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Is *Homo sapiens* Just Another Transient Species ?

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Abstract : During the five great biotic extinctions, huge numbers of species were lost. Over evolutionary time, biodiversity was restored and sometimes exceeded previous levels. This environment might well be described as a pulsing system that was affected by catastrophic natural events (*e.g.*, the impact of a large object from outer space with Earth). The sixth great extinction, now underway, differs from the first five because the major influence is human activities. Will the resulting ecological changes also have adverse effects upon human society? Global warming and other types of climate change, the coming decline in the availability of petroleum, acidification of the oceans, continued growth of the human population in both numbers and expectations, and ecological overshoot will surely have deleterious effects. Unanswered questions remain: (1) will humans replace their unsustainable lifestyle with sustainable use of the planet? and (2) if so, will social evolution be sufficiently rapid to be effective? As a species, humans are embedded in a huge, complex, multivariate system that will probably endure even if the human species becomes extinct.

Key words : Global species extinction, Future of *Homo sapiens*, Unsustainable practices, Sustainable lifestyle, Global warming, Exponential growth, Transient species.

Darwin's dice have rolled badly for Earth.
E. O. Wilson

Most of them (i.e., species) are doomed to rapid extinction, but a few may make evolutionary inventions, such as physiological, ecological, or behavioral innovations, that give these species improved competitive potential. **Ernst Mayr**

He who refuses to learn deserves extinction.
Rabbi Hillei

The extinction of the human species may not only be inevitable but a good thing . . . This is not to say that the rise of human civilization is insignificant, but there is no way of showing that it will be much help to the world in the long run.
***Economist* Editorial**

The worst case scenario of the consequences of destroying Earth's biospheric life support system is that humankind is so addicted to present unsustainable practices that no substantive change to more sustainable practices will be made; consequently, humankind will suffer major reductions in population size or even drive itself to extinction. Exponential growth in the production of greenhouse gases, resource consumption, population growth, and reduction in the amount of cheap, readily available energy are just a few of the many factors that constitute the present threat to human survival. Some world-class scientists (*e.g.*, James Hansen) believe humans have as much as 5 to 10 years to make the necessary changes. Once major ecological and/or societal tipping points have been passed, the situation will be beyond human control.

I hope that the major premise of this manuscript – *Homo sapiens* will become extinct – is wrong. After all, I have

children, grandchildren, former students, and friends whom I hope will have interesting, productive lives. However, mounting evidence of the degradation of Earth's biospheric life support system and humankind's failure to address the causes does not justify an optimistic outlook. However, I do remain optimistic about what humans could do to protect their species and other species with which they share the planet, even as I am increasingly pessimistic about what they *will* do. Unenlightened self interest is the norm. A common expression in the United States is "I look out for #1." Wilson (2006) has made an appeal to save life on Earth, and he describes the natural world as *embattled*: "In order to solve these problems, I've argued, it will be necessary to find common ground on which the powerful forces of religion and science can be joined. The best place to start is the stewardship of life." I hope and pray that humankind still has time to take the necessary steps.

Readers may wonder why the threats of global heating and other types of climate change (*e.g.*, droughts and floods) are not on the front pages of every newspaper every day. Why are government and industry not taking major steps to prevent the crisis? As Leeb and Strathy (2006) write, this crisis is not the first time a major economic threat has gone unacknowledged by world leaders. Leeb and Strathy's (2006) major illustrative example is the technology stock market bubble – until the moment the ax fell, everyone, including corporate executives, Wall Street analysts, and the media, portrayed the situation in glowingly optimistic terms. Global heating will probably cause even more economic hardship since effective remedial actions are not yet in place to make major reductions in greenhouse gas emissions.

Transient Species: Is There Any Other Kind? :

Earth has existed for approximately 4.5 billion years and has supported living entities for about 3.5 billion years. Barring a major catastrophic event, such as collision with a large object in space, Earth is expected to last another 15 billion years. The paleontological record indicates that most, possibly all, species have been transients. The assumption in the concept of sustainable use of the planet is that humans can inhabit Earth indefinitely, even though most articles and discussion on sustainability do not specify the number of years. Moreover, *Homo sapiens* has only been on the planet for 160,000 years. Even lasting another million years would be a noteworthy achievement. What are the prospects of doing so?

Energy and Human Destiny :

The ability to use energy extrasomatically (outside the body) enabled humans to use far more energy than any other heterotroph that has ever evolved (Price, 1995). This ability has enabled humans to modify their environment to suit their needs. However, Heinberg (2005) depicts graphically (in his figure 1 [p.31]) a very steep decline in world oil production in the first half of the 21st century. His figure 2 depicts a decline in world population – from 7 billion to under 4 billion – in a less steep

curve that is due to assumed impacts from oil depletion. Price (1995) states

The human species may be seen as having evolved in the service of entropy, and it cannot be expected to outlast the dense accumulations of energy that have helped define its niche. Human beings like to believe they are in control of their destiny, but, when history of life on Earth is seen in perspective, the evolution of *Homo sapiens* is merely a transient episode that acts to redress the planet's energy balance.

Some economists (*e.g.*, Simon, 1981) believe that resources are not limiting and, when depleted, can be replaced. However, cheap, abundant energy will most certainly not be available to replace petroleum. Most people in the United States, and in many other countries, assume the status quo will be maintained with other sources of energy, so they need not be more energy efficient. However, except for wind and solar power, all other sources have major problems.

1. The nuclear energy option produces no carbon dioxide, but nuclear wastes present serious, unresolved, long-term storage problems. In addition, cooling water supplies are sometimes too warm. For example, Spain's oldest nuclear power plant had to be shut down after river water became too hot to cool the reactor (Mudeva, 2006), and a similar situation occurred in France (Boselli, 2006). Worse yet, the planet's water resources face mounting pressures from other demands (Mygatt, 2006). Finally, weapon's grade nuclear fuel is a potential magnet for terrorists (Jahn, 2006).

2. If the huge reserves of coal are used, the burning will produce environmental contaminants ranging from mercury to carbon dioxide. For example, officials from the Otter Tail Power Company informed Minnesota regulators that the price of building the coal-burning Big Stone II plant could reach US$1.8 billion – up from US$1.2 billion – because of higher costs for labor, steel, pollution control equipment, and other factors (Meersman, 2006). Both nuclear and coal-fired power plants have resulted in some yet to be cleaned up serious environmental degradation; ecological restoration of this degradation should be completed before any building of more plants for either source of energy. The cheapest coal is near the surface. Damage on the surface is readily visible and can be corrected, but this restoration is not always achieved.

3. Biofuels is merely a modern term for converting an old fuel source – plant material – to a substitute for petroleum. Corn is a frequently discussed source that appeals to politicians, citizens, and farmers; however, since world grain stocks have fallen to 57 days of consumption while grain prices are starting to rise (Brown, 2006a), a clash is inevitable between providing food and fueling cars. The very wealthy will be able to afford both. The middle class, if it survives, will have a difficult choice, at least in automobile cultures. The free market system may not permit the extremely poor to either eat or drive. Will humankind's addiction to high energy consumption really lead to this unethical dilemma (Brown, 2006b)? Sugarcane appears to be a promising alternative from

the evidence from Brazil's 30-year effort, but its production will require arable land, which is in short supply. The world demand for oil is expected to increase by 37% by 2030 (BBC News, 2006). The demand will hit 118 million barrels per day (bpd) from the present demand of 86 million bpd. The US-based Energy Information Administration, the statistics arm of the US Department of Energy, estimates that the United States will be the world's largest consumer at 27.6 million bpd, up from 20.8 million bpd in 2006. However, A. B. Lovins (as quoted by Mufsen, 2006) has remarked: "Our energy future is choice, not fate. Oil dependence is a problem we need no longer have – and it's cheaper not to. US oil dependence can be eliminated by proven and attractive technologies that create wealth, enhance choice, and strengthen common security."

4. Oil shale (really a solid, organic material called kerogen) is often touted as a major future source of energy. For example, Athabasca tar sands in northern Alberta, Canada, are estimated to contain 870 billion to 1.3 trillion barrels of oil (after processing) – an amount equal to or greater than all conventional oil extracted to date (Heinberg, 2005, p. 127). However, Youngquist (1997, p. 222) dashes the cold water of reality on this utopian vision: "Adding up the water supply problem, enormous scale of the mining which would be needed, the low, at best, net energy return, and the huge waste disposal problem, it is evident that oil shale is unlikely to yield any very significant amount of oil, as compared with the huge amounts of conventional oil now being used." Nevertheless, the processing is taking place and is dramatically altering the environment (Brooymans, 2006). This development is merely a sample of what is to come; however, the water in the Athabasca River is not as clear as it used to be, the air occasionally reeks of chemicals, and the remaining trap lines of the McKay First Nation Indian tribe are dwindling in productivity.

Again, Youngquist (1997, p. 222) sums up the situation with refreshing candor :

It is doubtful that shale oil can ever play a significant role in replacing world oil supplies, if it can replace them at all. Shale oil cannot possibly make the United States energy self-sufficient in terms of liquid fuel. The extravagant statements which have been made to suggest that shale oil can make the U.S. oil independent are usually made by promoters who seize upon the fact that there are perhaps a half trillion barrels of an oil-like substance which could be distilled from the kerogen in oil shale. But some of these beds are only a few feet thick and hundreds of feet deep. The financial economics and the energy economics are simply not viable.

5. Wind and solar power are working quite well and are sustainable sources of energy. However, as usual, when something seems too good to be true, it usually is. Wind and solar power are unlikely to provide the levels of energy use that human society now obtains from petroleum. They are, however, immediately suitable for present transportation and agribusiness needs. More important, the process of hydrogen production always uses more energy than

it provides (Heinberg, 2005, p. 161). Hydrogen is a suitable energy carrier under certain circumstances, but is not an energy source. However, since both wind and solar power are intermittent sources, storage and carrier infrastructures are necessary. In North America, available solar energy influx is 200 watts per square meter (22 watts per square foot). The typical, present, US, suburban house continually consumes the equivalent of 25 horsepower (a unit of rate of work of an engine – 550 foot-pounds per second) of energy. Estimates are that 15 quads (quadrillion BTU [British Thermal Units – the quantity of energy necessary to raise 1 pound of water 1°Fahrenheit]) of energy could be produced in the United States per year. Total energy usage in the United States is approximately 100 quads (www.nrel.gov/wind/potential.html). Clearly, solar power is a very useful part of an energy mix, but not a replacement for petroleum. The same can be stated for wind power – to produce 19 quads of wind power in the United States by 2030 would require the installation of approximately half a million state-of-the-art turbines, or about 20,000 per year staring in 2005.

Energy Summary :

The era of cheap, abundant, easily available energy is ending. Humankind has two choices: (1) live as if the era will never end and let posterity cope with the consequences of the inaction or (2) adjust to two harsh realities – the era of cheap, abundant energy is over and all alternatives will be expensive monetarily and/or environmentally. Humankind has benefited, at least in industrialized countries, from the enormous amounts of energy available to it. However, even in this utopian period, the ecological overshoot has been 25% (World Wildlife Fund, 2006), with serious, possibly now uncontrollable, global warming. A global economic collapse (*e.g.*, Leeb and Strathy, 2006) would probably significantly reduce resource consumption, but this occurrence is clearly an inadequate substitute for an effective resource use and allocation policy. A major drawback in depending on economic collapse is that resource allocation to the poor would be neither equitable nor fair. However, in the United States, 11 states; Washington, DC; and several conservation groups (the Union of Concerned Scientists and the US Public Interest Research Group) petitioned the US Environmental Protection Agency to regulate carbon dioxide and other greenhouse gas emissions, but were rejected because the law does not allow such regulation (Henety, 2006). Utah and seven other US states back this decision, which is comparatively straightforward compared to global resource allocation, so the chances of a global consensus on resource allocation seem unlikely. Moreover, the human population is still placing even more pressure on finite resources. Since the ecological overshoot is possible only by expending natural capital, the carrying capacity of Earth for humans is being diminished. All these situations are bad for posterity, so a heightened sense of responsibility for future generations of humans and those of other life forms is mandatory.

The message is simple – China cannot continue to increase its oil imports by 30% annually nor can the United States continue to expect a disproportionate

share of the planet's petroleum resources. Heinberg (2005, p. 266) expects the global all-time peak in oil production to occur early in the window 2006-2016. Lack of significant planning for this defining moment in human history places humankind at great risk. Anarchy and intensification of resource wars is a worst-case scenario if present practices continue. Arguably, the worst of these situations is the global obsession for exponential growth on a finite planet. A close second is the belief that another source of cheap energy can be found. The cult belief that technology will save humankind from hard choices only mires it deeper in denial. In World War II, British Prime Minister Winston Churchill stated to the public that he had nothing to offer but "blood, sweat, and tears," and the people rose to the occasion. Humankind needs inspired leadership to inform the public of the truth about the changes needed to leave a habitable planet for its descendants. The citizens of the world will probably rise to the occasion, unless they see the political and corporate elite avoiding sacrifices.

Global Environmental Catastrophes :

Environmental catastrophes vary markedly from regional to global, although all impair the biospheric life support system. For example, Israeli military jets attacked oil storage tanks at the Jiyyeh power plant south of Beirut, Lebanon, on July 13 and 15, 2006. An estimated 10,000 to 30,000 tons of oil spilled into the nearby Mediterranean Sea (Noeihed, 2006). The damage to marine life appears severe, but precise details will only be available after a rigorous scientific investigation. However, with an oil spill of this magnitude, recovery time will be slow and will probably not restore the predisturbance conditions. This catastrophe was avoidable, which makes it even more regrettable. All too often, catastrophes are the result of human misjudgment and/or error.

The Mirage of Sustainable Development :

The United Nations World Commission on Environment and Development (1987) raised the hopes of the world by defining *sustainable development* as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." Corporations and economists in that era spoke of economic growth, which, in their view, was synonymous with development. Consequently, what the world has actually witnessed is increased ecological damage, overuse of world resources, and an exponentially growing human population. In 2006, many scientists believe that some major ecological tipping points (*e.g.*, global warming, marine fisheries) have been passed. Worse yet, the easy availability of cheap petroleum is ending, and the alternative sources of energy (*e.g.*, coal) are more likely to worsen global warming. Basically, no species, including *Homo sapiens*, can destroy its habitat and flourish. Extreme destruction is inviting extinctions. Humans began as a small-group species that was spread thinly over the planet. They were simply not capable of damaging the environment as much as an industrial civilization. At present, for the first time, most humans reside in cities in massive groups with minimal interactions with either natural systems or

each other. Biological evolution has not prepared humans for their present situations, but social evolution might.

Voluntary Transformation to Sustainability ?

The (Un)Happy Planet Index (NEF, 2006) provides an index of human well being and environmental impact.

1. Long, happy lives can be achieved with a much smaller environmental impact. Life satisfaction is almost identical to life expectancy in Germany and the United States, but Germany's ecological footprint (use of resources) is only about half that of the United States.

2. Countries with the same ecological footprint can produce lives of greatly differing length and well being. For example, Japanese can expect to live 17 years longer than Russians. In addition, the average Japanese reports a level of life satisfaction nearly 50% higher than the average Russian.

3. As a species, humans are overburdening Earth's currently available biocapacity by about 25%. Clearly, this percentage is not sustainable.

4. Despite wide variation across the western world, areas are performing poorly overall. Malta tops the pile at 40th place, while the United States brings up the rear at 150th place (out of 178).

5. First place in the Happy Planet Index (HPI) goes to the Republic of Vanuatu, an archipelago of 80 islands with a population of approximately one-quarter million people. The life satisfaction is 7.4, life expectancy 68.6 years, ecological footprint 1.1, and HPI 68.2. Over 100 languages are used in Vanuatu – an amazing cultural diversity. Obviously, high levels of resource consumption do not reliably produce high levels of well being. In addition, high levels of well being can be produced without excessive resource consumption. So why should some humans have so much stuff? Humankind's resource consumption is wrecking the planet and does not bring the life satisfaction that the advertisements proclaim. The present system of resource consumption in excess of the planet's biocapacity is not working! Why not try a life style that results in satisfaction?

These illustrative items from the NEF (2006) report indicate that greed is the only justification for consuming the vast amounts of resources that many individuals and nations do. In fact, evidence is persuasive of the danger of continuing unsustainable practices, especially if the human population continues to grow and the resource base of a finite planet does not.

Lean (2006a) notes that food supplies are shrinking alarmingly around the world. He further remarks that this year's harvest will fail to produce enough to feed everyone on Earth, for the sixth time in the past seven years. Global warming and other types of climate change (*e.g.*, droughts) will reduce the production of foodstuffs in the future. At a time when obesity is a major problem in the United States, approximately 800,000 people worldwide are constantly hungry. Perry (2006) notes an estimated 1.5 billion overweight people worldwide – far more than the number of undernourished people. This situation is a major ethical/ moral/religious problem. Lester Brown, head of the Earth Policy Institute, has

stated (as quoted by Lean, 2006a) that, between 1950 and 1990, grain yields more than doubled, but now the growth rate is modest or absent. Brown expects the food crisis to become much worse as more and more land becomes exhausted, soil erodes, water becomes scarcer, and global warming and other types of climate change cut harvests. Worse yet, proposals have been made to turn corn and other foodstuffs into alcohol (McCarthy, 2006) to fuel automobiles in the United States and elsewhere, when grain is in short supply and people are hungry. Is addiction to an automobile culture more important than compassion for hungry people?

The unwillingness to adopt sustainable life styles cannot be blamed on ignorance about the problems just mentioned when they are on the Internet and in the news media daily. Lipsher (2006) describes the situation in the community of Aspen, Colorado, where hummers (gas guzzling vehicles), 15,000 square foot second homes, and private jet airplanes are just a few of the ubiquitous signs of conspicuous consumption. This community is well educated, and some residents believe Aspen must rein in its greenhouse gases aggressively since they are about twice the US average of greenhouse gases per capita (and the United States is not a shining example globally). Global warming will affect important aspects of Aspen's local life, such as the length of the ski season. Mayors of nearly 300 US cities, including the Colorado cities of Aspen, Basalt, Boulder, Denver, Frisco, Gunnison, and Telluride, have signed a climate-protection agreement *promising* (italics mine) to cut greenhouse gas emissions dramatically in the next six years. Will this promise be met? McDowell (2000) thinks not: "Not too far in the future, people will look back on the fossil-fuel age as primitive. Here we are, burning up the reserves of fossil fuels built up on our Earth over millions of years to heat our houses in winter, and cool our houses in summer – converting solid and liquid fossil fuels into gases. This conversion from solids and liquids to gases is occurring on a geologic time frame that correlates to an explosion or at least a raging fire." In addition, McDowell (2000) remarks: "We have become very comfortable with our fossil fuels. Change is an unknown. But change is inevitable." However, even if change is inevitable, it is still being fiercely resisted, and catastrophes may be essential to the acceptance of change. Catastrophes involve suffering, which is a high price to pay for resisting inevitable change. One hopes for voluntary, rational change, but the prospects do not seem hopeful at present.

The End of Eden :

Powell (2006) reports on an interview with James Lovelock in which Lovelock stated: "Our global furnace is out of control." Lovelock's (2006) *The Revenge of Gaia: Earth's Climate Crisis and the Fate of Humanity* details how humans will suffer for abusing natural systems. A vicious cycle of positive feedback loops is making situations worse much faster than most scientists expected. Lovelock's *bottom line* is "There's no realization how quickly and irreversibly the planet is changing . . . Maybe 200 million people will migrate close to the Arctic and survive this" (as quoted in

Powell, 2006). Naturally, some scientists disagree with Lovelock's views. However, what if he is right? After all, the Gaia hypothesis was not welcomed with open arms nearly four decades ago, but now his theory has transformed the way scientists understand how Earth works.

China, India, and the United States :

All nations have a significant role to play in avoiding a global warming catastrophe. However, what happens in China, India, and the United States in the next decade will have a major influence on the outcome. China is the second most important emitter of greenhouse gases in the world – the United States is first (Jiahua, 2006). As a developing nation, China is not bound to limit its emissions under the Kyoto Protocol. However, China is adopting measures to diversify its sources of energy and to increase energy efficiency, which could slow the steep rise of its emissions. Still, Baumert and Peshing (2004) believe that China will be the #1 emitter in 20 years. Chinese authorities are well aware of the negative effects of drought and other types of climate change on their country and will undoubtedly make significant efforts to reduce them. One can only hope they will succeed. The United States is contributing US$1 billion to China's efforts to cut greenhouse gas emissions (Hebden, 2006).

India will not halt development to avoid greenhouse gas emissions, but is taking steps to adapt to climate change (Padma, 2006). This approach is understandable since about a third of the population of India lives below poverty level, earning less than US$1 per day. Nevertheless, Earth cannot tolerate any more greenhouse gases from any source, whatever the justification. Humankind is not adapting well to the climate changes already occurring. Nothing indicates that adaptation will be successful when the rate of change accelerates and conditions become far worse. Bhandari (2006) describes India's approach to climate change as pragmatic, citing the United Nations Framework Convention on Climate Change, which emphasizes that "economic and social development are the first and overriding priorities of the developing country parties." However, these priorities will not be achieved if Earth becomes less habitable (or even uninhabitable) for humans. Ramalho (2006) correctly notes that climate change debates need an ethical dimension. However, social inequality is used as an example. What about eco-ethics and the even greater inequality between humans and the 30+ million other life forms on the planet?

The United States should be the world leader in reducing greenhouse gases. Instead, it is a major obstacle to global attempts to reduce greenhouse gases. Texas, the US state that leads in the production of greenhouse gases, may add 16 coal-fired power plants in the future (Loftis, 2006). Texas is also an astonishing seventh worldwide – emitting more greenhouse gases than Canada and the United Kingdom. The approval of the 16 new power plants would add an estimated 1,117 million tons of carbon dioxide a year, more than the emissions of 33 other US states and 177 countries (Loftis, 2006). Ironically, of all the emissions from coal-burning power

plants, only carbon dioxide is not subject to any limits or controls, although this issue is being examined by the US Supreme Court. The US state of California, the world's twelfth worst offender among the world's greenhouse gas producers, has developed a widely acclaimed program to reduce greenhouse gas emissions (Editorial, 2006a). However, that enlightened act has not gone unnoticed. A week after reacting angrily to California's passage of landmark anti-global warming legislation, US Senator James Inhofe (Republican, Oklahoma) produced a bill to more than double fines on polluters that do not meet cleanup deadlines for soot and smog (Werner, 2006). The only two areas in the country to which this accusation of not meeting cleanup deadlines for soot and smog would apply are both in California. Democrats and environmental activists accused Inhofe, who chairs the Congressional Environment and Public Works Committee, of retaliating against California. Inhofe has stated that manmade global warming could be "The greatest hoax ever perpetrated on the American people." He called the bill that the California Legislature passed to reduce greenhouse gases a "feel-good legislation to appease liberal special interest groups" (Werner, 2006). *The Christian Science Monitor* (Editorial, 2006b) deplores the failure to produce an honest accounting of what should be paid in the battle against global warming. Regrettably, the editorial failed to emphasize the appalling costs ($20 trillion) of doing nothing to combat global warming (ENS, 2006). Another factor is the climate changes that either may not have been anticipated and/or for which coping preparations have not been made (Cowen, 2006).

Accepting Transient Status :

Humankind neither accepts transient status nor is making any effective behavioral changes to increase the probability of remaining on the planet as long as other species (*e.g.*, some ostracods) that have lasted millions of years and have no brain and are presumably less intelligent. One item is abundantly clear – cognitive dissonance is rampant globally. India has given reducing poverty a higher priority than stopping global warming. China has impressive economic growth and appalling environmental problems (*e.g.*, water [Bezlova, 2006]). The United States is consuming resources, particularly petroleum, as if it were the only nation on the planet. Britain will not meet its cherished target of reducing carbon dioxide emissions by 20% from 1990 levels by the year 2010 (Black, 2006). In the US state of California, which has been lauded for exemplary, proposed greenhouse gas emission controls, the South Coast Air Quality Management District trustees voted 8-1 to adopt amendments that would make more widely available air pollution credits that are normally used by essential public services such as hospitals (Tanglao, 2006). A deliberate Israeli air strike on an oil storage tank not only released 4 million gallons of oil into the sea, but also released a highly poisonous cloud that spread over a third of Lebanon – an area that is home to half Lebanon's people (Lean, 2006b). These few illustrative examples of cognitive dissonance indicate

serious deleterious consequences for humankind.

James Lovelock believes that a few hundred million people can retreat to the Arctic, while Stephen Hawking considers a voyage to another planet – location not specified. Many people believe, or have convinced themselves, that the present, favorable circumstances will last forever. Jensen (2006) posits an initial premise (volume 1, p. ix) that "civilization is not and can never be sustainable. This is especially true for industrial civilizations." However, in a subsequent premise, (p. x), he states: "The longer we wait for civilization to crash – or the longer we wait before we ourselves bring it down – the messier the crash will be, and the worse things will be for those humans and nonhumans who live during it, and for those who come after." Are these beliefs in survival of remnants of humankind a form of denial that humankind is, after all, not significantly different from all other species that became extinct? Or are they an affirmation that humans can achieve sustainable use of the planet as a small-group species? Since the cheap, readily available energy that made the present system of civilization possible will soon diminish (*e.g.*, petroleum), be difficult to process (*e.g.*, tar sands), or produce greenhouse gas at higher rates than petroleum or natural gas (*e.g.*, coal), humans will have much less energy available per capita than was available for over a century. The recent past has been an aberrant era in human history, so a return to lower per capita energy consumption should not be, as people addicted to cheap energy believe, an event to be feared.

Exponential Growth :

A situation to be feared is the lack of understanding of exponential growth and doubling time. Bartlett (in press) has a superb case history to illustrate this point, as well as a well reasoned analysis of the situation. Basically, the problem is "surprise" at the depletion rate of non-renewable resources because exponential growth and doubling time are not factored into energy policy or even the taboo topic of human population growth. Fables and folk tales illustrating the consequences of exponential growth go back as far as ancient Egypt, and probably much further. On a finite planet, exponential growth can be fatal if it continues.

The Future of *Homo sapiens* :

The average life span of a species on Earth is a few million years (Palme, 2006). However, the current unprecedented rate and degree of change (*e.g.*, global heating [I am following James Lovelock's lead in using *global heating* as a substitute term for *global warming*. *Global warming* suggests a cozy environment rather than the major environmental threat of global heating.]) may substantially reduce that time. Ironically, much of the change is due to human activities. As Palme (2006) notes, humans have so thoroughly modified their environment (*e.g.*, greenhouse gases, cities) that the risk becomes an environment modified to the point that humans cannot survive in it anymore. As Mayr (2001, p. 136) notes, new species occur mostly in limited populations. The exponential growth of the human population has made isolation far less likely. One or more global catastrophes

(*e.g.*, Diamond, 2005) could leave a number of small, remnant populations. However, theoretically, humans could evolve via genetic manipulation. If this happening were to occur, would the new species co-exist with *Homo sapiens*, as Neanderthals now appear to have done (Hooper, 2006), or would the new species drive humankind to extinction? Would either outcome affect the rest of life on Earth?

Illustrative Future Scenarios :

One could easily develop a large number of scenarios since global heating and the end of cheap energy will have different regional effects. Coal is cheap but more environmentally damaging than petroleum. By 2007, more than half of humankind will live in cities (Brown, 2006c). However, cities require delivery of food, water, energy, and other materials that must come from outside the city, requiring much energy for both delivery and disposal of garbage and other wastes. Urbanization will unlikely continue. In any case, urban dwellers are not likely to forage with success for their own requirements. Only a slight disruption in the transportation system or other components of the infrastructure of cities might result in serious difficulties. Virginia Abernethy (personal communication) provided some information from the Association for the Study of Peak Oil that reported on the billion barrel oil find, which is mostly gas, in the Gulf of Mexico. One billion barrels of oil (or its equivalent) would keep the world running for approximately 11 days – the United States uses about 84 million barrels per day.

The energy input/output ratios (*e.g.*, for converting corn to ethanol) do not appear promising, and the limited world grain supply means that humans may be forced to choose between eating and driving – the wealthy will have no problem, but the poor will.

Finally, these environmental changes make predictions about the distribution of species extremely difficult (Araújo and Rahbek, 2006). Individuals who might be able to live off the land under present circumstances might well find it difficult or impossible in the near future (*e.g.*, Bremer, 2006*)*. Since the amount of ice being formed in the Arctic winter has declined sharply in the past two years, the confidence has significantly increased that greenhouse gases from automobiles and industry are warming the Arctic and the planet (Kaufman, 2006). Some illustrative future scenarios follow.

A. Soft Landing Scenario :

This scenario is based on the following assumptions.

1. A global sharp reduction in greenhouse gases will be achieved in or before 2012.

2. The 25% ecological overshoot will be eliminated in or before 2012.

3. Population stabilization is not only important but mandatory.

4. Acidification of the world's oceans will be reversed. Since the greenhouse gas carbon dioxide is driving acidification, reducing emissions will reduce both global heating and oceanic acidification.

5. Resource wars will be eliminated.

6. An effective system of governance will remain at all levels (local, regional,

and national) throughout the world. Furthermore, survival and well being of humankind and the biospheric life support system must be the primary goal of all components. Some improvement may occur if dynamic leaders who are not beholden to special interest groups emerge and gain the public trust. To survive as a species, humans must function as a community rather than as over 6 billion individuals.

7. Scientists worldwide are committed to sustainable use of the planet and are willing to commit substantial portions of their time to achieve this goal. World leaders must not hamper or persecute scientists when they generate evidence that conflicts with political ideology.

8. Religions will cease being divisive and will teach and practice religious tolerance.

As Howden and colleagues (2006) note, Earth is changing as humanity watches, and, as Milmo (2006) states, humankind must act at once or humans will almost certainly suffer appalling consequences.

Even this "soft landing" will be a severe trial for human society and the other life forms with which it shares the planet. California made a decision to impose stringent demands on suppliers, even outside its borders, in an effort to remake its energy future. However, if a "soft landing" is still possible, society is most indebted to James Hansen and a few other scientists who have remained committed to the science of global heating for three decades (Gumbel, 2006). Incredibly, Hansen's first testimony before the US Congress in 1988 drew considerable ire because he stated that he was only "99 percent certain" of some of his claims. Of course, this percentage fell short of the absolute certainty some politicians have demanded of science, despite the fact that absolute certainty is not possible and certainly not characteristic of most human endeavors (*e.g.*, politics).

The "soft landing" does not appear to be very soft. Furthermore, unless the glacially slow response to global threats speeds up, humankind is not likely to "enjoy" a "soft landing." A serious disruption of the food supply will result in fatalities that could be in the hundreds of millions.

B. Hard Landing Scenario :

This scenario is based on the following assumptions.

1. Much talk, even opposition, will be offered to the remedial measures to reduce global heating and other threats to Earth's ecological integrity.

2. Both developed (*e.g.*, United States and Australia) and developing countries (*e.g.*, India and China) will resist implementing the Kyoto Protocol or other remedial measures to any significant degree.

3. Positive feedback loops that have accelerated an already worsening global heating process will continue.

4. At least some important world leaders will continue to impede global heating research and block research scientists whose evidence contradicts important political ideology.

5. Resource wars will proliferate as resources become scarce (*e.g.*, Philpott, 2006). Amicable sharing of resources will disappear, and the wealthy and powerful will temporarily acquire an even more disproportionate share than they now do. The "powerless" poor will strike back by disrupting the infrastructure that delivers resources to the powerful elite.

6. The political infrastructure of many nation states will continue to be in disarray, but will still retain some effectiveness.

7. Religions will continue to be divisive and may well become even more so as resource wars intensify.

8. Global exchange of scientific information will be hampered when it conflicts with political and/or corporate ideology and religious and political differences dominate human relationships.

The damage to Earth's ability to regenerate resources, plus the loss of cheap energy upon which society has become addicted, could cause loss of human life in the billions. Disruption of societal infrastructure by loss of cheap energy and by individuals who resent the inequity of resource distribution would have a severe impact. Hurricane Katrina showed how unprepared nations and world leaders often are, even when warnings from reliable sources had been coming for years for a horrible, but still less catastrophic, event.

C. Multiple Catastrophe Scenario :

This scenario is based on the following assumptions.

1. Global heating will disrupt both food production and water supply. Wildfires will increase in both intensity and frequency.

2. Governance will break down and anarchy will increase dramatically, making remedial measures on global heating and other factors producing catastrophes impossible.

3. Scientific research on global problems will effectively cease to exist.

4. The biota will change so rapidly, especially increases of invasive species, that even individuals skilled in foraging for food will have difficulty adapting.

5. Mortality and disease increases will have badly overloaded health care facilities, especially with huge numbers of environmental refugees.

6. Hurricanes, typhoons, droughts, desertification, flooding, and food shortages will increase the number of environmental refugees to many millions. Huge numbers of refugees commonly bring health and disease problems with them, further overloading hospitals and medical facilities.

7. At best, the educational system will suffer at a time when educated individuals are badly needed. The commitment of the United States to higher education is already markedly diminished, even in the absence of major catastrophes (Editorial, 2006c).

8. Major climate change will cause deep economic recession (Randerson, 2006).

9. The US legal system will become involved in scientific evaluations for which it is inadequately prepared (Gunther, 2006). This situation may delay

policy decisions globally if the US experience becomes common.

Discussion :

The basic problems are (1) too many people, (2) too few resources, and (3) a rapidly changing climate that will almost certainly reduce the quantity and quality of resource availability. The end of cheap, readily available energy will cause problems in both production and distribution. The obvious response is strict rationing of all resources. However, this approach means denying individuals the right to their own decisions without being primarily influenced by external directives. This consequence is a marked departure from the processes of nature that permit all sorts of individual decisions, but exact severe penalties when these are wrong.

At the international level, China's dustbowl and expanding deserts are producing mustard-colored dust that has begun reaching South Korea, Japan, and the west coast of North America. Not only are more than 200 million Chinese suffering from the health and economic impacts of desertification (Pocha, 2006), but breathing and skin disorders caused by the dust are on the rise and crop yields are falling. Nations are no longer isolated from each other. At all levels of human society, from individual to global, human priorities (*e.g.*, economic growth) are given precedence over preserving the health and integrity of the biospheric life support system. However, the laws of nature operate without regard to the perceived "needs" of any species. Presumably, other species do not contemplate the future, although it would be blatant anthropocentrism to assume humans are the only species with this ability. *Homo sapiens* has religions to deflect the fear and anxiety generated by the prospect of death. Humans also have denial. In fact, for years a network of fake citizens groups and bogus scientific bodies has been claiming that the science of global warming is inconclusive (Monbiot, 2006). Action on climate change has been set back at least a decade as a consequence. For the corporations that funded these efforts, the money spent has been worthwhile because their profits were not endangered. The denial industry uses a consistent approach on climate change: the science is contradictory; the scientists are split; environmentalists are charlatans, liars, or lunatics; and, if governments took action to prevent global warming, they would be endangering the global economy for no good reason (Monbiot, 2006). The findings these organizations dislike are labeled "junk science." The findings they welcome are labeled "sound science." In the United States, the denial industry has had a profound effect because it employs many lobbyists and makes substantial contributions to those running for political office.

Hunters and gatherers had to know their environment intimately. If they did not, they died. At present, human environments contain a major denial industry devoted to denigrating science and scientists. The fears of the people in power, both politicians and corporate executives, are disclosed by what they try to suppress. When intense efforts are set forth to denigrate science, scientists, and knowledge, those in power should be

greatly feared. This situation is most evident in the insistence on certainty when the scientific evidence disagrees with either political or corporate ideology. If the knowledge cannot be suppressed, then an attempt is made to control it by controlling educational materials and the media. In short, any thinking critical of a specific ideology must be outlawed and replaced by dogma. However, the Internet has foiled, to some degree, attempts to legislate out of existence any ideas contrary to present ideology (*e.g.*, economic growth is desirable under all circumstances). Human survival requires that these ideological traps be avoided.

Humans cannot judge other species from observations of pets and other domesticated animals. However, they have no difficulty accepting that all other species are transient or even that humans have hastened their extinction by replacing their habitat with shopping malls and other human artifacts. For example, polar bear habitat (ice) is being diminished by global heating. Their food (*e.g.*, seals) contains sizable concentrations of mercury and persistent pesticides. As a species, humankind is doing practically nothing to enable polar bears to continue to inhabit the planet. The same is true of countless other species.

Sustainable use of the planet is a strategy to extend human occupancy indefinitely or, more realistically, for millions of additional years – a record already achieved by other species. However, humankind is doing practically nothing to achieve this goal. Species succession is well established in the scientific literature. Where is the evidence that *Homo sapiens* is exempt from this process? Individuals may regret the loss of music, poetry, literature, and art; however, the majority of humans appear to be primarily focused on the acquisition of material goods. Humans are willing to drive other species to extinction to achieve this goal. However, this behavior is damaging the biospheric life support system that is so essential to the future of the human species itself. Short-term gratification has precedence over long-term survival of the species. Does intelligence, as humans define it, have any long-term survival value? Finding evidence to justify a positive response to this question is difficult.

Why should humans assume they are not a transient species? A related question is "Is there anything wrong with being a transient species?" As individuals, humans are short-term actors on the ecological stage of the evolutionary theater. Should they not accept the same limited role for their species? If the answer is yes, how should this affect humankind's relationship with other species that are on the ecological stage at the same time? Is the length of time the human species spends on the ecological stage so important that it is willing to drive other species to extinction and/or take over their habitat to satisfy humankind's perceived "needs"? Even if humans are not disturbed by this question, how can humankind justify not living sustainably so as to leave a habitable planet for posterity and the 30+ million other life forms with which it shares the planet? Not much time is left to adjust to the status of a benevolent transitory species.

As already indicated, a number of positive feedback loops speed up the process of global heating by 3 to 5 times the initially predicated rates. One of these is methane, a greenhouse gas 23 times more powerful than carbon dioxide, which is being released from permafrost as it thaws (Borenstein, 2006). Thawed permafrost also releases carbon dioxide. Ted Schuur, a professor of ecosystem ecology at the University of Florida, states: "It's kind of like a slow- motion time bomb" (as quoted in Borenstein, 2006). Although methane is far more powerful than carbon dioxide, it only lasts a decade before it transforms into carbon dioxide and other chemical compounds. However, carbon dioxide remains in the atmosphere for about a century. Methane release from permafrost and the oceans constitutes a positive feedback loop so it would be well to consider a "worst case" scenario or "hard landing." For example, Jha (2006) notes that a 3°C increase in temperature would bring fires, floods, and famine.

The individual human lifespan is finite, so humans should have no fear of being a member of a transient species, unless the consequences of global heating cause premature death. However, if humans have failed to take adequate precautionary measures, they have created the situation they fear. A more significant concern is that humankind has imperiled the future of its descendants. Adequate precautionary measures (*e.g.*, living sustainably) would have protected them. Humankind's unsustainable practices are a threat to music, poetry, literature, art, etc. and the creative activities of posterity. However, again, humankind has failed to take precautionary measures to enhance the probability of survival of these and other creative activities.

Humankind should not reject transient status if it is living unsustainably on a finite planet with finite resources, which are being used in excess because of exponential growth of population and consumption. However, even a transient species has ethical and moral responsibilities to both posterity and the other species with which it shares the planet. Humankind inherited a planet rich in natural resources and has depleted the old growth forests, lost much top soil, and displaced numerous other life forms from their native habitats. In addition, humans have released chemical substances harmful to both themselves and other species. The world's oceans have been acidified by carbon dioxide. A galactic landlord would be insane to rent a planet to humans. However, before humankind exits stage left, it can make efforts to clean up the mess it has made. Even if other life forms might not comprehend the effort, humans will know.

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