a negative effect upon agriculture and marine fisheries (already suffering from over harvesting). It is quite probable that production of foodstuffs will not keep pace with human a population growth.

[1] This saying is from a hand-stitched sampler that my companion of 63 years, Jeannie, made for our oldest daughter Karen at her request. It beautifully sums up the low-material-possessions lifestyle that must now replace the "shop-til-you-drop" lifestyle of many American citizens.

Boulding's (1971) Dismal Theorem states: "If the only ultimate check on the growth of population is misery, then the population will grow until it is miserable enough to stop its growth." Boulding's (1971, p. 137) Utterly Dismal Theorem addresses the population surge made possible by cheap fossil energy and improved agricultural technology. This theorem states:

> *Any technical improvement can only relieve misery for a while, for so long as misery is the only check on population, the (technical) improvement will enable the population to grow, and will soon enable more people to live in misery than before. The final result of (technical) improvements, therefore, is to increase the equilibrium population, which is to increase the total sum of human misery.*

Persuasive evidence of this situation is available at present when 1 billion (the total population in Malthus' time) are starving or malnourished, poorly housed, lacking adequate health care and safe drinking water, and inadequately educated for the present highly technical world. It would appear that Malthus (and more recently Paul R. Ehrlich [1968]) was right after all – as was Kenneth Boulding.

Global Food Situation

Use of corn and other foodstuffs for production of alternative fuels has already substantially increased the price of corn and, since corn is used as animal feed, the price of beef, milk, poultry, etc. In addition, China's prosperity is also increasing the price of milk – more discretionary income has led to a more than 25% higher demand for milk per year; China is now consuming about 30% of the world's milk output (Walker 2007). China has approximately 20% of the world's population, but only 7% of its arable land – 0.27 hectares per capita, or less than 40% of the world's per capita average, one-eighth the US level, and one-half India's level (Walker 2007). However, China's recent affluence has caused significant inflation, which could easily be exacerbated globally if the 1.1 billion people in India also become more prosperous.

Effect on the Ever Present Poor

The Millennium Development Declaration of the United Nations of September 18, 2000, included eradicating extreme hunger and poverty. Economist William Easterly is quoted by Schlesinger (2007, p. 61) as estimating that, while developed nations have donated $568 billion in aid to Africa since the 1960s, the poverty has only worsened. The population of sub-Saharan Africans living on less that US$1 per day rose from 41 to 46% between 1981 and 2001 – indicating that 150 million more individuals are in unenviable circumstances. Worse yet, the life expectancy of the 750 million people in this region is now about 46 years. Economist Jeffrey Sachs believes that the UN Millennium Villages Project will simultaneously improve agricultural yields, health care, and societal infrastructure and increase available clean water and access to sanitation. Economist Sachs believes this project will provide an economic cushion against unexpected problems.

The Severe Penalties of Ecological Disconnects

The professions of economics and ecology have virtually no theoretical and working relationships. Even though the UN Millennium Villages Project (Schlesinger 2007) appears insightful, carrying capacity for humans is not mentioned for the sub-Saharan habitat that serves as the life support system. Achieving the goals of the project means developing a harmonious relationship with the local ecosystems. Subsidizing the habitat with fertilizer and outside financial aid is only a short-term, temporary tactic for the transition period that is expected to lead to sustainable use of the habitat.

The situation in China is no more reassuring since food has been imported since at least 2004. However, pollution of aquatic systems, which has apparently driven China's freshwater dolphin to extinction (World Service Staff 2007), and the loss of arable land through development are arguably more serious problems. As a caveat, developed countries, such as the United States, have ecological deficits that are often rather large. These deficits are the consequences of overusing the biological capacity available per capita. The world has 11.2 billion hectares of biologically productive land and water, or 1.7 global hectares per person (11.2 ÷ 6.6), assuming no land is set aside for other species that constitute the human biospheric life support system.

However, Klinkenborg (2007) remarks that a June issue of the journal *Science* noted that by 1995 only 17% of the world's land area had escaped direct influence by humans. The article takes as a working assumption: "There really is no such thing as nature untainted by people." However, nature provides both natural capital and ecosystem services to humans without which humans could not survive. Moreover, humankind is not treating natural systems as the life support systems necessary to its survival and well being. Worse yet, practices are reducing biocapacity globally. For example, Shapiro (2007) reports on the severe

shortage of water in Crete, which a local official, Costas Kaliokannakis, says was not known in his childhood years: "this is the first time I've seen that we've completely run out of water." Rainfall has been slight, and water is inadequate for irrigation. Temperatures have been over 40°C and have caused wildfires, electrical blackouts, and some deaths.

Professor Costas Kosmas of the University of Athens wants people to think intently about the problems of heat and drought and about the way people make these problems worse (Shapiro 2007) – good advice for the entire planet, not just for Crete. Professor Kosmas explains: "When the land is degraded and desertified, this affects the climate, affects the economy, affects the environment." One does not need to be a professional ecologist to know that the biocapacity of Crete is diminishing.

John Maynard Keynes

Keynes was a member of the "Bloomsburg Group" at Cambridge University, which included Virginia Woolf, Arnold Bennett, H. G. Wells, and John Galsworthy (http://www.blupete.com/Literature/Biogrpahies/Philosophy?Keynes.htm). This group believed that man has power to change things and attacked "naturalists" who believed that humans are creatures of their environment (i.e., natural systems):

> *For at least another hundred years we must pretend to ourselves and everyone that fair is foul and foul is fair; for foul is useful and fair is not. Avarice and usury and precaution must be our gods for a little longer still* (Keynes quote from 1930; http://www.brainyquote.com/quotes/authors/j/john_maynard_keynes.html).
>
> *The day is not far off when the economic problem will take the back seat where it belongs, and the arena of the heart and the head will be occupied or reoccupied, by our real problems – the problems of life and of human relations, of creation and behavior and religion* (Keynes quote from 1930; http://www.brainyquote.com/quotes/authors/j/john_maynard_keynes.html).
>
> *Capitalism is the astounding belief that the most wickedest of men will do the most wickedest of things for the greatest good of everyone* (http://thinkexist.com/quotes/john_maynard_keynes/).

Why all the focus on John Maynard Keynes? Because economic growth has been the primary focus of both world leaders and the world society in the 20th century and the beginning of the 21st century, and Keynes has been described as the most influential economist of the 20th century. In contrast, Earth's ecological life supports are in imminent peril. The best evidence of this danger is that US President George Bush has stated that efforts to reduce greenhouse gas emissions would not be considered if they interfered with the economy. In practice, the US Congress and the general public have been unable to agree on the strong measures needed to avoid a major climate tipping point, although there is much discussion of planning to do something by 2050.

Of particular interest in the Keynes' quote is the idea that economic growth should not be perpetual but rather last ". . .at least another hundred years." Since this statement was made in 1930, the time span is remarkably similar to the estimated 100- year industrial era of 1930 to 2030, which depends on cheap fossil energy. Equally interesting is another portion of the quote: "Avarice and usuary and precaution must be our gods for a little longer still." A subsequent quote indicates that the economic problem will take the back seat and the arena of the heart and mind will be occupied or reoccupied. This statement seems startlingly similar to Eisler's (2007) call for a caring, compassionate economics. Eisler (2007, p. 153) notes that John Maynard Keynes and John Kenneth Galbraith were deeply concerned about human welfare but that the primary, often sole, focus in US economic schools continued to be market centered. Of course, economists such as Herman Daly take a broader view, especially in the field of ecological economics. They are aware of the massive threats to natural systems and call for a more ecologically responsible economic system.

The Disconnect Between Science and Politics

Science is a system of acquiring knowledge based on the scientific method, as well as the organized body of knowledge gained through such research. Politics is the process by which groups of people make decisions. As Bill McKibbin (2007, August 11 letter to environmental community) states:

> *There are occasional moments in history when we desperately need leadership, and this is one of them. If we're going to deal with global warming, then we need to go beyond politicians who say the right words and find champions who will do the tough work to transform our energy economy.*

His goals are: an 80% reduction in carbon emissions by 2050, 10% in three years; a moratorium on new coal-fired plants; and a Green Jobs Corps to help fix homes and businesses so their targets can be met. Begley (2007) has written a superb article about one of the major factors responsible for the vast gulf between science and politics in the United States – this factor is the well funded effort that gives equal time to the tiny group of minority global warming doubters, some with no scientific credentials, despite the well established scientific process, which is based on the preponderance of validated evidence and published in peer-reviewed professional journals.

Ethics Anyone?

Keynes expected individuals to treat avarice and usury as gods for at least 100 years and then enter the arena of the heart and head after that time. This ethical transformation is a Dr. Jekyll/Mr. Hyde act, very difficult for an individual and arguably impossible for a society. As a caveat, my hope for a willing transition from a fossil energy to an alternative society may be equally hopeless.

Some of these disconnects are due to disconnects between disciplines (e.g., economics, ecology, the social sciences) and, alternatively, deliberate deception. For example, Monbiot (2007) notes:

> *While no expense is spared in expanding motorways, airports, and thermal power stations, every possible tactic is used to frustrate the programme for installing renewable power. The reason is not hard to fathom; big business has invested massively in constructing old technologies, and wants to maximise its returns before switching to the new ones. It also demands the hyper-mobility which enables its executives and its goods and services to go anywhere at anytime.*

Monbiot (2007) also raises an important question about the effect of advertising upon societal decisions. The *Independent* (a UK newspaper) raises a difficult question about where to draw a line beyond which advertisements cannot go. However, nearly all advertising promotes excessive consumption, which damages the biospheric life support system. Thomas Jefferson hoped that an informed, literate citizenry was the answer, but that does not seem to be working now. Perhaps the right questions are just not being asked.

What are the Right Questions?

Physicist John Wheeler observes: "We make the world by the questions we ask" (as quoted by ecological economist Herman E. Daly 2007). Daly suggests: "Why not ask, can we systematically continue to emit increasing amounts of CO_2 and other greenhouse gases into the atmosphere without eventually provoking unacceptable climate changes? Scientists will overwhelmingly agree the answer is no." Some illustrative questions follow, not necessarily in order of importance.

(1) Is it wise for the United States to allow persons with no significant scientific credentials to alter scientific reports and attempt to impede government scientists from informing the general public about new developments in their field of competence? The answer should be "no," but the record shows otherwise. The experiences of world-class government scientist James Hansen documents that the answer is not a resounding "no."

(2) Is it ethical/moral to have more than 1.3 billion people "over-nourished" (i.e., obese) and more than 800 million people starving or severely malnourished (Stix 2007)? The answer should be a resounding "no"; however, the poor can also be obese (e.g., Popkin 2007), so the problem is more complex than it initially appears. Pinstrup-Anderson and Cheng (2007) also note that one-eighth of the world's people do not have enough to eat.

(3) Is economic growth more important than preserving the integrity of the biospheric life support system that has produced conditions favorable for the genus *Homo* for over 1 million years and for *Homo sapiens* for approximately 160,000 years? Enlightened self interest should produce another resounding "no," but, in practice, economic growth is worshipped worldwide and the environment is being degraded globally.

(4) Should humans have empathy and compassion for other life forms even if they did not constitute the biospheric life support system? The answer to the question depends on whether humans consider themselves

a part of nature rather than *apart* from nature. Perhaps the answer is already evident by the practice of labeling natural systems as resources and commodities.
(5) Is producing biofuels an environmentally friendly (i.e., green) process? Brahic (2007) answers this question:

> *It sounds counterintuitive but burning oil and planting forests to compensate (for greenhouse gas emissions) is more environmentally friendly than burning biofuels. So say scientists who have calculated the net emissions between using land to produce biofuels and the alternative: fuelling cars with gasoline and replanting forests on the land instead.*

(6) Is the carbon footprint larger when one travels by air? Protesters camped out at Heathrow Airport, near London, in mid-August 2007, to say "yes." Merrick, one protestor, stated: "Aviation is a luxury we can live without. It has to be scaled right back" (Rice-Oxley 2007). Rice-Oxley (2007) makes some important points: (a) "aircraft not only produce carbon dioxide but also nitrous oxide (a powerful greenhouse gas) and condensation trails, which may also contribute to global heating," (b) "given the limited prospects for a technological solution, a growing body of evidence is arguing for efforts to manage demand for air travel," (c) "some experts believe that personal carbon budgets – rationing – may be the only solution," (d) "it is too late for voluntary mechanisms; carbon allowances are the only fair way to deal with this."
(7) Is living in coastal cities safe? "No" say many of the former and present residents of New Orleans! Freudenburg et al. (2007) remark: "Katrina showed, unfortunately, that we do not seem to have the same level of technological capacity to undo the damage we create – to nature, to humans, or both." And further:

> *When Katrina hit New Orleans, what came through the levees was more than just a rush of floodwater. It was tragically graphic evidence that scientists' warnings about the risks of environment damage need to be taken seriously, and that boosters' claims of economic benefits need to be subjected to equally serious scrutiny. The leaders of New Orleans ignored that evidence, and the city suffered the consequences. The rest of us watched the painful learning experience. The question is whether we will actually learn from it.*

In addition, living in other coastal cities is risky, too. Almost 80% of the world's population lives less than 50 kilometers (30 miles) from a coastline, an inconvenient location since one of the effects of global heating is rising sea levels (Mongalvy 2007).
(8) Would individuals drive less to reduce greenhouse gas emissions and, thus, reduce the rate of global heating? The answer to this question usually is "I cannot possibly reduce my driving." However, if the question is rephrased to: "Would you like to leave a habitable planet for your children and grandchildren?", the answer is almost always "yes." Usually the person then asks: "How can I do that?" People just have not connected personal lifestyle with the future of their descendents. The planet is in imminent peril because people cannot, or will not, connect the most obvious dots.
(9) Are individuals part of the solution or part of the problem (i.e., environmental degradation)? Some people remember the early Earth Day statement: If you're not part of the solution, you're part of the problem. Anyone who believes that peak oil will occur in the middle of the 21st century is part of the problem: "'Based on (our) analysis,' the U.S. Department of Energy confidently asserted in 2004, '[we] would expect conventional oil to peak closer to the middle than to the beginning of the 21st century'" (as quoted in Klare 2007). Klare (2007) notes: "As originally formulated by petroleum geologist M. King Hubbard in the 1950s, the concept holds that worldwide oil production will rise until approximately half of the world's original petroleum inheritance has been exhausted; once this point is reached, daily output will hit a peak and begin an irreversible decline." The exact year of the peak is of some interest, but the part of the century in which this occurs is critical to industrial society. Klare (2007) notes that Hubbert's successors, including Professor Emeritus Kenneth Deffeyes of Princeton University, contend that about one-half of the original supply of oil has been consumed and, it is, or very near, the peak production moment predicted by Hubbert. Klare (2007) makes another very important point – the first half of the world's oil to be extracted and consumed will be the *easy* half. The last half will be the *tough* half. The remaining oil is located in politically dangerous areas, deep below the surface, and mostly in small, hard to find reservoirs. Depending on biofuels to replace lost fossil energy is not sound policy. For example, a team of UK-based scientists have suggested (in the journal *Science*) that reforestation and habitat protection are better options. The scientists state that forests could absorb up to nine times more carbon dioxide than the production of biofuels could achieve on the same area of land (BBC News 2007).

Actually, one can reduce the questions to a few that are so brutally frank that they will offend many people.
(1) Is this automobile or plane trip so important that I am willing to be part of collective actions that will place billions of people at risk because the ultimate result will be irreversible climate change that might well be unsuitable for humans, including my children and grandchildren?
(2) What if everyone on the planet consumed as many resources (e.g., energy, material goods, food) as one average citizen of the United States? What then?
(3) How will future generation of humans, if they exist, view over consumption and other excesses of the Industrial Age?

Conclusions

Humankind is now living in very perilous times and the peril is imminent. When Jeannie produced the sampler that serves as the title for this commentary, she was concerned with the resources in our possession, not the planet's. Humankind's profligate use of finite fossil energy and excessive use of Earth's natural capital are not only unsustainable but may be fatal for civilization and even the human species. Humankind is sleepwalking toward the precipice of a global climatic tipping point, but is focused primarily on perpetual economic growth. Time may exist, a decade at most, to initiate strong remedial measures (e.g., 80% reduction of greenhouse gas emissions), but motivation to do anything that might be effective is lacking – I cling to the probably irrational hope that political leaders will emerge who will be willing to accept scientific evidence, rather than suppress or ridicule it. Perhaps my hope is just the ultimate expression of denial. May it not be so!

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MOTHER NATURE DOES NOT BARGAIN OR FORGIVE

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Pity the meek, for they shall inherit the earth. Don Marquis

Let us not go over old ground, let us rather prepare for what is to come. Cicero

Hansen et al. (2008, p. 1) express the present global crisis bluntly: "If humanity wishes to preserve a planet similar to that on which civilization developed and to which life on Earth is adapted, paleoclimate evidence and ongoing climate change suggest that CO_2 will need to be reduced from its current 385 parts per million to *at most* [italics mine] 350 ppm." The first response from people is usually: "What can I do? I'm only one individual." My response to them is that billions of individuals caused the present climate problem; therefore, billions of individuals should be able to correct it by individual lifestyle changes. This effort would involve using far less fossil fuels for transportation (i.e., petroleum), electricity (i.e., coal), and heating (i.e., fossil fuels). Hansen et al. (2008) remark that a 350 ppm atmospheric carbon dioxide target may be achievable by phasing out coal use, except where carbon dioxide is captured (technology not yet available), and by adopting agricultural and forestry practices that sequester carbon.

The 350 ppm target may be too high since persuasive circumstantial evidence (e.g., polar ice sheet melting, Australian "big dry") indicates that 350 ppm was a climate tipping point. If this value is the tipping point, then staying well below it would be prudent in order to avoid the possibility of initiating irreversible catastrophic effects.

Actually, the best way to set a target for atmospheric carbon dioxide is by determining the assimilative capacity of the biospheric life support system for atmospheric carbon dioxide. If atmospheric carbon dioxide continues to increase, as it is in 2008, the assimilative capacity of the biospheric life support system is being exceeded (Cairns 2008). If the carbon dioxide concentration continues to exceed Earth's assimilative capacity, it will continue to accumulate in the atmosphere and klimakatastrophes will increase in severity and frequency.

If Mother Earth were capable of musings, they might read like the following.

> *"Increased atmospheric carbon dioxide is increasing global heating. I wonder if melting the polar ice sheets might attract humankind's attention to this urgent problem. — Good heavens, humans are viewing the loss of the Arctic ice cover as an opportunity to acquire more petroleum that, when burnt, will increase greenhouse gas emissions."*
>
> *"Humans seem to be fascinated with food, judging from the number of television shows devoted to cooking. Perhaps if climate change interfered with food production, they might notice the change in the climate. — Oh, no! They not only didn't notice, they are turning corn into ethanol to keep their SUVs going. Why can't they connect the dots?"*
>
> *"Perhaps increasing the number of pests might attract humankind's attention – such as rice leaf hopper or wheat rust. I might even move some human tropical diseases toward the poles. Just for good measure, destroying large forests with beetles might attract some attention. — Wrong again! Humans are even less observant than I thought. Of course, they gave themselves the species name* Homo sapiens*, although a wise species should have taken note that the planet is less habitable."*
>
> *"Humans love talking about the weather. Perhaps a change in rainfall patterns – droughts in some places, floods in others – might increase their focus on the climate.*

— It worked! But their solution is technological – make freshwater from ocean water. They still haven't associated climate change with their high fossil fuel/technological/automobile culture."

"The vast oceans cover approximately 70% of the planet's surface, are an important source of protein, and are recreationally important (e.g., scuba diving at coral reefs), so any adverse effects upon them (e.g., acidification and declining fishery stocks) should attract immediate, concerned attention. After all, restoring damaged oceanic ecosystems in time frames of interest to humans is highly unlikely. — Sigh. . . wrong again. Humankind has been told about all of these problems but seems unconcerned, even possibly indifferent. Even a charismatic species, such as the polar bear, is not getting protection in its home US state of Alaska. The governor of Alaska, Sarah Palin, has stated that the state will file a lawsuit in the US District Court in Washington, DC, challenging US Interior Secretary Dirk Kempthorne's decision to grant Endangered Species Act protections to the polar bear. Governor Palin feels that listing the polar bear as a threatened species will slow development in the state (Rosen 2008). What has happened to these humans and the way they think? They should feel a responsibility for all other species with which they share the planet, not just dwell on their fixation on economic growth, which primarily benefits a small portion of their own species. This responsibility requires paying attention to the health and integrity of the biospheric life support system, which has provided conditions favorable to all life now present on the planet. Faith in technology should not replace or impede "good works" that benefit all life forms. Knowing how the world works is more important than knowing how the human economy "works," since the latter derives its well being from the biosphere, without which the human economy would cease to function. Humans must develop an ecolate perspective – an understanding of how the complex, interlocking systems are structured and function."

"Humans don't realize that I don't bargain – if they make plans for 2025, 2050, or some other dates and greenhouse gas emissions keep rising, basic natural laws will not be suspended or modified. Human laws can be repealed or ignored, but not natural laws. The consequences of violating natural laws are severe, often fatal. I do not forgive either, as the fossil record shows. Five great extinctions have occurred and the sixth is well underway. These great extinctions caused species impoverishment, after which new and different complex systems evolved over substantial periods of time. Humans must accept that they are part of a pulsing system – ups and downs will always be present. The tragedy is that humans are causing the pulse, which has already driven approximately 33% of the planet's species to extinction. Humankind is not the compassionate, lovable species it believes it is."

Since Mother Nature neither negotiates nor forgives, what should humans do once they accept that they are on a finite planet with finite resources and that the fossil fuel, which enabled them to create a temporary high carrying capacity, is running out quickly? Population growth must be eliminated and then decreased, as well as consumption of natural resources. The Reverend Thomas Malthus failed to foresee the effects of technology based on cheap, abundant fossil fuel, but his analysis was sound, as humans are about to find out. The amenities that humans have taken for granted – abundant food, exponential economic growth, human population growth – must cease. Resources will still exist, but the instinct to solve the problem with resource wars must be effectively suppressed or far too many resources will be used for combat instead of facilitating the transition to resource scarcity.

The new goal for humankind is to determine the planet's new carrying capacity, which has been adversely affected by global climate change and the decline of cheap petroleum. In addition, humankind must resist the temptation to keep the flow of energy up to peak oil levels by using coal that produces much more greenhouse gases.

Dependence on Oil

No US citizen was surprised when US President George Bush observed in his January 2006 State of the Union address that "America is addicted to oil," and the remark has been widely quoted. However, Bob

Hopkins has concluded that dependency is a better metaphor than addiction (as quoted by Heinberg 2007, p. 135). Heinberg (2007, p. 137) notes:

> *Let us translate this thought exercise (societal dependence) to our oil dependency. Might we simply end it by developing new supplies of alternative fuels such as ethanol and biodiesel, or liquids from coal and natural gas? If the analogy holds, the result is likely to be not an actual reduction in oil consumption but merely an added dependency on these alternatives. And indeed this is exactly what we see in most cases; it is difficult to find an instance in which any nation has substantially decreased its existing oil consumption as a result of the development of alternative fuels. In nearly every case alternatives serve merely to reduce the rate of growth in demand for oil. It doesn't hurt, but neither does it address the core problem.*

In my opinion, humans are placing their perceived needs well before Mother Nature's needs – that is, preserving the integrity and health of the biosphere. In this case, the health of the biosphere means staying at or below the biosphere's assimilative capacity for greenhouse gases. Since greenhouse gases are rising at a rapid rate, a reduction in consumption of oil and other fossil fuels is essential. Reduction can only be accomplished by dealing head on with the dependency (Heinberg (2007, p. 137). Heinberg (2007, p. 141) remarks: "The problems of Climate Change and Peak Oil both result from societal dependence on fossil fuels. But just how the impacts of these two problems relate to one another, and how policies to address them should differ or overlap, are questions that have so far not been adequately addressed." Climate change concerns carbon emissions and their effects. Peak oil concerns coming shortfalls in the supply of fuels on which society has become overwhelmingly dependent. In my opinion, both problems are being addressed from a homocentric perspective. Climate change studies have a major ecocentric perspective, especially in the scientific reports, but the implementation of remedial actions (or lack thereof) is in the hands of politicians who have a strong homocentric perspective: "I put people ahead of fish (or some other groups of organisms)." Rarely is human dependence upon the biospheric life support system given much attention.

Speculative Future Scenario

An infinite number of possible scenarios exist for the future of life on Earth, all of which may be strongly influenced by stochastic events. As a father and a grandfather, I hope the following assumptions are wrong.
(1) The term *sustainable* means a practice that can be maintained over time. I have always preferred the phrase *sustainable use without abuse* since *sustainable development* on a finite planet is an oxymoron. Bartlett (1997-1998) gives a detailed discussion of the term *sustainability* that superbly analyzes the use and misuse of this term. Present human population growth and the use of fossil fuels and other natural resources are clearly not sustainable. Tainter (1988) and Diamond (2005) both note that collapse of complex societies is frequently the fate of societies that ignore the basics of carrying capacity and resource use.
(2) Humankind is damaging the biospheric life support system by driving species to extinction and co-opting both space and resources needed to preserve the system's health and integrity. The biospheric life support system has maintained conditions favorable to the genus *Homo* for approximately 2 million years. The biospheric life support system will probably return to a quasisteady state even after a major extinction (i.e., 90+%), but the new conditions may not favor the genus *Homo*.
(3) As Heinberg (2007, p. 6) notes: "Nevertheless the general picture is inescapable; it is one of mutually interacting instances of overconsumption and emerging scarcity." In short, humankind has grossly exceeded Earth's carrying capacity. No cheap, abundant energy will be available to fuel an attempt to further increase humankind's resource base. The inevitable result is a major population crash, featuring starvation, disease, and death.
(4) Climate change will persist for centuries due to the long residence time of carbon dioxide in the atmosphere.

How Did We Get in this Predicament?

Heinberg (2007, p. 175-176) remarks:

> *The economists had been operating on the basis of their own religion – an absolute, unshakable faith in the Market-as-God and in supply and demand. They figured that if oil started to run out, the price would rise, offering incentives for research into alternatives. But the economists never bothered to think this*

> *through. If they had, they would have realized that the revamping of society's entire energy infrastructure would take decades, while the price signal from resource shortages would come at the exact moment some hypothetical replacement would be needed. Moreover, they should have realized that there was no substitute capable of fully replacing the energy sources they had come to rely on.*

Hardin (1998, p. 1) discusses another human attribute – the ability to ignore unpleasant things. He uses the example of an infant trying to escape a threatening face by burying its head in a blanket as in the myth of an ostrich burying its head in the sand. He speculates that the infant's mind moves along the following sort of logical path: "My world is what I see. If I do not see something, it does not exist. I will cause the fearful object to cease to exist by wiping out its image." At the other end of the age range, the elderly might simply say: "I don't want to hear about that (e.g., global heating, peak oil, price increases for food)." Hardin (1998, p. 45) also addresses another human foible – doing nothing: "Yet to do nothing is not a realistic option because *nothing ever happens*." For example, humankind is not following the conservative recommendations in the Intergovernmental Panel on Climate Change reports to any significant degree, and, as a consequence, anthropogenic greenhouse gas emissions are increasing markedly. In fact, Sherwood Rowland, Nobel Laureate atmospheric chemist, estimates the peak atmospheric concentration of carbon dioxide could be 1,000 ppm. The current concentration is about 385 ppm, after never topping 280 ppm for at least 650,000 years (Revkin 2008a).

New and Old Words

The growing urgency of the climate crisis has generated some new words. *Klimakatastrophe* (climate disaster) is the German Language Association word of 2007. An equally alarming new word is *hypermortality*, which is defined as an extraordinary tendency toward death (Walker 2008). The UN Development Program Report entitled "Demographic Policy in Russia" states: "The Russian phenomenon of hypermortality comes to be observed primarily in working-age populations. . . Compared to the majority of countries that have similar levels of economic development, mortality is 3-5 times higher for men and twice as high for women" (Walker 2008). Another new word is *envirogee*, whose "semi-official designation *climate refugee* is defined as a displaced person who has been forced to migrate because of environmental devastation" (Thill 2008). Perhaps these new words will create a sense of urgency which seems, at times, to be totally lacking in public discourse on climate change.

However, one's expectations for change should not be too high! The term *peak oil* was used in 1956 by M. King Hubbert, a petroleum geologist, who predicted that US oil production would peak in the early 1970s, followed by a declining curve. This curve, now validated, is a classic, but still causes fear (Wilson 2008). The reason for the fear is that petroleum has produced a period of unparalleled economic growth, and resistance is strong to the idea that limits to growth exist or, worse yet, a return to a lower growth era. Wilson (2008) makes another important point:

> *When speaking of energy issues, politicians will often use the euphemism of energy security, acknowledging that the US has only three percent of the world's oil reserves and warning that most of the rest of it belongs to unfriendly or unstable governments. While there is truth to this type of statement, it sets up a framework for conflict by creating the perception that there is plenty of oil left but bad people are keeping it away from us.*

Wilson (2008) further remarks that politicians of both parties are willing to play the fear card and promote quick-fix measures that are ineffectual or downright ridiculous. This approach does not develop a good relationship with Mother Nature. Many congressional Republicans favor drilling in the Arctic National Wildlife Refuge, which would, at peak production, only meet 2% of the US oil demand (Wilson 2008). However, the Congressional Peak Oil Caucus Co-chair, Congressman Roscoe Bartlett (Rep), favors saving the Arctic oil for a real emergency. Clearly, the automobile culture puts drilling far ahead of alternative energy sources.

US Legislation

At present, many energy bills are before the US Congress. However, a recent poll carried out by the Public Opinion and Policy Center (2008) of the National Center for Public Policy Research found that 65% of Americans reject spending even a penny more for gasoline in an effort to reduce greenhouse gas emissions. A 203-page report, "The Effects of Climate Change on Agriculture, Land Resources, Water Resources and

Biodiversity in the United States," is a part of a continuing assessment of global heating questions that was initiated by US President George Bush in 2003. The report notes that the rise in concentrations of carbon dioxide in the atmosphere from anthropogenic sources is influencing climate patterns and vegetation across the United States and will significantly disrupt water supplies, agriculture, forestry, and ecosystems for decades (Revkin 2008b)

One would hardly guess that the climate report just discussed had little influence on the Lieberman-Warner climate bill, which effectively died in the Senate on 6 June 2008 (Sheppard 2008). The bill aimed to cut global heating emissions by 66% by 2050 (Zabarenko 2008). This value is far below the reduction in emissions recommend by the Intergovernmental Panel on Climate Change reports, but would have been a step in the right direction.

Tim Profeta, Director, Duke University's Nicholas Institute for Environmental Policy Solutions, stated: "Not many people see this [the Lieberman-Warner Bill] as a serious piece of legislation that will become law this year" (Eilperin and Mufson 2008). US Senator Barbara Boxer has stated: "This is landmark legislation, and enacting landmark legislation is never as easy task. There is always an excuse not to act – but in this case, the longer we wait, the harder it gets to solve this problem. Time is our enemy, and every expert has told us we face dangerous consequences from unchecked global warming if we do not address this problem now" (Eilperin and Mufson 2008).

Why Did Humankind Get into this Perilous State?

The short answer to the question of why humankind got into this perilous state is that it ignored scientific evidence. The "investigative reporters" failed to state that the preponderance of evidence confirms that global heating is indeed occurring and that anthropogenic greenhouse gas emissions were a major component of the change. Of course, overwhelming scientific evidence exists, but not enough in the United States to elicit major remedial actions.

Unquestionably, denial was a major factor in humankind's failure to address climate change threats. Worse yet, in the United States, science was suppressed and distorted when it was perceived as a threat to political ideology. For example, *The New York Times* stated:

> *The Bush administration has worked overtime to manipulate or conceal scientific evidence – and muzzled at least one prominent scientist – to justify its failure to address climate change . . . This administration long ago secured a special place in history for bending science to its political ends. One costly result is that this nation has lost seven years in a struggle in which time is not on anyone's side" (Editorial 2008).*

The editorial also reported that an internal investigation by the National Aeronautic and Space Administration's inspector general concluded that political appointees in the agency's public affairs office had tried to restrict reporters' access to its leading climate scientist Dr. James Hansen. The investigation also found that politics played a heavy role in the office and that it had presented information about global heating "in a manner that reduced, marginalized or mischaracterized climate-change science made available to the general public" (Editorial 2008). Fortunately, humankind is better off because James Hansen refused to be silenced. Few scientists could have endured the stress he was subjected to and continued their research, but Hansen did.

Finally, humankind got where it is because the CEOs of some corporations require scientific evidence far beyond what they provide when they engage in an activity that affects the environment. For example, Cattaneo (2008) states:

> *Rex Tillerson, chairman and chief executive officer of Exxon Mobil Corp., the world's largest oil-and-gas company, came out swinging Wednesday against the environmental movement, arguing the science of climate change is far from settled and that his company views it as its 'corporate social responsibility' to continue to supply the world with fossil fuels . . . Mr. Tillerson also said he expects little delay in the $8-billion Kearl oilsands project in Alberta, after a court challenge by environmental organizations this month resulted in the withdrawal of a key federal permit, halting important work.*

Redesigning to Favor Mother Nature

Scientists at Brown University (MLA 2008) have demonstrated that richer plant diversity significantly enhances an ecosystem's productivity. This evidence highlights a very important benefit – capturing a major contributor to global warming – carbon dioxide. Despite persuasive evidence of this type that humans derive enormous benefits from ecosystem services, such as carbon dioxide capture, they still depend upon undeveloped, unproven technology (e.g., "clean" coal). Ecosystem services must be given the attention they deserve before humans damage natural capital so severely that the services decline, disappear, or no longer benefit the genus *Homo*.

Social Evolution

In their superb book *The Dominant Animal*, Paul and Anne Ehrlich (2008, pp. 3, 4) state: "Humanity's rise to dominance is a result of both genetic and cultural evolution, both of which led to scientific advances that have spawned ever more powerful technologies . . . Knowledge of these reciprocal evolution-environment interactions is critical to our ability to make wise decisions affecting the long-term success of our species and of the natural world upon which it is utterly dependent." The Ehrlichs then note (2008, p. 4) the astonishing increase in knowledge about how Earth and its inhabitants – including humans – interact and how they have changed over time: "In theory, we could use that knowledge to create a sustainable civilization – one in which human beings live happy, productive lives into the indefinite future. Whether we can manage that in practice remains to be seen." Humankind has made no acknowledgment that it is utterly dependent upon Earth's life support system, although discussion of the human economic system is dominant. Wynn (2008) reports that the US chief climate negotiator, Harlan Watson, has commented that big cuts in greenhouse gas emissions cannot be met by 2020: "It's frankly not do-able for us." Had the United States not been a climate change denier for nearly eight years, a more positive statement might have been made.

The Ehrlichs (2008, p. 368) conclude:

> *Humanity's globalizing civilization must take this enhanced opportunity to explore conscious evolution and try new ways of organizing societies to cooperate to solve its burgeoning global problems. . . And humanity must do this even without assurance that the steps taken will be successful. Dealing with such profound questions along with the consequences of overpopulation, economic inequity, and the erosion of environmental resilience will surely not be easy. But each day that we do nothing forecloses options for creating a better future for ourselves and our fellow inhabitants of Earth. The qualities that made it possible for us to become the dominant animal could now be put to use in creating a sustainable future for ourselves and the rest of the world.*

Conclusions

Anthropogenic greenhouse gases are still pouring into the atmosphere at a rate that far exceeds the biosphere's capacity to absorb them. Much talk and little corrective action have been the response to catastrophic climate change thus far. In the United States, resistance to remedial action has been formidable in the federal political system and from organizations funded by some powerful corporations. The general public has inadequate literacy and numeracy to grasp fully the complex systems-level climate change problem. All too many political leaders emphasize adverse effects on the economy when greenhouse gas emission reductions are discussed. However, the human economy will not survive if climate change adversely affects water supply and food production or makes much of the planet uninhabitable by humans. If climate change continues at its present rate, *Homo sapiens* could become extinct or suffer a massive reduction in population size. If biotic impoverishment (i.e., species extinction and/or population declines of many species) continues at its present rate, the biospheric life support system may cease to maintain conditions favorable to humankind.

Still, scientists must continue to generate information about the effects of greenhouse gas emissions and do everything possible to dramatically reduce them. Doing nothing is not an option, however daunting the obstacles to success.

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The Mother of all Positive Feedback Loops?

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Saving civilization is not a spectator sport. Lester Brown

Well it had to happen! Humankind knew that "business as usual" would reach a tipping point after which climate change would be beyond human control. "New U.S. government data estimates that worldwide emissions of carbon dioxide have gone up 38% since 1992 . . . The Kyoto Protocol, which industrialized nations other than the United States have agreed to adhere to, aims to reduce emissions in those countries 5% *below* 1990 levels by 2012" (Shapely 2008). No robust evidence indicates that this goal will be reached. As a consequence, Earth's assimilative capacity for greenhouse gases will continue to be exceeded, and humankind will move the climate closer to major, irreversible tipping points.

"British scientists have discovered hundreds more methane 'plumes' bubbling up from the Arctic seabed, in an area to the west of the Norwegian island of Svalbard . . . It is likely that methane emissions off Svalbard have been continuous for about 15,000 years – since the last ice age – but as yet no one knows whether recent climatic shifts in the Arctic have begun to accelerate . . . climate change" (Connor 2008a) and " . . . details of preliminary findings suggesting that massive deposits of sub-sea methane are bubbling to the surface as the Arctic region becomes warmer and ice retreats" (Connor 2008b). Global carbon dioxide anthropogenic emissions last year (2007) outpaced the most dire predictions of international scientists (Eilperin 2008). "In 2007, carbon released from burning fossil fuels and producing cement increased 2.9 percent over that released in 2006, to a total of 8.47 gigatons, or billions of metric tons, according to the Australia-based Global Carbon Project . . . It is unclear how much industrialized countries will be able to reduce their carbon output in years to come," (Eilperin 2008) if at all, but, even if they do, increased emissions from third-world countries will probably cancel any reductions and still add to the global atmospheric carbon total. Carbon "sinks' such as oceans and forests "have absorbed 54 percent of carbon dioxide emissions since 2000, a drop of 3 percent compared with the period between 1959 and 2000" (Eilperin 2008). In short, Earth's ability to assimilate greenhouse gases is declining while greenhouse gas input into the atmosphere is increasing.

In addition to these increased anthropogenic emissions, emissions from formerly sequestered carbon, in the form of methane, appears to be increasing in the Arctic and probably elsewhere on the planet. These emissions will increase the rate of warming and result in increased release of carbon now sequestered in wetlands, tundra, permafrost, and frozen hydrated methane in the depths of the oceans and, thus, accelerate the rate of global climate change. More important, the essential point is that climate change is getting beyond humankind's control. The feedback loops did not seem to be at current levels of activity at 350 ppm carbon dioxide and were presumably essentially inactive at the pre-industrial atmospheric carbon dioxide level of 280 ppm. Humankind probably has warmed the planet sufficiently to activate the release of stored carbon from a variety of sources. Various parts of the planet have effects on other, sometimes quite distant, areas of the planet (e.g., Tierney et al. 2008). These sources of carbon sequestered by nature at rates difficult to estimate or measure are clearly now emitted at rates significantly above the recent past. Nearly a year ago, the Intergovernmental Panel on Climate Change (IPCC) "issued its strongest call for immediate action to save humanity from the deadly consequences of unrestrained greenhouse gas emissions" (Romm 2008). Instead, greenhouse gas emissions increased last year, setting a course that could push beyond the worst case scenario of leading scientists (Times Wire Services 2008).

Nobel Laureate Svante Arrhenïus noted the greenhouse effect of carbon dioxide in 1896, so the science is not new. The preponderance of scientific evidence demonstrates that anthropogenic greenhouse gases have a major effect on climate change, and no credible scientific evidence shows that they do not have effects. Of course, deniers are active, but they are usually persons with few or no scientific credentials and lacking publications in peer-reviewed, scientific literature. Vocal deniers in the US Congress and administration have

delayed reaching agreement on treaties to set quantitative goals on greenhouse gas emission reduction. In some cases, these actions go beyond global climate change to anti-science. The Union of Concerned Scientists has documented many cases in which the US government has changed, altered, or falsified science.

Uncertainty

Science is always a probabilistic determination based on evidence. Some uncertainties are characteristic of all scientific research. Furthermore, all scientists are responsible for continually probing for any weakness in scientific data and hypotheses. This quality control is essential to a robust, credible, scientific process. Regrettably, the general public, possibly strongly influenced by the news media, views these actions as scientific confusion rather than quality control. In global climate change, the preponderance of evidence that anthropogenic greenhouse gases play a major role is now awesome.

If continuing "business as usual" is likely to be catastrophic, precautionary measures are justified, even if scientific uncertainty exists in certain areas. For example, uncertainties involving the ebb and flow of continental ice sheets are unlikely to be resolved for many years. The exact greenhouse gas concentrations that will exceed major climate tipping points will probably never be known until they have been passed. The assumption that a new, dynamically stable biosphere will develop after major ecological disequilibrium will probably not be known for thousands of years – a time frame not commonly used in human decisions. Finally, Americans unused to US$4/gallon gasoline want to "drill here, drill now, pay less," which might make more fossil fuel available at a low cost but will increase greenhouse gas emissions. Coal, which emits more greenhouse gases per unit of energy, is increasingly favored for electric power generation – this burning also vastly increases greenhouse gas emissions. In the year-long US presidential debates, global climate change was barely mentioned.

Are Catastrophic Climate Changes Needed for an Adequate Wake-up Call?

Even climate scientists are surprised at the present rate of climate change. Former US Vice-President Al Gore, although not a scientist, is so disturbed at the depth and rate of change that he made the following statement at the recent Clinton Global Initiative: ". . . we are at a point in our world's history, and in need of such immediate action, that if you are a young person it's time for civil disobedience. In particular, to bring coal plants to a halt" (Brewer 2008).

I have never felt civil disobedience has been productive, except in Ghandi's case, but I understand fully Gore's desperation at the failure to reduce greenhouse gas emissions when time is so short to take remedial action. If another major climatic tipping point is passed in the near future, which will probably happen if the positive climate feedback loops increase rates of activity, humanity might survive in areas of the world that remain habitable, but the quality of life will not be attractive. Regrettably, loss of human life could be in the billions. Most of humankind's societal infrastructures will probably not survive a worst case scenario, and resources to repair or replace them will most likely be scarce. All these events are possible, even probable, if the positive climate feedback loops escape human control.

Why Worry?

Earth has had conditions suitable for the genus *Homo* for over two million years, and no context exists with which to integrate present day events. However, ancestors in the genus *Homo* faced major challenges, such as leaving trees for the savannah, and survived, although the price was probably often horrendous. The present generations have a significant advantage over their ancestors – they have the power to reduce greenhouse gas emissions. At present, humankind only seems to lack the will.

Infectious Exuberance

The recent financial meltdown in the United States has some lessons that may be applicable to the global climate change crisis that has yet to evoke fear in the US citizenry and in much of the rest of the world, although, based on evidence available, climate change could easily kill and/or displace billions of people. Shiller (2008) notes that financial bubbles are like epidemics – both should be treated the same way. Most of the world, and the United States in particular, worships economic growth, and all that is needed to kill legislation to reduce greenhouse gas emissions is to suggest that the legislation might have adverse effects upon the economy. However, in the United States, citizens were not protected against a financial meltdown and are not being protected from adverse consequences of global climate change. "Many culprits have been fingered for the housing crisis we're in today: unscrupulous mortgage lenders, dishonest borrowers, underregulated financial institutions. And all of them played a role" (Shiller 2008, p. 19). However, too little attention has been paid to the most fundamental cause – the contagious optimism, seemingly impervious to facts, that often takes

hold when prices are rising (Shiller 2008). Bubbles (e.g., financial, housing) are primarily social phenomena. Until society understands and addresses the psychology that fuels social phenomena, they are re going to keep forming. "Speculative bubbles are fueled by the social contagion of boom thinking, encouraged by rising prices. Sooner or later, some factor boosts the transmission rate high enough above the rate for an optimistic view of the market to be widespread" (Shiller 2008, p.20).

Tipping Points Again

Clearly, very few, if any, people realized that a financial tipping point was being approached. Or, if they did, Secretary of the US Treasury Paulson issued no warning, nor did US President George Bush. The US Congress appears to have been caught unawares along with, of course, the major financial institutions and the general public. As of 4 October 2008, a US$700 billion bailout was passed (+US$150 billion in "pork" for congresspersons who otherwise might not have voted favorably on the bill) and rapidly signed by Us President George Bush. Despite the large sum of money, the bailout might not work. The original bill submitted to the US Congress was three pages long; the final bill, the one singed into law, was reported to be 454 pages long – its size increased in just a few weeks. Surely, few people had adequate time to read the final, authorized bill carefully or systematically.

In short, no thoughtful approach was in place before the financial tipping point was passed. In fact, faith in the free market system was too encompassing and the free market ideologs disregarded common sense. In any case, perpetual growth of population, economics, resource use, and all non-cerebral growth cannot continue indefinitely on a finite planet.

Conclusions

Crossing a financial tipping point does not seem to have altered people's attitudes on population growth, ecological overshoot, global climate change, or even infectious exuberance, although all involve global tipping points. Perhaps enough time has not passed for reaction, although people should be asking what else could go wrong.

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Just Give Me a Freeze Dried, Talking Fish on a Stick

Some months ago, I attended an interdisciplinary meeting where problems of pollution were discussed. One of the nonecologists present plaintively but humorously asked, "Why can't you environmental toxicologists just give us a freeze dried, talking fish on a stick? This fish could be inserted in any aquatic ecosystem where pollution problems were suspected and the fish would immediately expand, determine the biological condition of the water, and give the person holding the stick the answer verbally."

If one vigorously suppresses the automatic impulse to explain the complexities of ecology and toxicology to this "ignorant' individual, it becomes abundantly clear that those two simple sentences contain a beautiful description of the kinds of methods the rest of the world wants from ecologists and environmental toxicologists. My interpretations of these characteristics follow:

- The method is simple and the apparatus portable.
- The all-purpose method will work well in any aquatic ecosystem.
- The method can be used by a variety of individuals with little or no professional training.
- Results are obtained immediately and communicated in generally understood terms.
- Because of the stick, the investigator need not expose himself unnecessarily to the potentially harmful material.
- The device is inexpensive and readily available. (This is less apparent from the two-sentence hypothesis, but on checking with the originator of the statement, I found my assumption is correct.)

Although there is always the possibility that some creative individual who does not know "it can't be done" will develop the freeze dried, talking fish on a stick, for the foreseeable future, we must live with the existing methodology.

When developing or improving methods to assess the probable or actual damage caused by persistent chemicals, ecologists would do well to keep these criteria in mind, particularly in terms of communicability. Scientists could, of course, adopt the "trust us" attitude of some professionals – the matter is too complicated to explain to laymen and, therefore, no attempt should be made to so.

This has not been a smashing success in the past for environmental problems and is unlikely to be so in the future. What will probably happen if this is done is that unqualified persons with simplistic solutions will take over. Of course, meeting the needs (which are not well understood) of others is just as difficult as meeting the needs within a discipline, even though the requirements are different. This requires an investment of time and energy in a period when it is impossible to keep up with all the literature within a single discipline. Nevertheless, it is abundantly clear that we must improve methods as well as communication among ourselves.

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"Hail Mary" Technologies to Engineer Earth's Climate*

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A variety of technologies has been proposed to avoid further increasing Earth's temperature by emissions of anthropogenic greenhouse gases in excess of Earth's ability to assimilate them. The two most popular technological approaches are (1) reflecting solar energy back into space and (2) sequestering and storing carbon so that it will not reenter the atmosphere (e.g., Brahic 2009). These two approaches are among a group of mind-boggling concepts now being referred to as "Hail Mary" technology. [The term "Hail Mary" was first used in American football to describe a forward pass that is made in desperation and that has only a small chance of success.] Humankind is now giving serious consideration to "Hail Mary" technologies that have not been adequately researched to address one component of a much larger problem (e.g., increase in global mean temperature).

You Cannot Do Just One Thing

Humans are not superior to the biosphere – they are a part of the biosphere. However, humans are acting as if they are apart from the biosphere. The biospheric life support system (also called *Gaia* by James Lovelock) has maintained conditions favorable to the genus *Homo* for approximately 2 million years and the species *Homo sapiens* for 160,000-200,000 years. The biospheric life support system is a highly interactive, dynamic system that has evolved over the last 3½ billion years. Therefore, actions have many interrelated consequences – no one activity can be completed in isolation from the effects on other components of the biosphere.

For example, other "Hail Mary" suggestions include using aerosol particles to reflect solar radiation into space or spraying seawater mist from ships toward low-lying clouds to make them brighter so they would reflect more sunlight away from Earth (Tierney 2009). The intent of both approaches is to reduce global heating. However, all these technologies must be considered in the context of what else they would do besides possibly lowering global mean temperature. How many side effects will be identified before the technologies are used on a large scale? Politicians have indicated that global mean temperature should not rise more than 2°C. Since politicians have been reluctant to restrict anthropogenic greenhouse gas emissions, they may be tempted to use one of the "Hail Mary" technologies in a few years.

Global-Scale Experiments

Engineering global climate will be the largest experiment carried out by humankind. How will quality control be carried out on experiments that could have unintended global consequences? In fact, Turney (2008, p. 29) notes: "A recent paper suggests that the odds are only in our favour of keeping below 2°C – with an estimated risk of 28% – if the equivalent level [Greenhouse gases have different heat trapping abilities – it is useful to refer to them collectively as carbon dioxide equivalents.] is kept to 400 ppm; a value of 550 ppm has a 68 to 99% chance of breaching 2°C. It's not very heartening when we add together the heating capability of today's greenhouse gases and find we're at around 460 ppm. We're already beyond a safe level." Furthermore, no global agreement has been reached on reducing greenhouse gas emissions. Every year that passes without a substantive reduction in anthropogenic greenhouse gas emissions increases the probability that a desperate situation will arise that will persuade politicians to use a "Hail Mary" technology. Without an agreement on either the rate or extent of anthropogenic greenhouse gas emission reduction, the crisis could occur at any time.

Hegerl and Solomon (2009) state: "Observations indicate that attempts to limit climate warming by reducing incoming shortwave radiation risk major precipitation changes." The contrast with the promoters of climate change engineering is stark. They are primarily focused on climate engineering as a commercial, for profit, project, and their information is not primarily published in peer-reviewed, scientific journals. I am not against for profit solutions to environmental crises. What is of concern is both the tunnel vision focus on what the climate engineering will do and the failure to document what else it will do. One Hegerl and Solomon (2009) publication is a perfect example – the "Hail Mary" technology might be effective in reducing global temperature but might not the changed rainfall patterns affect agricultural productivity and wildlife? Even though Hegerl and Solomon (2009) analyzed rainfall patterns, any "unexpected" events should also be the responsibility of the climate engineers (i.e., people and organizations that benefit financially should bear the costs of unexpected [i.e., not studied enough] outcomes). Such a situation could occur in the freshwater of Asia if climate engineering reduced rainfall, which would affect production of food (BBC News 2009). Other problems could occur as well. Should the climate engineers bear the fiscal and ethical responsibility?

"One would think that by now most people would have figured out that climate change represents a grave threat to the planet. One would also have expected from Congress a plausible strategy for reducing the greenhouse gas emissions that lie at the root of the problem" (Editorial 2009). However, climate engineering that produces unexpected climate change would also be a threat to national security (Editorial 2009). Shouldn't this possibility be considered before a climate engineering project is approved? What government agency/agencies should be assigned the responsibility for authorizing and monitoring climate engineering projects?

Role of Scientists

Scientists working for the Intergovernmental Panel on Climate Change (IPCC) have worked for a decade on examining and analyzing an enormous amount of data. Other research investigators, including James Hansen and Susan Solomon, have also carried out research on climate data. The preponderance of scientific evidence and the majority of qualified scientists agree that humans are a major cause of global heating. However, the political system has not made much use of this scientific information. Some members of the US Congress even vigorously denounce global heating science (e.g., Senator Inhofe and Congressman Barton). In addition, substantial lobbying occurs against global climate change science. National Academies of Science or their equivalents in other nations agree that anthropogenic greenhouse gases are a major factor in global heating. However, the news media treat the issue as if an equal number of scientists support each side. The media refer to this situation as balanced coverage, but the impression is that a major disagreement exists within the scientific community on global heating and other aspects of climate change – this situation is far from true.

This skewed representation is understandably upsetting for many scientists who serve on climate change committees without compensation. All have a variety of other responsibilities, such as teaching, advising, supervising or serving on graduate committees, writing grant proposals, serving on various academic committees, carrying out their personal research, and so on. Naturally, they are upset to find their scholarly contributions denounced in the news media by politicians. However, the most discouraging aspect must surely be having their publications, which have been accepted, even applauded, by the scientific community, denounced by politicians and ridiculed in the news media. The time they spend, as a public service, on global climate change could have been spent on students, family, or some civic activity.

Should Industrial Civilization Be Saved?

A recent debate between Paul Kingsnorth and George Monbiot (2009) puts the climate engineering question in perspective. Portions of a letter from Kingsnorth to Monbiot state:

> *Yet very few of us are prepared to look honestly at the message this reality is screaming at us: that the civilisation we are a part of is hitting the buffers at full speed, and it is too late to stop it. Instead, most of us – and I include in the generalisation much of the mainstream environmental movement – are still wedded to a vision of the future as an upgraded version of the present. We still believe in 'progress', as lazily defined by Western liberalism. We still believe that we will be able to continue living more or less the same comfortable lives (albeit with more windfarms and better lightbulbs) if we can only embrace 'sustainable development' rapidly enough; and that we can then extend it to the extra three billion people who will shortly be joining us on this already-gasping planet.*

A portion of Monbiot's response reads:

> *But the interesting question, and the one that probably divides us, is this: to what extent should we welcome the likely collapse of industrial civilisation? Or more precisely: to what extent do we believe that some good may come of it? I detect in your writings, and in the conversations we have had, an attraction towards – almost a yearning for – this apocalypse, a sense that you see it as a cleansing fire that will rid the world of a diseased society. If this is your view, I do not share it.*

I strongly recommend reading the entire exchange (Monbiot 2009).

My Personal Perspective

I have children and grandchildren and have chaired 74 graduate committees and served on many others. I am sad and dismayed at what we have left for posterity. Still, humankind had over 200 years to use its intelligence more effectively and has failed to do. I concur with Kingsnorth that his message had to be said. I also fear that Monbiot (2009) was prophetic when he stated: "However hard we fall, we will recover sufficiently to land another hammer blow on the biosphere." I agree that the human population is well beyond Earth's carrying capacity for it. The total biocapacity of Earth is 5.1 acres/person, and the total ecological footprint is 6.7 acres/person. This measurement results in an ecological deficit of -1.6 acres/person or a percent overshoot of 31% (2005 data from World Population Balance at www.WorldPopulationBalance.org). Earth is a finite planet with approximately 33.6 billion acres of biologically productive land and water. Whatever our emotions, millions, possibly billions, will suffer, even die.

Brown (2009) remarks: "The throwaway economy is on a collision course with the earth's geological limits. Aside from running out of landfills near cities, the world is also fast running out of the cheap oil that is used to manufacture and transport throwaway products. Perhaps more fundamentally, there is not enough readily accessible lead, tin, copper, iron ore, or bauxite to sustain the throwaway economy more than another generation or two." Of course, such actions are very damaging to the biosphere. Earth is losing species very rapidly due to a multiplicity of causes, including habitat fragmentation and loss. These species collectively constitute the biospheric life support system that maintains conditions on Earth that favor humans. In short, more than one crisis is brewing (e.g., Prugh 2009), and, if nothing is done now, humankind may well face multiple crises simultaneously and be greatly tempted to use a "Hail Mary" climate engineering technology.

Conclusions

If humankind does nothing effective to address the multiple, interactive problems, which may soon pass various tipping points that will place various complex systems into instability, the situation will probably be beyond its control. Humans have been addicted to the conviction that a technological solution is available for every problem despite the fact that technology has actually caused, directly or indirectly, the problems. Wiser use of technology is essential, especially if it accompanies major changes in human behavior and lifestyle.

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Ecological Overshoot is Suicidal*

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Tuesday, October 10, 2006, was ecological deficit day – the day humankind began living beyond its means (i.e., ecological overshoot) and creating a deficit for that year. Humanity's first ecological deficit day was December 19, 1987 (www.footprintnetwork.org/gfn_sub.php?). In 2008, the day was September 22. In 2009, ecological deficit day will occur sometime in September (www.footprintnetwork.org). The trend is shocking, but it is almost unknown to the general public and its political representatives. Each year since 1987, humankind has used more resources than the biosphere can regenerate (ecological overshoot).

A good metaphor for the concept of ecological overshoot is a bank account – living off the interest means not using any of the capital. However, living beyond one's means results in using some of the capital to do so. Each year that some of the capital is used will diminish the capital and reduce the interest. The part of the biosphere that generates "interest" (i.e., ecosystem services) is termed *natural capital*, and if it is used, then ecosystem services (i.e., production of resources, maintaining the atmospheric gas balance) are reduced.

At the same time that ecological overshoot is occurring, Earth is adding 215,000 new consumers daily (births minus deaths). If humankind cannot keep its population within Earth's carrying capacity, Mother Nature (natural law) will do so with her usual methods of starvation, disease, and death.

At present, humankind is far from achieving sustainable use of the planet and moving further from that goal daily. Since global climate change has an adverse effect on agricultural production, one immediate remedial step is for both individuals and nations to reduce emissions of anthropogenic greenhouse gas. Individuals can reduce their carbon footprints and eliminate rampant consumerism, which is an important factor in ecological overshoot.

Barnosky (2009, p. 22) notes that the average species of mammal has a life span (as a species) of between 1.7 and 2.5 million years. *Homo sapiens* has inhabited Earth for only 160,000-200,000 years. Humans need to "shape up" if they intend to match or beat the average mammal.

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The End of Abundance: Will It Bring Resource Wars or Sharing?*

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When industrial civilization began, the global human population was small and widely scattered. Forests and other natural resources were abundant and relatively easy to obtain. Naturally, humans used the resources that were most easily acquired. In some places, petroleum was readily accessible on the surface (e.g., Pennsylvania, USA). However, limitations on resources are increasing at present – humankind is simply running out of everything at a dangerous rate (Grantham 2009). For example, the largest oil discovery in the Gulf of Mexico for the last 20 years will keep automobile engines running for a mere 41 days; 30 tons of ore once produced a ton of copper – now 500 tons of ore are needed (Grantham 2009). Common commodities such as water (1,000 tons are needed to produce 1 ton or corn) are necessary for a variety of activities and are becoming increasingly scarce.

Friedman (2009) states the problem succinctly: "We're trying to deal with a whole array of integrated problems – climate change, energy, biodiversity loss, poverty alleviation and the need to grow enough food to feed the planet separately. The poverty fighters resent the climate-change folks; climate folks hold summits without reference to biodiversity; the food advocates resist the biodiversity protectors." Humankind persists in attempting to address the crises individually, but this approach is not working. The biosphere (nature) is a seamless, interactive system and must be viewed from a holistic perspective. The recent attempt of the US Congress to produce an effective climate change bill is a perfect example of this battle between holism and special interests. Civilization as presently known will probably not survive a 3°C global temperature increase. However, attempts to limit anthropogenic greenhouse gas emissions are met with fierce resistance by special interest lobbyists. Even an increase of less than 2°C has had adverse effects on food production in nations widely separated geographically – Argentina, Australia, and Kenya.

Some biologists (Palmer and Pringle 2009) disagree with the idea that integration of solutions is the answer to all problems: "You can't integrate a bull with a china shop. In the 1960s and 70s, environmentalists learned what politicians have always known: people hate being told that they can't always get what they want." This statement is true, but at times when individuals can see for themselves the situation and the objective, they can approve a stalwart procedure – for example, Prime Minister Winston Churchill told his nation that it could only look forward to blood, toil, tears, and sweat (Cairns 2009) in his famous speech at the outset of World War II. The present crises need a respected leader who is unafraid of the truth – no small task, and one that will be shunned by most politicians. Humankind needs courageous leaders who are aware that the cornucopian era is over. "Plenty" disappeared with the decrease in cheap, abundant gas, excess food, and the belief in "more" always being available.

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Let's Talk About the Elephant in the Living Room*

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It is harder to conceal ignorance than to acquire knowledge. Arnold Glasgow

Overpopulation is the "elephant in the living room" – everyone sees it but no one wants to talk about it. Exponential growth on a finite planet is neither sustainable nor desirable; however, even though sustainability is the "buzz word" de jour, humankind worships growth. Most politicians would rather walk through a mine field in their bare feet than discuss population control with their constituents. One reason for their fear may be that perpetual economic growth is often linked to perpetual population growth – more consumers = more economic growth. However, the reluctance to discuss overpopulation must be more than just fear of alienating people. For example, in the United States, a several-year, heated debate ensued on immigration, but overpopulation was rarely, if ever, mentioned. Abortion clinics have been bombed and physicians who performed abortions have been shot and killed, so passions run high. A civil, objective debate must be held on a global scale NOW.

In 1950, approximately 2.5 billion people inhabited Earth; in 2009, the population is nearly 7 billion. This exponential growth simply cannot continue on a finite planet. Barnosky (2009, p. 9) remarks:

> *By the time babies born today are in their fifties, even the best-case scenario predicts that more greenhouse gases will be in the air than has been the case in three million years – if we go on our merry way without any mitigation efforts. In just the years since 1950, we have approximately doubled the amount of greenhouse gases in our atmosphere. That was on top of the doubling that had already taken place between the start of the industrial revolution, say around 1700, and 1950.*

However, species in ancient time frames often experienced a comparatively slowly changing environment that allowed more opportunity for relocation and/or adaptation. At present, a hot Earth is probably here for a long time, especially if human population expansion continues. The sad aspect of the situation is that humankind flourished with the Earth it had, but humankind is probably changing much of the planet irreversibly.

Earth's human population has more than doubled in my 86 years of life. Some projections place population size at 15 billion by 2100. With nearly half the present population starving or malnourished; lacking potable water; and needing better medical care, housing, and educational facilities, the 2100 estimate is probably not plausible. A major consideration is that, every time the population doubles, then food supplies, housing, school systems, medical systems, police forces, sewage treatment plants, and energy supplies must also be doubled to maintain at least the status quo after the last doubling. Of course, humans should use less polluting energy, but even this approach is beside the point – the point is that the human population simply cannot double within one human lifetime even one more time.

Earth's resources are already being used far faster than they can be regenerated. The population must be stabilized within Earth's long-term carrying capacity as rapidly and humanely as possible. To do less will condemn posterity to a life of squalor and misery.

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How Much Space on Earth Should be Allocated to the Biospheric Life Support System?*

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I believe wolves need to be eliminated. Rex Rammell, Republican Candidate for Governor of Idaho (as quoted in Egan 2009)

Since *Homo sapiens* appeared on Earth approximately 160,000 years ago, the species has gradually encroached on the space and resources that were originally the domain of the biospheric life support system. Only a few spaces are left on Earth that are not significantly affected by humans in some way. Despite persistent stories of a mutualistic relationship of humans and natural systems, humankind has always been a rogue genus. For example, humans were responsible for the extinctions of the late Pleistocene megafauna, even though humans had only primitive weapons and tools. When humans acquired fossil fuel energy and developed better tools and technology, they became a global geophysical force now termed the Anthropocene, which began about 1800. Evidence is widespread of the vast damage done to the biospheric life support system (Steffen et al. 2007).

Humans Are Still Taking Space from Wild Creatures

Most people have never heard of the biospheric life support system, although their lives depend upon it. Many of the "wild" places on Earth are now markedly different than they once were. Block (2009) laments the encroachment of humans into coyote territory:

> *A neighbor, fed up and sleep deprived, appeared one night at our front door with a lantern and a shotgun, asking my dad to hold the light while he fired. My dad – an urban Jew of Eastern European descent – knew a thing or two about displacement and assured the man that the coyotes, starved of their resources and their freedoms, would soon leave on their own. June proved my dad right; the howling finally ceased. The city, confident that the residents and Shih Tzus of Glenhollow Estates had nothing to fear, built a concrete walking path that wound along the creek.*

The wild creatures had lost their space. Wild places are ever diminishing ecosystems that are usually quite isolated from each other. Diminishing them further by building shopping malls, "big box" stores, and housing developments is suicidal.

The Oceanic Biospheric Component

The oceans occupy about 70% of Earth's surface and are a key component of the biosphere. No robust information has been gathered on the relative activity of the land and the ocean components of the biosphere, but the oceans have been a major sink for carbon dioxide and are now less so. This situation alone justifies serious concern. At present, another major issue needs attention – a huge mass of waste plastic is floating in the North Pacific between Hawaii and Japan. This garbage patch is estimated to contain 100 million tons of plastic debris and is twice the size of the US state of Texas. The physical damage to marine creatures is already known and serious, e.g., turtles and seals have been trapped in pieces of plastic. However, a possibly

more serious danger has become known – the plastic breaks down more rapidly than expected and releases contaminants (Editorial 2009). More evidence is needed to document these risks fully, but adding to the oceanic contaminant load is not prudent.

Two Possible Scenarios

Scenario #1 – (1) Humankind pushes the present biospheric life support system beyond its tipping point, (2) it loses more biodiversity, (3) goes into disequilibrium, and (4) the surviving species build a new biospheric life support system.

The new biospheric life support system will not likely produce conditions as favorable to humans as the present system. Consequently, the population will diminish to fit the carrying capacity for humans (if any) of the new system. Once a tipping point is passed, the situation is irreversible. Unfortunately, the tipping point is not known until it has been crossed. Species are becoming extinct, possibly at 1,000 times the normal rate, but the human population is still growing exponentially; resources per capita are markedly diminished; the era of cheap oil is over; and climate change is having adverse effects on agricultural productivity.

Scenario #2 – (1) Humankind systematically returns space to wildlife – not space for which humans have no use but space suitable for wildlife and (2) nurtures the biospheric life support system as its highest priority.

Economic growth has badly damaged the biospheric life support system, so economic growth in its present form is a threat to the integrity of the biospheric life support system. Nothing should be discharged into the atmosphere that is beyond Earth's assimilative capacity – a good start would be the marked reduction of carbon dioxide and other greenhouse gases emissions and, next, chemical substances that are endocrine disruptors. Even at present, Earth's assimilative capacity for these discharges may be zero. The human population must be reduced to fit Earth's carrying capacity. Ecological overshoots (deficits) must cease now.

These changes require an unprecedented adjustment in human behavior. "Business as usual" is no longer possible if the biospheric life support system is to be maintained in its present form. The already lost species cannot be replaced, but species that remain could be given a change to achieve optimal function. To assume that a replacement biospheric life support system, if one develops, would provide equally suitable conditions for humans is delusional! The only choice is preserving the present biospheric life support system.

Conclusions

The general public and its political representatives have not grasped the unique nature of tipping points. Reaching a tipping point is basically incremental – take more on a regular basis, and, if nothing happens, take even more. A good metaphor for a tipping point is walking toward a cliff on a pitch black night without a flashlight – take a tentative step forward and nothing happens – take another step and nothing happens – the third step is the catastrophic step off the cliff. The point at which the biospheric life support system will go into equilibrium is unknown. However, it will eventually collapse, and, over evolutionary time, a different biospheric life support system will be produced. This different system may support life, but probably not the life forms with which humankind currently shares the planet.

A prudent course of action would be to nurture the present system in hopes of its continuing to nurture humankind. Human nurturing should include allocating more space for the biospheric life support system over the entire planet. Eliminating toxic stressors and ecological overshoot is also a prudent step. Life support for humankind should be the primary goal of human society – not using natural systems to fuel economic growth.

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THE INTELLECTUAL ELECTRIC FENCE[1]

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The world is increasingly a place of interactions. The world's major problems of population, environmental pollution, ecological destruction, ozone holes, acid rain, hazardous materials that must be stored for thousands of years while they decay, short-falls in water quantity and quality, global loss of agricultural soils, and biotic impoverishment (just a few examples) transcend the capabilities of one discipline. The present structure of the educational system is toward depth in a particular discipline rather than in breadth in a variety of disciplines as one ascends the educational ladder from secondary school to a B.S., M. S., and finally to the Ph.D. Reductionist science is the norm and integrative science is the exception, although less so than it was a decade or two ago.

This separation is regrettable because almost every activity of human society (except perhaps such passive activities as meditation) has an environmental impact. The per capita energy use in developed countries, as well as use of other natural resources, is markedly higher than it is in developing countries. On the other hand, rate of population increase is at unprecedented levels in many of the developing countries and appears unlikely to stabilize as a consequence of societal efforts until well into the next century, if then. There is always the possibility of large-scale human deaths due to disease, malnutrition, hazardous water supplies, etc. The Union of Concerned Scientists (Cambridge, Ma., 1992) issued a "World Scientists Warning to Humanity" indicating that the present rates of population increase and environmental destruction cannot continue without severe impact on human society. The fact that this was signed by over 100 Nobel laureates and over 1,600 members of the U.S. National Academy of Sciences and its counterparts in other countries indicates that mainstream science believes there is substantive evidence to support this view. Additionally, the officers of the Royal Society of London and the U.S. National Academy of Sciences (1992) released a report with essentially the same view.

Why, with all the environmental crises in the world requiring the interaction of two or more disciplines, has interaction and integration not occurred in the educational system and in the larger world more frequently than it has? The root cause is the intellectual electric fence which each discipline uses to prevent defection from the discipline and to repel invasion from other disciplinary tribes. From the moment a student enrolls in an institution of higher learning, there are "jolts" to keep her/him within the tribal boundaries of the chosen discipline.

The most powerful of these deterrents are the prerequisite courses, without which a B.S. or B.A. is unattainable. These are so numerous and so carefully structured that it is virtually impossible for a student to develop substantive literacy in any other professional field, except on labeled "the minor." If a student strays too far outside the disciplinary boundaries, mild to severe penalties occur. The worst of these is not having the necessary prerequisites for graduation, which is a penalty in both money and time because it may require an extra semester or even an entire academic year to fulfill the needed requirements. Not only are money and time lost, but this delay might raise questions about the student's sincere interest in a particular discipline when he/she applies for graduate school in the same discipline or for a position in that discipline.

In graduate school, the penalties for straying outside disciplinary boundaries are continued by requiring additional courses, most with a strong disciplinary orientation. Graduate students share offices with other students in the same discipline and may not be encouraged to attend seminars in other disciplines that are attended by students and faculty from a variety of disciplines. Finally, preliminary examinations and final examinations for the Ph.D. are committee examinations of the candidate by tribal "elders" (i.e., staunch disciplinarians) who decide whether a candidate qualifies to be an apprentice elder.

A number of barriers or intellectual electric fences are designed to reinforce disciplinary purity and to avoid or reduce substantive relationships with other disciplines. A powerful barrier is a series of tribal languages (which the uncharitable might call disciplinary jargon) not intelligible to the uninitiated. The jargon does serve a useful purpose within the discipline to convey much information in a few words if a large, common-knowledge

base is shared by all members. It does inhibit exchange with disciplinary tribes that do not share the common-knowledge base and, therefore, are mystified by the jargon. Implementers of disciplinary language "purity" are the editors of, and the reviewers for, tribal journals who exclude publication of research that does not emphasize the disciplinary language. Manuscripts intelligible to a wide variety of disciplines are generally designated as "shallow" and as "lacking knowledge of the field." Since professional status is usually determined within a discipline, failure to conform to these requirements can have serious, sometimes fatal effects on professional careers.

Tribal languages and the journals that reinforce them are by no means the only isolating mechanisms with which the intellectual fence is charged! Disciplines on a university campus have a patchy distribution, each discipline occupying a particular spatial patch. On those rare occasions when space shortages or other problems prevent a high degree of geographic integrity for a particular discipline, the least senior members or the departmental outcasts are housed in areas predominately occupied by another discipline. The graduate students and faculty are encouraged to gather for reinforcing rituals, such as departmental seminars and the like. Seminars given by world-class outside speakers are poorly attended at some institutions because the faculty feel the seminar is not on a topic "in my field," which translates into "not my specialty." This is particularly incongruous when uttered by people with a Doctor of Philosophy degree.

Another important segregation occurs at the major annual meeting of a particular discipline, either nationally or internationally. This is the intellectual equivalent to the aggregation of some species at a particular breeding ground each year where the attributes of the species that will be dominant in the population are determined. This intellectual isolation is, in some important aspects, analogous to genetic isolation where outbreeding is discouraged. Thus, a species that is actually capable of successfully mating with another species does not do so for behavioral rather than genetic reasons.

Practically everyone in academe needs money in order to foster intellectual renewal through research. In the past, most of the gatekeepers (i.e., people who decide who will be funded and who will not) were selected by discipline and represented a relatively homogeneous group in the sense that, while they might not have the same areas of specialization, they were all within a discipline or subdisciple. The gatekeepers have the power to exclude applicants by denying access to funding – the surest way to impair a professional career. Without funding, a researcher cannot have postdoctoral fellows, graduate students on research assistantships, technicians or other assistants, substantive computer time, major travel funding for meetings, or even the money to pay for page charges for publications and to buy reprints to honor requests from colleagues. Those so afflicted are less able to exchange ideas with colleagues at other institutions, either personally at professional meetings or through exchange of reprints.

Ironically, however, extramural funding is becoming one of the major factors facilitating interdisciplinary activities. Comprehensive research universities are sensitive to shifts in funding priorities and sources of funding. Without extramural funding, their research programs would be a pale shadow of their present activity level, the graduate programs would be severely attenuated, their faculty would cease to win the accolades and honors that have a major effect on university ranking, and last, but far from least, a major source of income through overhead would be lost. Furthermore, since major problems that transcend the capabilities of a single discipline routinely generate major funding far in excess of the typical grant for a "lone wolf" investigator, these shifts in funding have not gone unnoticed by comprehensive universities dependent upon extramural funding. In a real sense, faculty research fitness requires skill in foraging for resources, and this influence upon individual professional survival, strongly coupled with institutional academic stature, has seriously weakened the intellectual electric fences that were so successfully maintained by the disciplines for many decades.

I hasten to add the caveat that the barriers to interdisciplinary interactions are not entirely bad. For example, quality control is much easier when the attributes of the "product" are crisply identified. A comparable robust quality control system for interdisciplinary activities has yet to emerge, although professional organizations, such as the Society for Environmental Professionals, have a certifying process that exercises quality control at a society level, but only for those who voluntarily apply for certification. Additionally, the basic quality control process should be at the degree-granting institutions. An additional caveat is that reductionism and specialization within a discipline will continue to be as essential in the academic system as it has in the past. However, maintaining disciplinary integrity should no longer be permitted to impede interactions among the disciplines or exercise penalties on those individuals who choose to study problems that transcend the capabilities of a single discipline.

The thrust toward interdisciplinary activities is now too well underway to be stopped. In the last 15 years, numbers of interdisciplinary journals have appeared on the international scene, such as *Environmental Toxicology and Chemistry* (combining environmental toxicology and environmental fate of chemicals), *Ecotoxicology* (combining ecology and environmental toxicology), *Ecological Economics*, and *Integrated*

Management. Research investigators, frustrated by the fact that their interdisciplinary research is not a "good fit" with the disciplinary orientation of most journals and the fact that the reviewers are more suited to comment on the quality of a manuscript in only one area, have finally found that it takes less energy to launch a new journal more suited to their needs than to fight the established system. Thus, the intellectual electric fence has been weakened further by the inability of the classical journals to deny publication of manuscripts that lack disciplinary purity. Again, the quality control system for interdisciplinary activities is far from perfect, and some journal space must be expended because the readers do not share the same information base to the extent that they do in a specialized or strongly disciplinary journal. However, this is a transient problem since the number of persons working in the interfaces between and among the disciplines is increasing markedly.

The most serious weakening of the intellectual electric fence will probably result from the events discussed in the Virginia Tech President's Symposium on Environmental Literacy. The environmental literacy movement is an inevitable result of the information age. For policy- and decision-makers, information is of greatest value if it can be integrated with a variety of other information to make policy and decisions about complex, multivariate systems. Almost every major global problem, and practically all regional and national problems, comfortably fit within this category. Because we are in a global market and because society depends on both an ecological and a technological life support system, environmental literacy (or knowing something about how the natural world works) is of importance to all disciplines. It is interesting that the impetus for this appears to have come primarily from outside the academic system because of the need of corporations active in the international marketplace to have management employees who can make decisions based on information from more than one discipline. Therefore, students in economics must understand ecological restoration, and those in biology must understand economics. Natural resource managers must understand both the benefits and limitations of waste treatment technology; engineers must understand the nature of the receiving systems (i.e., natural systems) into which their wastes are discharged. Additionally, the political and cultural aspects of all decisions must be given serious consideration. These are but a few of the illustrative examples of the wide array of information that is routinely involved in landscape level natural resource planning and management.

However, students cannot become environmentally literate if the faculty is not. Therefore, along with all the other changes occurring in teaching methods, course structure, student preparation, and the like, faculty members must become environmentally literate in the context of their basic disciplines. Although environmental literacy appears to focus on the environment, in fact, its primary focus is interdisciplinary; and, if carried out properly, it will not focus entirely on environmental matters but rather on a suite of information of which the environment is one component. If this movement is successful, even though it may be altered considerably by feedback loops that modify the original plan, it may be the single most important factor weakening the intellectual electric fence. After all, today's students are tomorrow's gatekeepers and are the ones who will decide how potent the barriers to interdisciplinary activities should be and, more importantly, what the new boundaries should be.

As a person who has repeatedly ventured beyond the boundaries of my original discipline of biology, I welcome this expansion of intellectual horizons. At the same time, I am apprehensive that the intellectual quality control system, which was and is one of the major contributions of a disciplinary orientation, does not yet have a counterpart in the rapidly developing interdisciplinary system. This is probably an unwarranted fear because, if the will to develop a robust quality control system exits, it should not be any more difficult for it to develop.

It is worth remembering that, in the early days of science, it was not uncommon for astronomers, biologists, geologists, chemists, and a variety of other disciplines, including those in the humanities, to exchange ideas on a common ground such as the British eating clubs. The enormous increase in both numbers of professionals in the various categories and a concomitant increase in amount of information and literature weakened the interactions among the disciplines that was once take for granted by scholars. We should, therefore, remember that we are not abandoning the disciplines in re-establishing the interactions among and between them, but rather returning to an earlier mode of information exchange that pre-dates the intellectual electric fence.

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Adapting to the New Biosphere*

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Business as usual is dead – green growth is the answer to both our climate and economic problems.
Anders Fogh Rasmussen
Danish Prime Minister

Speculation about the future is essential in this era of rapid environmental change lest human society gets caught by unexpected events. Species are being lost at a rate unprecedented in human history. Rainfall patterns are changing, and habitats, such as forests, are still being lost. All too frequently, surprising shocks occur, such as the unexpected decomposition of plastics in the oceans and the probable release of toxics.

Surviving Species

The surviving species of the present great extinction will be dominated by ones least affected by human activities and technologies. If "business as usual" continues, the further loss of species can be expected. From those remaining, a new array of species will evolve, if the past five great extinctions are a reliable guide. If politicians are unable to adopt legislation to reduce anthropogenic greenhouse gas emissions sufficiently to arrest climate change, the temptation will emerge for using "Hail Mary" climate engineering technologies to manage Earth's climate. These technologies may or may not do what they are designed to do and may also do things they are not designed to do. Another adaptive challenge for humankind for the new biosphere will be those organisms highly resistant to human control. Perhaps the lesson from this experience will be that humans have less control over nature than they once thought.

Energy Resources

The discovery of petroleum gave humans more individual power than any other species has ever had. However, now the era of cheap, abundant energy is ending. At one time, petroleum was near Earth's surface and easily acquired with a minimum of effort. At present, drilling for small pockets of oil that are miles below Earth's surface is not uncommon. Petroleum is very useful to agribusiness, which generally involves huge tracts of land. The price of oil is, at present, a major factor in the price of food and is likely to continue to be so for decades to come.

A major unknown is how well domesticated species will respond to climate change. Already climate change has affected wheat and meat production in places as widely separated as Australia and Argentina. Grapes previously grown in a Mediterranean climate are now being grown in southern England because of climate change. If global mean temperature continues to increase, the agricultural system can be moved ever closer to the poles if temperature is the only limiting factor. Rainfall patterns are also critically important – rain must fall when the crops need it. Quantity of water is also important – 1,000 tons of water is need to produce a ton of grain.

"A study, recently published online in Proceedings of the National Academy of Sciences, looked at three frequently used scenarios for global warming. It found the average U.S. yields for corn, soybeans and cotton could plummet 30 percent to 46 percent by the end of the century under the slowest warming scenario, and 63 percent to 82 percent under the quickest" (Price 2009). "David Walter Wolfe, a Cornell University expert on the

effects of climate change on crops . . .” has stated: “They’re no longer farming in a static environment . . . They can’t rely on the calendar to tell them when to plant, they can’t rely on the variety of seeds they have always used, and they can’t rely on dealing with the same insect pests, because it’s all a moving target now” (Price 2009). Humans might adapt to a slow warming scenario, but only if it ceased after a few decades. Adapting to changing conditions will never be easy. Failure to adapt could be fatal.

Rate of Climate Change

McGrath (2009) notes: “The worst-case scenarios on climate change envisioned by the UN two years ago are already being realised, say scientists at an international meeting. . . . More than 2,500 researchers and economists attended this meeting designed to update the world on the state of climate research ahead of key political negotiations set for December this year [in Copenhagen, Denmark].” Although most of the tools needed to reduce anthropogenic carbon dioxide emissions are available, they are not being widely used and probably will not be until politicians take global climate change seriously. Some political leaders are acting on scientific evidence – for example, “Japan’s next leader [Yukio Hatoyama] has promised a big cut in greenhouse gas emissions, saying he will aim for a 25% reduction by 2020 compared with 1990 levels” (Black 2009).

Conclusions

Two volumes – Mark Lynas’ *Six Degrees: Our Future on a Hotter Planet* (2008) and Chris Turney’s *Ice, Mud, and Blood* (2008) – are useful reading on the problems of adapting to a hotter planet. Lynas used the Intergovernmental Panel on Climate Change reports as a basis for the global mean temperature (in °C) increases and devotes a section of the book to each °C increase. A 2°C increase is not something to look forward to; above 2°C is the stuff that causes bad dreams. Turney spends quite a few pages in his book discussing the Paleocene–Eocene Thermal Maximum (PETM). This warming occurred about 55 million years ago and provides fascinating information on what Earth might be like if the global mean temperature increase is hovering about 3°C. Human society has not faced up to the hard facts that thousands of credentialed scientists have provided, and now is the time to act!

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Your Personal Responsibility for Earth*

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. . . the tender flower of objectivity is really crushed by what is taken to be the necessity of the moment.
Garrett Hardin

In the 20th and 21st centuries, Earth has been regarded as a supply of resources to promote perpetual economic growth. The thinking was that, if a resource were depleted, human ingenuity and creativity would soon find an acceptable substitute at a reasonable cost. The other species with which humans shared the planet were viewed as just components of the resource base. However, humankind recently has become aware that it is also just a component of the biospheric life support system that has maintained conditions favorable to the genus *Homo* for approximately 2 million years. Humankind is now beginning to realize that its activities (e.g., anthropogenic greenhouse gas emissions) have a major influence on global climate. In addition, if "business as usual" continues, it will soon accelerate the positive feedback loops that will put climate beyond human control. Eilperin (2009) states: "Human-generated greenhouse gas emissions have helped reverse a 2,000-year trend of cooling in the Arctic, prompting warmer average temperatures in the past decade that now rank higher than at any time since 1BC. . ." Only a few non-scientists seem disturbed by this situation. Perhaps individuals have lost the sense of a personal responsibility for the integrity of the biosphere. Some illustrative ways to correct this lack of responsibility follow.

(1) Develop a systems perspective

Hardin (1985) states: "The basic insight of the ecolate citizen is that the world is a complex of systems so intricately interconnected that we can seldom be very confident that a proposed intervention in this system of systems will produce the consequences we want." The US Congress has been working on legislation to avoid deleterious global climate change. However, rarely are members of Congress exposed to a perspective of how the global climate system works. Unfortunately, special interest groups (i.e., lobbyists) are most likely to be focused intently on one component of an extremely large, complex system. Members of Congress are then expected to integrate this fragmented information – an elusive goal since the debates generally focus on the fragments.

(2) Develop a high level of environmental/ecological literacy for integrating disparate bits of information

(3) Numeracy

The evidence of climate change studies consists of both numbers and the analysis of numbers. One must understand the enormous changes that can occur in both ecosystems and agricultural systems following a 1° to 2°C shift in the global mean temperature. Although Al Gore and the Intergovernmental Panel on Climate Change have accomplished much on climate literacy and numeracy, public debates and town meetings show how very far citizens and their representatives have to go.

(4) Become familiar with science as a process

"It's only a theory" is often stated, which implies that the premise is just a guess when, in fact, it is a carefully structured statement based on a body of evidence.

(5) Do not be fooled by the "balanced view" tactic

The US news media often imply that a major disagreement exists among scientists about a specific issue (e.g., the role of anthropogenic greenhouse gas emissions on global climate change). In actuality, scientists give most weight to the preponderance of evidence, but the news media usually give equal time to

deniers and believers, even when deniers number only a few and believers number in the thousands. This situation gives the impression that scientists are confused even though the National Academy of Science, or its equivalent in other nations, has stated for decades that anthropogenic greenhouse gas emissions have had a major influence on global mean temperatures for decades.
(6) Corporations and their lobbyists have set up a number of institutes with impressive names and staffed by people with impressive titles to advocate a variety of special interests. A number of very useful, objective organizations, such as the Earth Policy Institute, exist. Individuals must be environmentally literate enough to identify false or misleading information and become immune to its destructive influence. Hardin (1985) called environmental literacy the mental shields and "Filters Against Folly." When individuals use fear rather than reason to persuade people and shout slogans to prevent discussion – beware! Hardin (1985, p. v) remarks: "Ecology's most profound insights call for far-reaching modifications of long-standing social arrangements. It takes intellectual independence to achieve and voice such insights, as well as financial support to make the intellectual work possible."

Conclusions

Financial globalization moved quite rapidly during the last part of the 20th century and the first part of the 21st century, but protection of the biospheric life support system has not. Individuals can do much to protect and nurture the biospheric life support system, as can sovereign nations through taking a leadership role. Even though this challenge is formidable, both individuals and sovereign nations must effectively address global climate and other system-level problems that will determine the future of humans and civilization.

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Conditions for Crew Membership[1] on Spaceship Earth[2]

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[1]"Crew membership" applies to the officers and captain – Spaceship Earth has no passengers.

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Freedom is the recognition of necessity. Friedrich Engels

We travel together, passengers on a little spaceship, dependent on its vulnerable reserves of air and soil; all committed for our safety to its security and peace; preserved from annihilation only by the care, the work and I will say, the love we give our fragile craft. Adlai Stevenson

Garrett Hardin's (1968) *Exploring New Ethics for Survival: The Voyage of the Spaceship Beagle* introduced the metaphor of Earth as a spaceship. (The ship that carried Charles Darwin to the Galapagos Islands was the HMS Beagle.) Although the metaphor did not receive the attention it deserved, perhaps because humankind retained the cornucopian mindset, the current global crises in 2009 make the spaceship metaphor even more appropriate than when it was first published. Humankind must be continually reminded that it is on a finite planet – Spaceship Earth. The conditions humans must accept or perish are all based on natural law, which has existed for at least 4 billion years. In contrast, human law, the late arrival, has existed for 200,000 years at the most. Some illustrative conditions follow.

(1) Spaceship Earth's carrying capacity must never be exceeded – doing so endangers the entire crew. The crew member who is responsible for allowing the additional person has endangered the present and the future and can only make amends by ceasing at once to occupy a space on the ship. Harsh – but reality is harsh.

(2) Ecological overshoot/ecological deficits provide evidence that humankind is using resources 40% more rapidly than Spaceship Earth can regenerate them. Even a large, traditional spaceship of television/movie fame would have crew members who know each other and would have a shared empathy. On Spaceship Earth, crew members have little in common with most other crew members and, thus, only a tiny sense of community. Crew members are unaware that globalization has increased the probability that all humans are likely to share a common fate. Also, politicians are unlikely to view all problems through the lens of sovereign nations. The "negotiations" on global climate change have shown this all too clearly.

The spaceship metaphor is cruel because it prohibits all the usual delusional and denial tactics used to avoid unpleasant decisions on Earth. "I don't want to hear about that" is a common avoidance tactic that would not be permissible on a spaceship. "Let me know when you have good news" is another tactic; however, crew members must be informed about all situations pertinent to the integrity of the spaceship. Ideologies of any kind (e.g., race, politics, economy) are counterproductive in the operation of a spacecraft. However, Earth is self maintaining, and every condition for sustainable use is being violated. Only scale is a key factor in determining which conditions are acceptable and which are not.

(3) Resource Allocation

On a spaceship, resources are finite and can be viewed by the crew. On Spaceship Earth, resources are also finite, but so widely distributed as to be beyond the view of a single individual. In addition, many of

Earth's resources can be regenerated by the biosphere. Regeneration of resources might be possible on a spaceship constructed by humans if it had a biologically based life support system.

Even with its importance, the metaphor of Spaceship Earth is flawed. Mother Nature (i.e., natural law) favors quantity from which she selects quality – a process called natural selection. A large number of individuals are not suited (i.e., fit) for the habitat of a particular time and perish, although they may have been competitive at some time in the future. Evolution is "wasteful" because quality is selected from quantity. However, the process is "efficient" in selecting the fittest (i.e., most competitive) individuals for a particular habitat that existed at a particular time. The pivotal question is: should humans depend on Mother Nature to keep the human population within Earth's carrying capacity with her usual methods of starvation, disease, and death? With approximately half the planet's human populations starving, malnourished, and living in poor conditions, a tipping point is in the near future or has already been passed. Mother Nature's way is very hard on individuals now living but more humane toward future generations.

Conclusions

The carrying capacity of a constructed spaceship can be estimated accurately and has been done successfully for limited space travel not far from Earth. However, all crew members of the constructed spaceship are volunteers who have met particular predetermined conditions deemed necessary for space travel. The crew of Spaceship Earth was born on the planet and has the broad range of fitness that one would expect in a population of nearly 7 billion. Controlling human population size is a subject most people avoid discussing. However, if no discussion takes place and exponential human population growth continues, Mother Nature will reduce population size until it is within Earth's carrying capacity. Her methods will not be applauded by most humans. Nevertheless, humans will probably start talking and appointing investigative committees when the catastrophes worsen. Effective action is highly improbable. Doing nothing is always costly with global problems.

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The Midas Touch in the 21st Century*

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One day when King Midas was walking in his garden, he saw an elderly satyr asleep in the flowers. Taking pity on the old fellow, King Midas let him go without punishment. When the god Dionysus heard about it, he rewarded the king by granting him one wish. The king thought about it for a second and then said: "I wish for everything I touch to turn to gold." And so it was.

> *The beautiful flowers in his garden turned toward the sun for light, but when Midas approached and touched them, they stood rigid and gold. The king grew hungry and thin, for each time he tried to eat, he found that his meal had turned to gold. His lovely daughter, at his loving touch, turned hard and fast to gold. His water, his bed, his clothes, his friends, and eventually the whole palace was gold.*
>
> *King Midas saw that soon his whole kingdom would turn to gold unless he did something right away. He asked Dionysus to turn everything back to the way it had been and take back his golden touch. Because the king was ashamed and very sad, Dionysus took pity on him and granted his request. Instantly, King Midas was poorer that he had been, but richer, he felt, in the things that really count.*
>
> (from http://www.hipark.austin.isd.tenet.edu/mythology/midas.html)

The 21st century equivalent of gold is economic growth – everything humans touch in the biosphere (i.e., natural systems) is degraded and all too soon ends up as trash or artifacts (e.g., shopping malls) that displace natural habitats and cause species impoverishment. Unfortunately, the mythical god Dionysus cannot return Earth to its previous ecological state. However, preserving the present biosphere may still be possible, but would require an immediate massive change in human practices (e.g., reduce human population size to fit Earth's carrying capacity).

Following each of the five great species extinctions on Earth, a new biosphere evolved. Such an event will probably occur after the sixth great extinction (which is now in progress). Of course, predicting what the new biosphere will be like is impossible, but the species composition of Earth changed after each of the five great extinctions and will presumably happen again. Adaptation to the rapidly changing conditions during the transition from one biosphere to another will not be easy for any species, including humans.

Careful examination of the problems of adapting during a transition period where rapid change is the norm and adapting to a quite different new biosphere might persuade humankind to nurture the present biosphere with the hope that it might be saved. Estimating how close the present biosphere is to a major tipping point is not possible. As a consequence, nurturing should begin at once, even though the effectiveness of this nurturing is uncertain. However, equal or greater uncertainty exists about humankind's ability to adapt to the conditions (e.g., atmosphere) produced by the new biosphere.

King Midas was fortunate in having his "golden touch" reversed by Dionysus, but humankind must reverse its "trashing touch" itself. Yes, humankind can!

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Humankind's Faustian "Pact" with Fossil Fuels*

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A Faustian "pact" is a myth indigenous to parts of the world where a belief in the devil occurs. In the myth, the devil offers diabolical favors in exchange for an individual's soul. Although the pacts are usually made by individuals, societies apparently are not excluded.

When humankind discovered it could obtain large amounts of energy from fossil fuel, no oral or written pact was made between them and nature. Humans found they could have huge amounts of energy at their disposal (or a nation's disposal) merely by extracting fossil fuel and burning it. Individual humans had more energy per capita than any other species on the planet. Humankind knew what fossil fuel could do – provide energy for transportation, heating houses, and what appeared to be control and mastery of nature.

Humans became so addicted to the benefits of fossil energy that they failed to ask what else its use would do to the planet. Extraction and use of fossil fuel made possible the doubling of the human population within a single human life span (at least for developed countries). Cheap, abundant fuel made globalization possible. Ordinary people could travel over the planet at low cost, sometimes carrying diseases and agricultural pests with them. Raw materials could be shipped to China from all over the world and finished material goods could be shipped anywhere in the world.

However, burning fossil fuels produced greenhouse gases that changed the climate since coal produces much more carbon dioxide per unit of energy generated than either petroleum or natural gas. In addition, Heinberg (2009, p. 55) notes that coal consumption has been rising at a rate of up to 10% per year, which means a doubling of demand every seven years. This situation is high risk, even if non-carbon alternatives (e.g., solar and wind) were available, which they are not, in adequate quantity in the United States. Also needed is an updated, national, electric transmission line.

Heinberg (2009, p. 27) lists three conclusions concerning coal reserves.

> (1) *World proven reserves (i.e., the reserves that are economically recoverable at current economic and operating conditions) of coal are decreasing fast . . .*
> (2) *The bulk of coal production and export is getting concentrated within a few countries and market players, which creates the risk of market imperfections . . .*
> (3) *Coal production costs are steadily rising all over the world, due to the need to develop new fields, increasingly difficult geological conditions and additional infrastructure costs associated with the development of new fields.*

Brown (2009) reports:

> *The United States has entered a new energy era, ending a century of rising carbon emissions. As the U.S. delegation prepares for the international climate negotiations in Copenhagen in December, it does so from a surprisingly strong position, one based on a dramatic 9 percent drop in U. S. carbon emissions over the past two years and the promise of further huge reductions.*

Before getting carried away by optimism, human society needs to remember that greenhouse gas emissions still exceed Earth's assimilative capacity for them. Even with the heartening present reductions, the emissions will continue to accumulate in the atmosphere.

Conclusions

Humankind is, figuratively, driving full speed (powered by gasoline, naturally) toward a brick wall (i.e., energy crisis) without a reduction in speed. A major part of the problem is that, as socialist Robert Brulle remarks: "At best, global warming remains an abstraction for many people" (as quoted in Revkin 2009).

Freedom has been won by the blood of citizens, but it is nurtured by a well informed citizenry. However, the "news" media (as in the United States), under pressure from advertisers and other special interest groups, has morphed from employing investigative reporters like Walter Cronkite to a medium for the propagation of misinformation. As a result, far too many citizens in the United States believe "clean coal" technology is available at present when it may never be economically or technologically feasible (e.g., Weld 2009). This unsubstantiated belief is how a society makes Faustian "pacts" that it will later regret.

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The 21st Century Fountain of Youth*

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The ability to delude yourself may be an important survival tool. Jane Wagner

The Fountain of Youth is a myth based on legends that anyone who drinks its water will have a restoration of youth. Juan Ponce de Leon, Governor of Puerto Rico, searched for the Fountain in 1513 in Florida. Some other cultures have similar myths.

The 21st century counterpart of the idea of the Foundation of Youth is sustainable use of the planet (i.e., use for an indefinite period). If Earth's population were reduced and everyone had smaller ecological and carbon footprints as well as a lifestyle that nurtured the biospheric life support system, sustainable use of the planet should still be possible. However, more than a sustainability tee shirt, an efficient light bulb, or a bumper sticker on a Prius is needed to achieve sustainability.

Achieving sustainability will not be easy – as many people are discovering. Seeking eternal youth is also difficult – successive face lifts and other cosmetic procedures are both expensive and time consuming. Even with these modifications, nothing makes the inner body younger. Healthful living could help, but the lifestyle requires knowledge and focus. Even this approach will not bring eternal youth, but it may help achieve a longer and healthier life.

Sustainability can be achieved, but it will require nurturing the biospheric life support system, getting and keeping the human population within Earth's carrying capacity, eliminating ecological deficits/overshoot, reducing greenhouse gas emissions to match Earth's assimilative capacity for them, using no more natural resources than Earth can regenerate, and not treating other life forms as commodities. The changes constitute a tremendous challenge, but it is one that humankind can meet.

Sustainability is basically a gift (leaving a habitable planet) from older people to younger people now alive and to future generations. Older people should make a major shift to begin the effort to achieve sustainable use of the planet as an example to their children and grandchildren because of their love for them and as a final gift to them. Lifestyle would have to change in developed nations, who must also assist developing nations during the transition period, which will take the entire 21st century or more. Everyone must change, but an initial step by the older generation would energize the effort. Material goods, possessions, and energy per capita will decrease in developed countries, but, if the effort comes from the heart, social capital will increase. The possibility of a habitable planet for future generations will result in great joy.

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Putting the Cart before the Horse*

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Cowardice asks the question, "Is it safe?" Expediency asks the question, "Is it politic?" Vanity asks the question, "Is it popular?" But conscience asks the question, "Is it right?" And there comes a time when one must take a position that is neither safe, nor politic, nor popular but one must take it because one's conscience tells one that it is right. Martin Luther King

All the resources for economic growth originate in the biosphere (natural capital). Hawken et al. (1999) list four types of capital: (1) natural capital, on which the other types depend, (2) financial capital, (3) manufactured capital, (4) human capital. Why then, at the recent G20 meeting (Climate Change Summit in New York), attended by Chinese leader Hu Jintao and US President Barack Obama, was the upcoming December 2009 meeting on climate change sidelined (Corcoron 2009)? Andrews (2009) reports: ". . . leaders from both rich countries and fast-growing powerhouses like China agreed on Friday to a far-reaching effort to revamp the economic system." If economics is judged more important than the environment by world leaders, then the important relationship between economics and the environment will be ignored at any systems-level, global conference. However, the biosphere should be the key component in all global conferences – after all, it is the life support system! Not connecting all the dots can be fatal in any undertaking – especially one that is global!

The biosphere is already endangered by global climate change. However, Krugman (2009) states:

> *So the main argument against climate action probably won't be the claim that global warming is a myth. It will, instead, be the argument that doing anything to limit global warming would destroy the economy. As the blog Climate Progress puts it, opponents of climate change legislation "keep raising their estimated cost of the clean energy and global warming pollution reduction programs like some out of control auctioneer."*

The claims of the deniers (of global climate change) appear to inhabit a different planet. How can they possibly believe that ignoring the damage to the biosphere will somehow protect them? Or, in the unlikely event that they could flee to anther planet, would they, as destructive new arrivals, be welcomed? Krugman (2009) believes, as I do, that bogus claims of immense economic damage are as bogus, in their own way, as climate change denial.

The biosphere is not only the source of the resources that are the foundation of the human economy, but is also Earth's life support system. The biosphere cannot be excluded from discussions on human economy.

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21st Century Cassandras in an Era of Climate Change Denial*

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Cassandra was blessed with the gift of prophecy by Apollo. However, she shunned Apollo's romantic advances, and he added a twist to her gift. Cassandra was doomed to tell the truth, but never to be believed (Fitton 1998). Scientists are not prophets but do make statements and predications based on the preponderance of evidence.

Krugman (2009) comments on the present day situation: "These days, dire warnings aren't the delusional raving of cranks. They're what come out of the most widely respected climate models, devised by the leading researchers. The prognosis for the planet has gotten much, much worse in just the last few years. . . . In a rational world, then, the looming climate disaster would be our dominant political and policy concern. But it manifestly isn't. Why not?"

Most individuals who carry out research on troublesome problems have been called a Cassandra. In much older times, the emperor, king, or chieftain had the bearer of bad news beheaded – but, the bad news did not disappear. Every academic institution has at least one Dr. Doom. Better yet, they are not beheaded or even injured. A common reaction to bad news is "Let me know when you have good news!" Obviously the best way to make good news is to do something about the bad news. "Why don't you scientists do something about global heating?" is becoming an increasingly common question.

Deniers of the global heating are encouraged to persist in their position by a constant barrage of misinformation, counter arguments, and, sometimes, falsehoods. The news media have not been helpful. All too often, the preponderance of evidence is on one side (plus data) and a handful of deniers (with questionable or no data) are on the other. However, the public gets the impression that no scientific consensus is possible and even that scientists are confused. Lawson (2009) comments on one writer who used religious arguments against Darwin's theory of evolution: "The validity of any scientific theory can only be established by scientific methods." The proper place to assess scientific theory is in peer-reviewed, scientific journals.

Of particular concern is that global warming is speeding up (Associated Press 2009), but public understanding of the problem is not keeping pace. Humankind did not even keep pace when things were moving much more slowly. Had it done so, one hopes that more effective, direct remedial action would have been initiated (e.g., marked reduction of anthropogenic greenhouse gas emissions).

If humankind wishes to keep Earth's climate hospitable, it would be wise to pay attention to the "Cassandras" who are using evidence.

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"The Gift of the Magi": Slashing Living Standards*

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Lord, make me an instrument of your peace,
where there is hatred, let me sow love;
where there is injury, pardon;
where there is despair, hope;
where there is doubt, faith;
where there is darkness, light;
where there is sadness, joy;

O Divine Master, grant that I may not so much seek to be consoled as to console;
to be understood as to understand;
to be loved as to love.

For it is in giving that we receive;
it is in pardoning that we are pardoned;
and it is in dying that we are born to eternal life. St. Francis of Assisi

Live simply that others may simply live. Mahatma Gandi

In the short story "The Gift of the Magi" by O. Henry, the characters of Jim and Della lived in poverty. Neither had much money for a present for the other as Christmas time approached. Della decided to sell her extremely beautiful, long hair (which Jim loved) for $20 so she could buy a fob for Jim's pride and joy – his grandfather's gold pocket watch. Unknown to Della, Jim had decided to sell the watch so he could buy her combs for her beautiful, long hair. The irony of the situation touches the reader's heart, but O. Henry remarks: "O all those who give and receive gifts, such as they are wisest. They are the magi."

Humankind can give a great gift to its descendants and to all life on Earth by reducing anthropogenic greenhouse gas emissions and reducing the threat of runaway climate change. Webster (2009) quotes Professor Kevin Anderson, Director of the Tyndall Centre for Climate Change Research: "The wealthier parts of the world . . . will have to seriously consider reducing their levels of consumption over the next 10-15 years while we put in place low-carbon technologies." This message is one that most politicians fear to give their constituents, especially if an election is in the near future. Many citizens are so strongly against government intervention that dissent and lack of civility will impede global negotiations on global heating. Most people do not understand that the wealthy countries have exported much of their manufacturing to third world countries, which accounts, in part, for the rapid rise in greenhouse gas emissions in developing countries. Per capita emissions also show a vast difference – "20 tonnes per person per year in the US and 10 tonnes in Britain but only 5 tonnes in China and less than 2 tonnes in India" (Webster 2009).

Ardipithecus ramidus (“Ardi”), a current fossil find, indicates that hominids have been around for over 4 million years (Hale 2009). The genus *Homo* has been around for about 2 million years and *Homo sapiens* (humans) has been around for 160,000-200,000 years. Except for the last 10,000 years, when the Agricultural Revolution occurred, hominids appear to have been tribal – certainly *Homo sapiens* was. At present, in less than 100 years, political globalization must occur rapidly to avoid catastrophic, runaway climate change. No signs show that this change is happening, but *Homo sapiens* has been a remarkably adaptable species, so it is capable of achieving the needed changes.

Humankind must slash its living standards, yet retain compassion for each other and other life forms, in order to leave a habitable planet for posterity. The world’s population is now 7 billion – lifestyles must change so that humans fit into the finite carrying capacity of Earth. Undertaking the challenge is this generation’s “gift of the Magi” as expressed by O. Henry.

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Globalize or Perish*

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The issues of global climate change, overpopulation, ecological overshoot, species extinction, and resource depletion are interlocking and interactive. Failure to solve any one of them could mean the end of civilization as presently known. Greenhouse gas emissions must be reduced, which will require maximum participation by all nations.

Reducing overpopulation will benefit from individual action, but a call for such action has not reduced the population size to fit Earth's carrying capacity. Exponential population growth simply cannot continue on a finite planet.

Ecological overshoot is using more resources than Earth can regenerate. In 2009, Overshoot Day occurred in September. For the rest of this year, humankind will be depleting natural capital, which provides the ecosystem services upon which humankind depends for survival. Humankind's survival also depends upon the biosphere, which includes all Earth's species.

Five great extinctions have already occurred and have reduced the number of species to as low as 5% of the original total. However, life is resilient and eventually diversity was restored, although the biosphere did not resemble the predisturbance condition. Earth is now in the sixth great extinction. Clearly, remediation action is needed now!

All living species require resources, and all species are subject to limits to growth (i.e., carrying capacity). Usually one resource (e.g., water) is limiting.

While half the population of humans is living well, the other half is not. Starvation, malnutrition, disease, and death are the penalties. They are unattractive but are the inevitable result of inadequate resources. Should humankind see how many people can be packed on the planet or how many can be fed at an optimal level? Most people would select feeding all at the optimal level, but human practices are leading more to just a subsistence level living for many people.

The economy is a subset of the biosphere because the resources come from the biosphere to run the economy. Economic growth has caused problems in the areas of overpopulation, ecological overshoot, species extinction, and resource depletion.

A wide variety of reactions have been developed to avoid responding to these problems: "I don't want to hear about that!" or "I didn't do it" or I'm only one person, what can I do?" or "No catastrophes will occur in my lifetime." Everyone on Earth caused the problems, and the people who caused the problems should do something about them! Some people may have caused fewer problems than others, but, when catastrophes occur, all will suffer. No one can say "Your end of the boat is sinking!" because everyone is in the same boat and will have a common fate if a catastrophe occurs. So what is humankind waiting for?

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"The City Mouse and the Country Mouse[1,2]

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[2]From *Aesop's Fables*, Illustrated by Heidi Holder, 1981, Viking Press, New York, NY.

The tale of the city mouse and the country mouse (the country mouse learns that a modest life with peace and quiet is better than a material one with danger and strife) is a useful metaphor because humankind is destroying the present biosphere as it worships perpetual economic growth. Before the recent, global economic meltdown, the "shop till you drop" slogan was widespread in affluent societies and the top one or less percent of impoverished societies. However, billions of people are starving or impoverished. How can the affluent part of humankind be so insensitive to the fate of other humans and other life forms with which it shares the planet? Worse yet, humankind is destroying the integrity of the biospheric life support system that made and makes the planet habitable for humans. Human activities can and are endangering humankind's security, but it seems, except for a small part of the population, blissfully unaware of its fate. Earth cannot afford the excessive loss of resources to produce more stuff for more people. The country mouse figured out the situation – perhaps humankind will as well.

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The Bee Hive: Controlling Environmental Temperature with No Brains*

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Bees are very vulnerable to small changes in temperature within a hive – as vulnerable, for example, as humankind is to small changes in global mean temperature. Violent fluctuations in hive temperature could be fatal to bees, just as global heating is already having adverse effects upon agricultural productivity. For honey-bees, "temperature modifies their reactions more than any other [climate] factor" (Dunham 1931). Maintaining hive temperature is a colony activity involving large numbers of individuals (Dunham 1931).

Humankind is not facing changes in temperature (climate) as a colony (globally) because it worries about the cost of reducing greenhouse gas emissions (e.g., Eilperin 2009) and the effect of doing so on economic growth (e.g., Jung 2009). This viewpoint exists despite the deleterious effects of economic growth on the biosphere. Both the honey-bee economy and the human economy are dependent upon the biosphere. Even though the United States should take the lead in climate negotiations, "President Obama's top climate and energy official said . . . that there was virtually no chance that Congress would have a climate and energy bill ready for him to sign before negotiations on a global climate treaty begin in December in Copenhagen" (Revkin 2009).

Bees have existed for 100 million years (Goudaryi 2006) without a brain, but *Homo sapiens* (humans) may commit suicide with excessive greenhouse gas emissions after a mere 160,000-200,000 years despite having a brain. Brains have enabled scientists to provide evidence that rising greenhouse gas emissions could destabilize the climate to a degree that would prove devastating to agriculture (Dumanoski 2009). Shouldn't humankind's intelligence enable it to grasp the catastrophe that will result if "business as usual" continues? Greenhouse gas emissions could be markedly reduced if humankind had the will to do so.

If a catastrophe affects human society, the human economy will probably not survive in any semblance to its present form. Global climate change has already adversely affected the biosphere, which produces the natural resources on which the human economy is based. The biosphere also constitutes Earth's life support system. Humans are a part of the biosphere. The human economy is a subset of the biosphere, without which it could not survive. Perhaps some day humankind will understand this relationship.

If humankind wishes to persist as long as the honey-bee, it would benefit from observing the model of a species with no brain – which knows how to regulate the temperature upon which its survival depends.

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Lessons from Avoiding Overpopulation: "Primitive" Polynesians*

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History is a vast early warning system. Norman Cousins

Since humankind persists in carrying out global experiments (e.g., global heating) with Earth's biospheric life support system and since islands often experience biological phenomena that occur more rapidly on them, they are worth studying. Charles Darwin was the first person to use islands to study speciation. The small Pacific island of Tikopia has avoided overpopulation and is worthy of examination. "The small size of the island of Tikopia and its isolation has meant that for generations past the maintenance of an adequate relation between quantity of land and population has been a problem of fundamental importance in the economy of these natives. In olden days they appear to have attained a rough equilibrium, and kept it by various mechanisms of adjustment; in recent years this has tended to be upset as a result of contact with European civilization" (Firth 1983, p. 367). In 1929, the population was 1281 (Firth 1983, p. 368). ". . . until recent years the population of Tikopia was normally in a state of equilibrium with its food supply" (Firth 1983, p. 373). This situation was partly the result of occasional famines. "The relation of population to natural resources is not expressed in purely individual terms, but in terms of family equilibrium" since each family has a finite portion of the land (Firth 1983, p. 373). The number of people on each family tract of land is kept sustainable by (1) celibacy, (2) *coitus interruptus*, (3) abortion, (4) infanticide, (5) war, (6) sea-voyaging (especially by young, unmarried men).

"It might be thought that the so-called sanctity of human life is not an end in itself, but the means to an end, to the preservation of society. And just as in a civilized community in time of war, civil disturbance or action against crime, life is taken to preserve life, so in Tikopia infants just born might be allowed to have their faces turned down, and to be debarred from the world which they have merely glimpsed, in order that economic equilibrium might be preserved, and the society maintain its balanced existence" (Firth 1983, p. 376).

If the planet's population were only 1 billion, instead of nearly 7 billion, humankind's present lifestyle would not be a problem. Earth has more humans than it can sustain, and approximately 215,000 new mouths (births minus deaths) are added daily. Obviously, nurturing the biosphere is an act of enlightened self interest. Global heating and other types of climate change might destroy millions of species and civilization, but a new, different biosphere will emerge – almost certainly one that will not favor humans as the present one does. Saving the present biosphere is essential to the survival of civilization. Talking about the dangers to economic growth is a transparent tactic. Where would the economy be without humans?

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Life is Uncertain: Get Used to It*

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The only thing that makes life possible is permanent, intolerable uncertainty. Ursula Le Guin

Would we listen to nature if our lives depended on it? Derrick Jensen

Life is uncertain – eat your dessert first. Ernestine Ulmer

In the early part of the 21st century, substantive action on reducing greenhouse gas emissions was delayed because some politicians were using the idea of uncertainty in science as a justification for delayed action. Of course, science is a probabilistic endeavor based on hard data (persuasive evidence). Rarely will scientists claim they are certain about a particular outcome. However, all of life is uncertain – politicians may not live up to their campaign promises, the global financial meltdown shocked people who believed the free market was self regulating, all too many people found their "secure" jobs were not secure and their house would not appreciate in value at 10% annually, climate change reduced the global agricultural productivity, and some corporations (e.g., General Motors) needed government financial aid to survive. In short, the "secure" civilization turned out to be far less secure than anyone expected. Tsunamis and wildfires have shown that nature has greater "control" than people thought. Arguably, above all, the reduction in agricultural productivity, when the human population is still growing exponentially, can no longer be ignored or be based on greenhouse gas reduction plans with dates like 2020, 2025, or 2050. Finally, positive feedback loops could release greenhouse gases from the frozen hydrated methane in the ocean depths or locked up in the permafrost, putting the global climate system beyond human control. The fear that these things might happen should not prevent taking action now.

Humankind has delayed action on all global problems far too long, but the interactive problems must be addressed now with concrete action. Talk and world conferences have not led to major or even significant remedial action, but this situation is no excuse for inaction now. Of course, even if atmospheric carbon dioxide is reduced to 350 ppm, risk should be reduced for runaway climate change. Too much time has been spent doing nothing about reducing greenhouse gas emissions.

By using uncertainty to delay action on reducing greenhouse gas emissions, uncertainty about the climate of the future has been increased at least an order of magnitude. "Business as usual" increases the risks, increases the cost of remedial action, and increases uncertainty about the future climate. Life is full of uncertainty, and some remedial action may provide enormous benefits. Why wait?

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The Fisherman and His Wife: More Does Not Make You Happy*

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Human nature, in no form of it, could ever bear prosperity. — John Adams, Letter to Thomas Jefferson

Success has made failures of many men. — Cindy Adams

Failure changes for the better, success for the worse. — Lucius Annaeus Seneca

The tale of the fisherman and his wife (collected by Jacob and Wilhelm Grimm) is about greed and recognizing when enough is enough. Basically, a fisherman and his wife live in a filthy shack near the sea. One day, the fisherman catches and releases a flounder that is an enchanted prince. When the fisherman relates the experience to his wife, she tells him to go back to the fish and ask for a little cottage for them. The flounder immediately grants the wish and, when the fisherman returns to his wife, she has a nice, little cottage. However, the wife is not satisfied and sends the fisherman back to ask for a palace; the wish is granted. Next, the wife wants a kingdom; the wish is granted. Then she wants to be emperor; the wish is granted. She continues by asking to be like God; however, the flounder sends the fisherman home to his wife, who is in their filthy shack again. Often the addiction to material possessions and the desire for more does not ensure satisfaction or happiness.

In its quest for evermore material possessions, humankind has impoverished the biosphere, and profligate use of fossil fuel has added more greenhouse gases to the atmosphere than the biosphere can assimilate. The result is that global climate change is already endangering human society. Politicians seem unable to grasp that the only solution is to reduce greenhouse gas emissions until they match the biosphere's assimilative capacity for them. Percentage reductions of greenhouse gas emissions by 80% by 2050 or 20% by 2020 have no relationship to the biosphere's assimilative capacity (which is not constant) for greenhouse gases.

In short, humankind's quest for more material goods and energy has endangered the biosphere, altered Earth's climate, and still left billions of people in poverty. The upper 1% of the planet's population has accumulated much wealth, but the rest of the population has not. Even the very wealthy do not feel more secure and have not achieved happiness (i.e., satisfaction in life). Present destruction of the biospheric life support system brings neither security nor happiness, so why do people still want more?

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