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Population and Consumption: Environmental Problems as Problems of Scale

Bryan G. Norton

Almost every time I teach environmental topics to undergraduate students, at least one student confidently states the opinion that environmental problems are most basically caused by human population growth, and that if we could control population growth, that would be the end of the problems. Although I try never to show how appalled I am by ignorance among students—especially when they are volunteering opinions in a process of thinking through problems—I admit that in these cases I must consciously restrain myself from rebuking the student aloud. What is more appalling is that I fear that this belief is shared by many adults in the United States and perhaps throughout the developed world. This woefully oversimplified formula for understanding environmental problems is not just oversimplified, it is also morally dangerous. When used in conjunction with the apparent fact that industrially developed nations are bringing their population growth under control, the reduction of environmental problems to population problems brings about a not-so-subtle shift of responsibility for existing and emerging environmental problems to the less-developed world. In class, I try to shake the students' complacency about their own role, pointing out to them that, if the blame for environmental damage can be located in the act of parenting, they should realize that each American child born (given current consumption patterns) has 40 to 50 times the environmental impact of a child born in poorer nations. Huge proportions of that consumption are made possible by material flows from less-developed nations of the South into the industrialized North. Even when these material flows bring rapid economic growth, as in Indonesia, for example, the environmental and cultural costs are enormous, and it is often the case that only elites benefit from this growth.

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My point here is not to deny that overpopulation is among the factors that affect environmental problems; indeed it is one important and often-neglected factor. Aside from noting the highly differential impact of individual consumption patterns around the world, my main point is that the equation of environmental problems with population is a moral oversimplification because population growth cannot be considered an independent driver of the social changes that result in environmental degradation

In this paper, I adopt as my first task to show that there is a quite real sense in which the developed world has responsibility, indirectly—and in some cases, directly—for the cycles of poverty, population growth, and increased poverty that have gripped those unfortunate countries that have been caught in the midst of the demographic transition. Unable to lower their birth rate to match lower death rates instituted by medical and health advances, these societies seem trapped in a hopeless spiral of population growth and poverty. In Part 1, I discuss the question of intergenerational responsibilities and summarize my answer to anyone who thinks environmental problems are due mainly to population growth in developing nations. In Part 2, I argue that developed nations and societies have an important obligation to help deal with problems of population growth, famine, and deteriorating environments in developing nations. It will turn out, however, that it is much easier to establish a general responsibility to help; and much more difficult to specify exactly what kind of help would be efficacious. So, in Part 3, I will begin to explore the nature of the obligation of wealthy nations to the poor and to the future, arguing that there is an important sense in which environmental and resource use problems are problems of scale and that, given this insight, we can begin to understand these obligations more clearly by interpreting them as cross-scalar obligations to protect *options* and *opportunities* for people today and in the future. Finally, in Part 4, I briefly explore what is implied by an obligation to protect options and opportunities for persons in distant nations and of the future.[1]

1. WHY IT IS APPALLINGLY SIMPLISTIC TO BLAME ENVIRONMENTAL PROBLEMS ON POPULATION GROWTH IN THE DEVELOPING WORLD

In Daniel Quinn's haunting novel, *Ishmael* (1992), which describes a dialogue between an articulate and self-educated gorilla and a "student" who wishes to learn how to save the world, Ishmael asks the student when the agricultural revolution (which they agreed had begun around 8,000 to 10,000 years ago) came to an end. Perplexed, the student is finally maneuvered into admitting that the agricultural revolution continues today. Agriculturally based cultures, which support huge population concentrations in cities through intense—usually monocultural—agriculture, continue to expand their tendrils into more remote areas, destroying hunter-gatherer societies everywhere they come in contact. Using the story of Cain and Abel as a metaphor, Ishmael points out that the process that began with agriculturalists driving

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out and destroying herding and hunter-gatherer societies in the Middle East, still continues today, as even the last indigenous tribes in remote mountains and in densest jungles are either exterminated or inexorably drawn into the profound revolution that establishes hegemony, first of intense agriculture, and later of the world economy, over every last society, and every last culture on the earth.

One of the consequences of the inexorable spread of European culture into the New World has been, it must today be acknowledged, the disruption of an earlier way of life that had developed in relative isolation for 20,000 years (Cronon 1983; Crosby 1986). At least for some areas and for some times, those Native American cultures had persisted for many generations. They had, in some cases, we now know, co-evolved a quite efficient interaction with their environment, an inter-action that supported their populations, relatively small by today's standards,[2] at quite acceptable standards of living. The tribes of New England, for example (Cronon 1983), apparently maintained a diverse, patchy landscape quite intentionally; by the use of fire and other methods, the tribes increased game fields and maintained a productive environment, moving to resources in migratory patterns. As colonization occurred, imposition of a European concept of land ownership disrupted the traditional patterns of migration, patterns that had been worked out over generations among tribal elders. This disruption of migratory patterns, in addition to diseases and outright killings in wars, was one major cause of the population collapse of most tribes. My point here is not to assign blame—for I too am of European descent—but rather to understand a phenomenon; and examine its moral consequences across several generations and across political boundaries. The phenomenon is that, when technologically advanced civilizations encounter localized, isolated tribal systems, the technologically advanced culture destroys the less technologically advanced culture.[3] According to the mythology of the expanding, colonizing nation, they are bringing "civilization" to the "Natives" (Quinn 1992). But in point of fact, the original culture/civilization is displaced by an imported culture, which is at least at first more efficient in capturing resources and putting them to human use; in the process, original cultures of great complexity and antiquity are fragmented and eventually destroyed. Members of these original societies are not really offered a choice; they can be assimilated, or die.

Today we are asking ourselves: How can we live sustainably in the United States, or Canada, or in Central and South America? Anthropology and archaeology now tell us that there have been many examples of successful land tenure and resource access systems that have developed in particular places, allowing tribes to survive for many generations as distinct and place-based cultural entities (Gadgil and Berkes 1991; Anderson 1996). The irony is that the current system—which we fear is not sustainable–has destroyed, and is destroying, these traditional "sustainable" lifestyles at every place where the cultures come in contact. Although I wish to go on record here in favor of the protection of indigenous cultures as an urgent moral issue, my concern in this paper is directed at the areas and countries where the process of replacement of indigenous cultures is largely complete. Such places are easily recognized—the countryside is devoted to intense, usually monocultural, cash-oriented crops for export

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wherever agriculture is possible. If there is forest cover, it is in the process of being wastefully stripped, usually for export; and then comes the monoculture. These areas of intense agricultural development and the industrialization that accompanies it, are also easily recognized because of the ever-faster-growing slums surrounding their ever-growing cities. These are the countries caught in the population-poverty trap, and in these situations it is impossible to go back to anything like the old system. But it could not hurt to know how the traditional systems worked if we want to shift into a sustainable model.

I do not mean to romanticize the life of indigenous peoples. One can find cultures among them that are admirable and reasonably democratic, and ones that are hierarchical and to our eyes, harsh. One can also find many examples of indigenous cultures that have over-exploited their resource base and died out, as in the case of an earlier civilization on the Easter Islands. But the point is that, among these traditional cultures there are some that have successfully lived in relative harmony and stability with their environments for many generations; they have the secret we seek (Anderson 1996; Gadgil and Berkes 1991; Rappaport 1968).

William Cronon's ecological history of the New England landscape seems to me to be a landmark in our understanding of the process by which the "wilderness" of the New World was transformed into a cog in international industry and trade, and in the process "civilized" by the imposition of European law and European customs. What Cronon, and subsequent ecological historians have shown, is that the process of "development" of colonial cultures—in response to world markets and cash economies and the production of exportable, capital-producing goods and services—was simply the other side of an ecological process of homogenization of landscape and the destruction of the habitat of pre-existing tribes that had inhabited the area for thousands of years. In New England, the Native Americans had cultivated a diverse landscape, mainly through the utilitarian use of fire, and then migrated to the resources as necessary, employing negotiated access agreements among clans to avoid undue conflict in resource use. The Europeans brought a tradition of fee simple ownership and imposed it upon the land, plot by plot. Thus, whereas in the earlier system a reed marsh was valued for occasional use for basket-making by many clans at different times, a European settler had an incentive to drain a marsh on his land because he could not use it to produce goods to export in exchange for cash.[4] The tendency of a cash and trade-based economy at long distance from markets is to produce, in response to world demands, a small number of export crops and products. Social institutions shifted from place-based systems to more centralized ones; these institutions, in turn, are expressed on the landscape as homogenization of land use, a tendency toward monoculture, and a reduction of diversity (Curtin 1995).

Again, my point is not to assign blame—it is to understand the phenomenon of "economic development" in all of its ramifications; and my point is that the imposition of a European-style economy, with money, trade, and fee-simple ownership of land and the resources on it, resulted in the destruction of a diverse landscape and the elimination of a system of land use that had evolved gradually over many generations.

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It might, of course, be argued that this replacement is simply an expression of the "survival of the fittest" and, by analogy, it is sometimes argued that it was "necessary" for the less-developed tribal structures to be replaced by more structured systems because the latter are more efficient. But here the central irony re-asserts itself. If it is meant that the imported systems are more efficient and will support more people *in the short run*, then it is hard to dispute the case. If, on the other hand, the question is whether the newly arrived system will be successful in establishing a viable and sustainable culture in that place *in the long run*, then the answer has to be that we simply do not know. The imported system has not been here long enough. All we know is that traditional systems that had evolved over milennia were replaced in the last two or three centuries, by a new and experimental system. The results of the experiment are unknown.[5] We have not been around for long enough to test that crucial hypothesis of cultural longevity, though the evidence is now coming in. This paper is premised on the belief that the evidence coming in is mostly negative.

The phenomenon of cultural replacement can be understood ecologically. The ecologist, Ramon Margalef (1968), who studied planktonic communities, formulated the law that, when two biotic communities, one with a high degree of organizational structure and one less organized, come into contact, energy flows from the less-developed community to the more developed one. For example, if a coral reef is established in a shallow sea that is rich in free-floating plankton, the plankton will become food for the more complex organisms that have evolved in the more structured reef community. It is possible to understand European colonization of the New World by analogy to such an ecological development.[6] Consider an area of the ocean bottom that is suitable habitat for coral; it has the proper depth, climate, and water conditions, but has no coral present. This is a potential site for a coral reef, but we can assume that coral suitable to this site has not yet established itself close enough to colonize the site in question. We know from ecology that the biotic communities that evolve in open ocean are usually limited in structure, and so we would expect our site to be inhabited by mainly planktonic and perhaps a few benthic species, the latter poor because of limited sunlight piercing the water column. Fish species mainly migrate through the site, harvesting the energy produced by the plankton. This is a lightly structured system with relatively few layers in its energy pyramid; add a sunken ship—or a coral reef–and we expect to see increments of diversity and complexity over time, as species colonize and adapt to differing microhabitats created on the formerly uniform ocean bottom. Within these communities, there will evolve more diversity, because the differing niches provide varied strategies for exploiting the basic resource, the free-floating planktonic communities that represent most of the biotic productivity in the system. There will be decreasing niche breadth, and specialized species will replace opportunists as species are "packed" along various resource gradients.

So we can think of European emigration to the new world as broadly analogous to coral species invading and colonizing an area of the shallow ocean floor. The shallow ocean has immense productivity, but there exists no complex system for exploiting that productivity efficiently. The European colonization is therefore ecologically anal-

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ogous to the building of a coral reef—a structure of infrastructure and social organizations that provides varied niches for exploiting the resources of the New World, using more sophisticated and specialized technologies. The existing biotic communities, analogous to the plankton, are consumed in the process of building a huge and complex structure, with variation, for exploiting the "natural" (original) system with increased efficiency. Resources are thereby turned into "capital" on which the growing community depends for further growth and expansion of opportunities. It is well known that coral reefs are very efficient exploiters of their biotic resource; each planktonic unit of energy is cycled and recycled many times. Eventually, a dynamically stable, and increasingly complex, community is formed by the reef.

But now we must consider the ways in which human migrations and colonizations between 1500 and present have been different from building a coral reef. To build a coral reef, complete with its many components, layers, and complex processes, requires millions of years of speciation, natural selection, and adaptation. Again, on the ecological scale, large-scale alterations are usually gradual, spanning the lifetimes of many generations of individuals. The components, and the processes they support, are all adapted to that place over many, many generations. The systems that have survived have survived all sorts of conditions, including rapid change and climatological shifts. So the European colonization of the New World, while of a much larger scale than the development of any coral reef, has been nearly completed in less than 300 years. Changes of this scale seldom occur in nature, minus humans, barring a catastrophe such as a large meteor striking earth. The invading Europeans, in the geophysical scale, therefore arrived on the scene more like a meteor than a coral reef. Because advanced metallurgy and technology made the colonists more efficient in exploiting resources, not just marginally, but by orders of magnitude, the locally developed, tried-and-true wisdom and constraints in use of resources was wiped out along with the inhabitants.

If we cannot let even one of these cultures survive in peace, we should at least race to understand their knowledge of local flora and fauna, because the information and wisdom they have stored about their resources and how to use them represents the details of a system that is sustainable in the place in question. Continuing the coral reef metaphor, this would be trying to cram all the knowledge stored in genetic information in a coral reef into a short-course; it would be saving information about local ecologies as sources of energy and fiber, but it would also be saving the "stories" and the wisdom of the place-based societies of the past. If cultural adaptation is like genetic adaptation, we should not expect short-term strategies of opportunistic species, grabbing resources early in the process of development, to be as successful in the long run.

If creatures of the coral reef sustain themselves for millennia on the existing planktonic communities, it is because they do not completely destroy those communities or extinguish the species of which they are composed. In the human case, traditional patterns of resource use were adapted to their ecological context by trial-and-error (survival of the fittest) learning by tribes *on a local level.* Thus, while it is possible to find many examples of local cultures that over-exploit their resources, if

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trade is limited, these cultures will eventually die out because they have exhausted their resource base. If, therefore, we find a culture which has survived for many, many generations in a particular place, without imports of resources through trade or conquest of neighboring territory, then we have an example of an adapted, sustainable society (see, for example, Rappaport 1968; Anderson 1996).

What is different about the invading, colonizing cultures of capitalism in comparison with traditional culture is that they are not "place-based"; they are in this sense fundamentally different from traditional societies, and from coral reefs. This difference has two aspects: first, the expansion of European culture into the New World was built upon a platform of intense development in the home country, including technologies that were developed in another place and under intense competition among artisans at the local level and by international competition. This platform encouraged investment in exploitational industries, and allowed the exportation to the New World of technologies, from guns to plowshares, technologies that represented a quantum leap in the ability of pre-existing cultures to bring power to bear upon the task of exploiting resources in the new world (Cronon 1991). The coral reef, lacking such a platform and external source of "investment," must be created using the normal flow of energy *available in the place where it evolves.* The imposition of European culture on the New World was in this sense more like dropping a pre-formed ecosystem into a new place, and differs importantly from the in-place evolution of coral reefs and traditional civilizations.

The second fundamental difference, resulting from the first, is that the invading societies are not culturally place-based—their technologies have not been honed against the regimens of the local place where the colonists applied them. They have probably not survived the proverbial 500-year storm. The imported cultures thus run on free-floating technologies; in contrast to the technologies of traditional societies; they are applied without being shaped by generations of incremental learning (Marglin 1990). Whereas the coral reef builds a true community, with every adaptation being tested and integrated in place over many generations, colonial cultures, relying on advanced technologies (and, eventually, a huge, and artificial, input of energy from fossil fuel), leap-frogged the processes that normally test changes that are small and incremental.

Culturally, this led to a society that, unlike indigenous cultures, is place-independent. Among traditional cultures that are territorial and place-based, if one group expands across traditional boundaries, the encroachment is repulsed. If a new colony is successfully established, this represents a shift in boundaries. There was no possibility, for example, that Navajo families, prior to European colonization, experiencing crowding, could migrate hundreds of miles and *become* Sioux. Their arrival would be contested and, if they nevertheless successfully colonized, they would not be assimilated. But in the modern U.S., if someone becomes tired of the crowding on the Eastern Seaboard, they can move to less populated areas such as Idaho, and become Idahoans. This difference created a profound difference in the way European settlers thought about places and in their attitude toward mobility and migration (Relph 1976;

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Sagoff 1992; Quinn 1992). A virtually place-independent culture emerged probably for the first time in history.[7] Local responsibility for resource use was disrupted, and rapidly expanding economies exploited resources wherever they were discovered, leapfrogging from place to place in search of resources and wealth.

Within this growth-at-any-cost system, free trade and world economics are expected to resolve local resource shortages wherever they occur. Through the self-fulfilling policy of subsidizing transportation and energy costs, the colonial system, in its modern, economic version, treats place-centeredness and localism as an annoyance to be remedied by a good dose of internationalization. Human migrations of the Modern, post-industrial age are, therefore, different from past migrations in that newly established cultures apply a generic, place-independent set of assumptions, approaches, sources of demand and, above all, generic technologies that make up for their lack of adaptation to local conditions with the overwhelming force of subsidized energy.

Modern development, which responds to a world economy, means, essentially, the creation of an efficient infrastructure for moving resources great distances toward population centers. The process of industrialism and increased productivity through technological development, however laudable in some respects, is simply a positive reflection of the destruction of cultures of immense integrity and development, some of which developed in response to highly constrained and fragile environments.

Although I recognize the significant moral implications of my analysis, I am so far trying simply to explore a causal chain of events, delaying the moral considerations until Part 2. The central point I want to make is that there is a very precise sense in which I am responsible for the plight of people of nations and cultures caught in the population-poverty spiral: the very same process of "development" of resources that were "under-utilized" was a process by which native populations, with their less intense patterns of exploitation, were destroyed or transformed. Once again, in the New World, Cain slew Abel. Less intense patterns of land use that evolve slowly and over many generations have created cultures that can survive for multiple generations. But when these come in contact with technologically developed cultures, the locally adapted do not survive, or survive only by being assimilated. This process, as Margalef's studies of planktonic communities showed, is just what we should expect. Ecologically developed cultures absorb energy from less-developed ones, just as well-organized ecological communities absorb energy from less-organized ones, once they come in contact.

2. THE MORAL PROBLEM

What are the moral consequences of recognizing that the process that is called "development" by colonializing countries is in fact destruction of an existing lifestyle that has evolved over many generations in a particular location? Functional and well-adapted social and economic systems of traditional societies are destroyed when they come in contact with technologically developed cultures. In this process, many individuals are severely injured, materially and spiritually (Fried 1963; Relph 1976). Many do not survive. Many others seem disoriented by the requirement

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of rapid adaptation to a new culture. In Part 1 it was shown that there is a quite clear sense in which the people of wealthy nations are causally responsible for the disruptions and depressed conditions in many poor nations. They are responsible in the sense that they have, over generations, participated in a process which, when viewed from their perspective was "economic development" and unquestionably good, but which, when viewed from the perspective of peoples of the colonized nations, was a process of destruction of their longstanding lifestyles and cultures. Since traditional cultures had evolved to use locally produced resources which were available in their pre-colonial "habitats," the enclosure of the lands necessary to access those resources was tantamount to destruction of their local cultures and lifestyles.

But causal responsibility may not in all cases entail moral responsibility, and in this Part I inquire regarding the moral consequences of the above analysis. Several reasons could be given to deny, or minimize the moral relevance of the above arguments. First, it could be argued that the destruction of traditional cultures was not the *intent* of our ancestors—they simply pursued economic development, it might be said, and the destruction of traditional cultures was an unfortunate side effect of otherwise laudable, or at least permissible, actions. But, since a person is responsible not just for intended effects of actions taken, but also for predictable collateral consequences of those actions, this argument excuses the actions of our ancestors only if it is further argued that they could not have been expected to predict the negative impacts of their development choices on traditional cultures. This argument from ignorance is strained here, however, because the destruction of the tribal cultures by exclusion from their usual resources is identical to the process of expropriation, enclosure, and "improvement" of traditional tribal lands that characterized colonial development. The problem, then, was not an inability to predict that expropriation and enclosure would harm Native Americans, but rather an attitude that harms to the Natives did not count very much because they were considered "not really human."

Although I do not think of my ancestors, who carved poor farms out of the cut-over forests of Southern Michigan, as moral monsters, it is clear that they willingly, even enthusiastically, participated in a process the effect of which was genocidal. Looking back, we realize they justified their acts of aggression against the native populations with a fabric of false assumptions and half-truths. Our forefathers justified their actions according to their ideology—it was an ideology that said resources are there for the taking, and the development of under-utilized resources was seen as the Work of God. Judging from the success of their enterprise, and the pervasiveness of their effects, industrial "development" and replacement of prior cultures is in its ecological scope and pervasiveness a world-scale phenomenon much more momentous even than the shift in zoological dominance to mammals from dinosaurs. The difference in this case is that the cultural colonization occurred in an eye-blink of evolutionary time; and it was based on a huge number of conscious, including many thoughtless and very self-serving, decisions and actions of our ancestors who colonized, for example, the North American continent. The fact is that our ancestors knew, or should have known if they cared to examine the situation objectively, that their actions harmed Native Americans. Thus, neither the excuse based on lack of intent, nor the

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excuse based on ignorance regarding full consequences successfully excuses colonizing cultures for their rapacious destruction of pre-existing cultures in the New World.

It is tempting to say that the aggressive colonization of less-developed countries is a thing of the past, and that while we have benefitted from expropriations, we did not participate in them personally, nor could we do anything to prevent it. According to this excuse, one might plead: what my ancestors did to Native Americans was wrong, and they should have recognized this, but we cannot be held responsible today for what occurred in the past. The problem with this excuse is that the same process grinds on, inexorably, in more remote places, and this process remains today an essential part of the economic system from which I benefit. Cain, as we speak, is slaying Abel in hundreds of remote places on this earth, and it is this constant growth and expansion that fuels the economies of developed societies. The task of expropriation and extinction of traditional cultures has mainly been transferred from individual colonists, who operated with the assistance and support of colonial governments directed from the colonizing center, to large, multi-national corporations that use investments as a means to expropriate lands of traditional peoples. Since I know, if I am honest with myself, that many of my consumer choices in fact contribute to the ongoing process of cultural replacement, and that I enjoy many luxuries and amenities as a result of this process each time I accept benefits from the world economy, I re-iterate my ancestors acts by my complicity. In this sense, although my participation is less direct than my ancestors, it is no less efficacious in driving the destruction of cultures in developing lands. So, whereas it is possible to raise a number of qualifications to the moral responsibility of citizens of developed nations for their actions and for their complicity in actions of others, in the end none of these excuses is adequate to fully excuse them from moral responsibility.

It might be asked, nevertheless, more positively, what is the exact nature and moral foundation of the responsibility of citizens of wealthy nations for the suffering in less-developed nations? There are three arguments, which can be based on widely accepted moral precepts used in conjunction with our argument for causal responsibility developed above, that such moral obligations exist. The first argument is based on the fact that people in developed nations benefit from the world economy, and the world economy of growth feeds itself upon the very habitats of peoples who are being driven out of the countryside and into slums in huge cities in search of an opportunity to make a living. In this case, the emergence of a world economy has forced many people, and enticed many others, into a world economic community, a community from which we in the developed world benefit directly and indirectly. In the words of the English philosopher, John Locke, our responsibilities to perpetuate the government and support the common welfare are accepted in an "implicit contract," a contract that is renewed each time we accept, without protest, any benefit from the community. Similarly, if people of other nations become, by choice or by force, participants with us in the economic system we create and export, then they become a part of our "community," and we have some obligation to protect the people of those nations. This is, for example, the justification usually given for paying one's taxes—because I benefit from the security and opportunities offered by a minimally well-run

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government, I have a responsibility to contribute to their support. Similarly, the expansion of our economy and the flow of benefits from distant lands toward us establish a responsibility to ensure that a new order is established, an order that is not simply efficient in the short run, but as sustainable as the regime that was replaced. In the process, I think, there is an obligation to protect indigenous and aboriginal lifestyles, including suitable habitat, wherever possible. In the sense in which those who benefit from the productivity of a community are obliged to contribute to the support and sustenance of that community, we as beneficiaries of the world economy clearly have a responsibility to work toward a sustainable future for the world as a whole and for the many local communities that are struggling to survive in an increasingly complex and competitive world driven mainly by conscienceless international businesses.

Although it may be thought that the moral responsibility I have so far established is weak and rather diffuse, I believe that that responsibility is greatly strengthened by a second argument, intimated above, that many members of traditional cultures have had no choice but to become enmeshed in the world economy and that this process has been quite harmful to them. The point is not that they do not choose this individually, but rather that the system is shifted so that there are few choices left to practice traditional lifestyles.[8] The fact that this opportunity to continue their lifestyle is destroyed by the onslaught of European culture seems to me to greatly strengthen the obligation of those nations.

Although I think these two arguments, which are based on well-established principles—the principle of the obligation by implicit contract and of the importance of consent—are sufficient to imply a moral obligation on those in the developed world who benefit from the world economy, I offer also another argument which rests on a somewhat more controversial foundation. If one believes in collective responsibilities—responsibilities accepted by societies and cultures because of their common actions and policies, then the case for moral responsibility of wealthy nations becomes even stronger. Aside from individual actions, individuals gain responsibility for the actions of their society if they participate in decision processes and if they benefit from those actions in a broader, collective sense in which the mission—and the ideology—of our colonizing culture provided individuals the moral cover to act in ways that were, and are, unconscionable if one looks at the impacts of these individual acts on persons in other cultures. I recognize that these broader, collective responsibilities are controversial in some circles, but even if these are rejected, it is possible to fall back upon the two prior arguments.

Based on this reasoning, I believe the argument for responsibility of rich and powerful nations toward less fortunate ones, and also of their responsibility for the future of human civilizations, is completely convincing. To "reduce" global-scale problems to overpopulation and degradation by the impoverished is to falsify, in an unconscionable manner, the extent of our responsibility and complicity. I conclude, therefore, that the people of wealthy and industrially developed nations—given their role in imposing a new economic order on existing indigenous populations, have a significant moral obligation to help poorer societies that have been trapped in the transition to a modern way of life.

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But despite my confidence in the general argument for responsibility and obligation, choosing specific policies remains difficult. How are we to contribute to fixing what we helped to break? These, I think, turn out to be more difficult questions than the question of responsibility; whereas it seems clear that we have responsibility to do something, given the complexity of the problems faced, it is very difficult to know what to do. Partly, this is simply a matter of our having learned that, once complex and fragile social arrangements are disrupted, it is extraordinarily difficult to repair the system, or to create an alternative system artificially. But it is also true that the developed world's record in development assistance is grotesquely embarrassing, especially if it is judged on criteria of environmental justice. The problem of choosing fair restitutive actions is even more difficult because in the time since the original usurpations, there have been subsequent usurpations, changes in governments, and so forth. Correcting the original usurpation, while no doubt laudable where possible, would often simply result in further injustices and broken compacts and promises. Aside from our tendency to sidestep responsibility and to excuse ourselves from moral complicity, it remains difficult to draw clear directives for effective actions, even when we sincerely recognize our responsibilities.

Having visited Costa Rica recently, I saw the poverty and need for jobs around the ever-growing cities of Latin America. Anyone could see that they need economic development—jobs must be created to support the growing population. To see the ambiguity of the situation, however, consider how complex must be my decision whether to buy pineapples imported from Costa Rica. I like pineapples and the rapid development of the Costa Rican pineapple industry has kept the price affordable. Each week I face this dilemma: if I buy the pineapple, my purchase supports jobs for poor laborers. Viewed individually and in the short term–and assuming that the trend toward industrial, monocultural agriculture continues there–it is in my interest and the interest of individual laborers in Costa Rica for me to buy one or more pineapples. On the other hand, I know that foreign-owned pineapple plantations there are driving much of the deforestation of the fragile hillsides, destruction of tropical diversity, and turning the forest people into day-laborers on pineapple fields. Every time I buy a Costa Rican pineapple, I fuel the very process in which the poor of Costa Rica are caught. Note that I generate this ambivalence not by shifting moral sides, so much as by shifting from an individual, economic perspective on buying pineapples to a longer scale that takes into account how my decision, when taken in conjunction with predictable decisions of other consumers, drives a process of ecological and economic conversion from one style of land use to another.

3. ENVIRONMENTAL PROBLEMS ARE PROBLEMS OF SCALE

At this point, I want to approach the problem of intergenerational and international obligations from a different viewpoint, a viewpoint suggested by the insight, just noted, that resource use and access problems have a scalar

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aspect. Three new analogies will be useful in exploring this scalar aspect of these problems.

First, consider a generalization of Garrett Hardin's classic argument (1968) of the tragedy of the commons, which explains by a simple analogy the tragic destruction of common access resources. If one imagines an open-access pasture, Hardin noted, each herder will reason as follows: by adding an animal to his own herd, he will reap most of the benefits of the addition. The costs in degradation of the pasture, however, will be shared by the whole community. Inexorably, this reasoning leads to the destruction of the pasture and the ruin of all as each individual follows the logic of self-interest without concern for the attendant stress on the communal resource.[9]

Note that Hardin's schematic analogy, originally formulated to illuminate human population growth, can be generalized to apply to any public good that can be destructively over-used by individuals. Hardin's tragedy has *two* scalar aspects. First, the tragedy can be tracked as one of *comparative* scale–the addition of animals to the collective herd incrementally changes the ratio of animal to vegetative biomass on the range.[10] In the common pasture analogy, this represents an ecological relationship between grazing animals and plants in the system. Comparative scale—the size of the herd relative to the volume of vegetation is a physically describable ratio—at some point in the process of adding animals (and possibly with co-causes such as a drought), the communal grazing resource will predictably be damaged.[11]

But the increasing comparative scale of activity to resource base is only a symptom of a second, underlying problem of the scale at which decisions are made. The tragedy of the commons dramatizes the fact that self-interested individuals, acting rationally, inexorably destroy a collective good. Note that Hardin's argument involves "goods" that emerge on separate levels—there is the "good" of individual herders and the communal "good" of a healthy pasture—the tragedy is that unconstrained pursuit of individual good leads inevitably to the destruction of another good that exists on the community level and in the long run.

Economists often argue that the problem with open-access resources—as described in Hardin's tragedy of the commons—is a problem of market externalities caused by lack of private ownership in the resource. On this analysis, assigning ownership rights to the resource would create incentives to protect the resource. But this analysis misses the remarkable robustness of the Hardin model. For example, Colin Clark (1974) has shown that, even when there is ownership in a resource, the profit motive will encourage destruction of the resource-bearing process, provided the discount rate—here understood as the "opportunity cost" of money—is high. If there are high-yield opportunities for alternative investments, Clark demonstrated, owners of a renewable but fragile resource can maximize their profits by over-exploiting and destroying the resource and investing their immediately enhanced profits in other ventures. Clark's result is important because it shows that ownership is *not sufficient* to protect a resource-producing systems of great public value.

The analysis of common property resources as a lack of private ownership has also proven inaccurate, or at least misleading, historically. Careful study of traditional

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societies and their regimes of resource management has shown that it is important to distinguish *access rights* from *property rights* (Ostrom 1990). There are many ways to control access, of which fee simple ownership or similar ownership schemes represent only one type of examples among others. To assume that private property ownership is the *only* solution to resource protection is to ignore the historically successful systems that have been created by traditional societies to control access to, and protect for many generations, resource-productive processes. So, property rights are neither sufficient—nor necessary—to ensure protection of a productive resource to occur. In Part 4, I return to the important question of access to resources. But first it is necessary to explore in more detail the scalar aspect of Hardin's analogy.

What we have shown so far is that the problem with decision processes that end in tragedy is more basically a problem of *scale* than a problem of *lack of private* property ownership, at least in the sense that the impact of individual-scale rationality on collective goods drives the commons tragedy toward its inexorable conclusion. Tragedies occur because the incentives under which individuals operate are based on short term and immediate profits, at the expense of longer-term goods of resource protection. The community's interest in maintaining the resource-producing system of natural processes, and proposed investments to protect and enhance this interest, must be understood and measured on a longer frame of time than is usual in individual's calculations of their economic interests. If long-term investments to protect resources must compete with private investment opportunities, then these investments will often not be made; a resource of great long-term public value will in these cases be over-exploited and lost. High opportunity cost of money—which would normally be associated with a high rate of real interest and of value-expanding opportunities, creates conditions in which private profit motives generate decisions that, taken cumulatively, may destroy a resource.

Consider a second analogy, related to Hardin's, but also expanding on the scalar relationships in a new way. Herman Daly has introduced the analogy of a Plimsoll Line as a way of understanding the carrying capacity of an ecological or physical system (Daly 1991). The Plimsoll Line refers to a line placed on the side of a ship; as long as the Plimsoll Line shows above the water, it indicates that the load on the ship does not exceed its capacity. The search for an ecological Plimsoll Line provides an illustration of the basic role of carrying capacity. Economic rationality urges the owner of a boat to add more cargo to increase the efficiency of transport, but physical characteristics of the boat place limits on the volume (impact) of the load that can be carried safely. Regulation becomes necessary to protect the lives of sailors from economic forces.

But references to carrying capacity are problematic in their own right, and for some of the same reasons that the Plimsoll line analogy is imperfect. The analogy inaccurately suggests that there is a physically definable point at which the boat becomes "unsafe." What is "safe" for a ship depends also on the roughness of the waters it will cross, for example. Similarly for resources: use of a pasture that is acceptable in most years might lead to collapse in a drought year. In extreme cases, aggregated be-

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havior can lead to desertification, a major and irreversible shift into a new, much less desirable, steady state. This interscalar dynamic can also enhance, as well as degrade, productive resources. The "carrying capacity" of the land of Israel is today many times greater than it was in 1948 as a result of actions by many individuals and agencies. As George Woodwell (1985) says:

> The earth is obviously finite; its resources limited . . . [But] the question of the limits for the support of man, at first sharp and reasonable, loses clarity under scrutiny; what seems finite becomes infinite, and what should be infinite becomes finite. And the entire frame of references shifts with human adaptation to a new circumstance. Nonetheless, there are limits although the limits may not themselves be unitary, stable, and finite.

Daly's Plimsoll analogy can be made more realistic by reference to yet a third analogy based on a tragic incident during U.S. preparations for the Gulf War. Servicemen returning from shore leave all rushed to one side of their smaller transport boat as they approached their home ship, causing the boat to capsize with much loss of life. This tragic example gives us a simple paradigm case of a "communal" value—the stability of the ship—that was, through oversight, destroyed by many trivial individual preferences. Thinking abstractly, this example links two unquestioned values—human, individual freedom of action (represented by the free choices of individual passengers to locate themselves where they wish on the ship) and the shared value of avoiding capsize, a survival value that affects all equally. The example represents the possibility of cross-scale spill-over effects from cumulative individual action on those very structural stabilities that provide the opportunities for free choice. Cross-scale spill-over effects, once a threshold has been passed, express themselves as flips into a new and less attractive steady state—an upside-down ship or a desertified landscape.

The capsizing boat example represents the dynamics of economies within a larger ecological system—the safety and the freedom of the "passengers" to act as individuals depends on a complex relationship between "carrying capacity" and trends in individual behaviors. Suppose there are only a few dozen passengers on a boat that has a capacity of 300 passengers. There will be no need for restrictions on passengers' individual activities beyond those necessary to protect other individual passengers from harm or annoyance. On the next trip, suppose that the boat is full to capacity. Although the boat can float safely and stay aright with this load, there may need to be special limits on individual behavior nonetheless. At some point in loading the ship, it begins to matter a great deal where individuals stand or sit. Analogously, changes in the *comparative scale* of human use of a resource over decades can be expected to affect the freedom of choice—the options and opportunities of individuals

This unique characteristic of environmental problems—the fact that they threaten communal, long-term goods as the accumulation of human impacts increase toward maximal capacity—provides an important clue regarding environmental values. Environmental values are inherently and unavoidably scalar, contextual, and emergent. These features characterize the *physical* structure of the system in which individuals

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and communities formulate and articulate environmental values. These physical features do not fully specify the *content* of environmental values, but they do provide information about their structure; *environmental* values are values that are experienced *from* a place, within a nested system of space-time relations (Norton and Hannon 1998). Once we are sensitive to this scalar structure of environmental valuing, it is possible to associate different human values with different scales in space and time. Various values, that is, are associated with various physical dynamics in nature, physical dynamics that unfold at physical scales associated with those values. Rather than practicing intertemporal reduction of all values to present values, as economists usually do, the proposed approach associates human values with varied temporal and spatial "horizons."

To illustrate the idea of scaled values in a common social situation, consider the values expressed by citizens and delegates when it is decided, democratically, to have a constitutional convention. The context of a constitutional convention extends the temporal horizon on which we evaluate social institutions and legal rules (Page 1977; Toman 1994). A delegate who supported constitutional provisions that will be of purely individual interest, or of short-term value, will be considered selfish or shortsighted. Because, as was argued above, environmental public goods also emerge on the community and on the intergenerational scale, the values of sustainability should be understood in this broader, multigenerational context. Creating a sustainable society, including democratic institutions to control resource use and implementing conservation policies requires a multigenerational temporal horizon of perception and evaluation. These are the communal values that are relevant to assessing whether a society can survive in a specific place for many generations; and these are the values that are relevant to intergenerational comparisons and judgments of intergenerational equity. Because sustainability cannot be defined in general, or in advance (Gunderson, Holling, and Light 1995), however, the search for a sustainable society must be place-based and iterative, and involve an ongoing interaction of scientists and the public in search of better goals and better policies for a locale (Norton and Steinemann [under review]).

As was learned in our examination of the tragedy of the commons scenario, environmental problems involve an asymmetrical problem in decision scale—actions that are rational from an individual viewpoint lead inexorably to the destruction of a public, community-level value that emerges on a larger and more long-term scale. In this sense, failures of sustainability are driven by a social trap inherent in a scalar discontinuity between the scale of individual concern and the scale at which landscape-scale environmental problems emerge (Costanza 1987; Platt 1973). Second, since environmental problems result from large-scale impacts of cumulative trends in individual decisions, multi-generational values are the ones that are relevant to assessing the choices, the options, and the opportunities available to future people. Understanding these longer-scaled values may also help us to understand the costs of those people who suffer because of the breakdown of traditional, multi-generationally tested institutions to control use and access to resources.

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4. OPTIONS AND OPPORTUNITIES

Having thus linked the physical processes of exploitation and over-exploitation of resources to a central human value—freedom of choice—we can now return to an analysis of our obligations to future generations and our obligations to individuals in cultures that have been the victims of the process of "development."

To the extent that our culture imposed development on traditional cultures, to this proposed analysis, we are responsible for narrowing the choices of viable lifestyles, causing the loss of traditional hunting-gathering options/opportunities.[12] The loss of opportunities to freely choose among a range of life strategies, among a variety of ways of using resources, is the common element in the loss we attribute to poor individuals in the slums outside huge megalopolises, and the loss we may impose on future people if our bequest to them is a world over-crowded and resource poor. To return to the analogy of the coral reef, the imposition of the European style of ownership of land and resources on it destroyed the social structure of Native American populations by eliminating their habitat and hence their particular niche in an existing system. The fear regarding our impacts on the future, similarly, is that we will destroy the opportunities that constitute the human niche, more generally. This does not so much harm individuals directly, insofar as many individuals embrace the new culture and consider it a benefit; it would therefore be more accurate to say that the harm is the narrowing of choices for lifestyles–the loss, in particular, of the possibility of continuing in a traditional lifestyle and to continue place-based and time-tested adaptations to a local environment. The harm, one might say, is that individuals in the culture lose the opportunity to maintain the multi-generational institutions that constitute them as a distinct cultural entity, with a distinct and local natural history. Similarly, the future would be justified in vilifying us if they face a world in which, for example, resource shortages are so severe that only a totalitarian government can sufficiently control population and limit access to over-taxed resources, thus breaking their ties to earlier generations that have painfully evolved toward democratic control of governments (Norton and Hannon 1998). They could also be critical of us if we pass on a world so altered by human interference that the options of enjoying and recreating in places of solitude and quiet in nature are lost.

One aspect of my argument is not new. Many philosophers and economists, when discussing our obligation to the future, have agreed that what we owe the future should be understood in terms of opportunities and options. Solow (1993), for example, says that the obligation to the future "is an obligation to conduct ourselves so that we leave to the future the option or the capacity to be as well off as we are" (181) (see also Barry 1989; Page 1983). But until now, measurement of opportunity has, by most economists at least, been assumed to be a matter of *economic* opportunity—that is, as a variety of opportunities for remunerative employment and ability to invest and consume. Opportunity, understood within the economic paradigm, is assumed to track over-all economic well-being, so it is assumed that, as long as the economy is growing, and investment is adequate, individuals in the future will have opportunities equal

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to ours. But this approach to sustainability has proven inadequate, as more and more arguments firmly establish that achievement of "weak sustainability"—the maintenance of a nondeclining stock of general capital indefinitely into the future through growth and an adequate economic investment policy—is not sufficient to rule out destructive over-use of resources (Asheim 1994; Daly and Cobb 1989; Howarth 1995; Norgaard 1992; Norton and Hannon 1998; Norton and Toman 1997; Toman, Krautkraemer, and Pezzey 1994). There are many economic scenarios, that is, which exhibit adequate growth and adequate investment and still lead to environmental degradation. These papers, and several independent arguments they contain, apparently establish that weak sustainability—definitions of sustainability based on projection and comparison of economic growth and adequate investment—do not provide sufficient conditions for sustainable use of resources (Norton and Topman 1997).

What may be different about my approach is that, by recognizing values that exist at various physical scales and emphasizing the relationship between changes in the comparative, physical scale of the economy and its ecological context, an association is established between physical characteristics of the system and the important human value of free choice. This association departs from the approach of the microeconomists and relates human values directly to changes in physically measurable variables. The proposed scalar system of analysis is therefore more powerful than micro-economic models because it accepts measurements of physical parameters as direct indicators of environmental value. I associate opportunity with changes in the physical scale of an economy in comparison to its resource base. As in the case of the capsizing ship, once safe capacity is reached, further "loading" of an ecological system (the more heavily it is exploited and altered by growth in population and consumption), will require a reduction in human, individual freedom if the system is to avoid "capsize" (= collapse of the resource base). A definitional linkage is established—not only between opportunity and micro-economic measures, but also between opportunity and changes in the physical (comparative) scale of consumption and impact. Although my definition remains schematic, it supplements purely microeconomic indicators of sustainable growth. Because it associates changes in resource use with a human value—freedom—directly, rather than through the mediation of economic measures, it establishes an eco-physical basis for hypotheses about what policies and practices are sustainable. If important, limiting resources are destroyed, the range of choices available to individuals is narrowed. Healthy and sustainable communities in the future—and if such can be re-established in the currently disrupted societies of the developing world—must be integrated into an ecophysical community that is healthy and supportive of a wide range of choices for individuals. Such a society must have economic opportunities, but there is also value in choosing development paths that protect natural systems and limit over-exploitation and alteration of them, because these "investments" hold open a variety of possible choices of lifestyles. What we should hope for the future, and what we should hope to re-establish in areas of the world decimated by over-exploitation that comes with colonialization and centralization of economic power, is that these peoples will enjoy a full range of options for lifestyles and cul-

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tures. I believe it is especially important that the option of maintaining a lifestyle that is connected to that of one's ancestors is particularly important. If cultures cannot maintain their distinctive relationship to their environment—the niche they have carved out and the self-identity that comes from their natural history in a place—how can they maintain cultural integrity? And if there is no cultural integrity, how could one hope to develop sustainable institutions and social institutions strong enough to protect the public good that flows from a physical system that retains its diversity and productivity.

Up to this point, I have not distinguished between two terms—"options" and "opportunities"—assuming that as options widen, opportunities increase. Although this is no doubt a useful approximation, it is also important, in discussions of sustainable development, to draw a distinction between these related concepts. Although protecting resources by limiting the comparative scale of an economy to its resource base is a necessary condition for protecting opportunities, it is not sufficient to ensure opportunities because simply protecting resources does not guarantee *access* to those resources. We can imagine, for example, totalitarian societies in which impacts are limited or reduced by exclusion of many people from access to resources, retaining all resources for an elite while the rest of humanity lives in abject poverty. We can contrast these societies with other ones that have democratically set limits on resource exploitation. One can hope, in this latter case, that there will also be equitable distribution of the benefits of restraint, as all people share relatively equally in benefits of natural resources in their region.[13] In the first case, we will say that "options" have been protected, in the sense that the ecophysical system can still physically support a variety of choices and lifestyles (options). If, however, human institutions have not been developed to ensure equitable access to resources, a society that preserves its range of options, may not have succeeded in protecting *equality of opportunity* across times and across societies. Adequacy of opportunity therefore requires (1) that a reasonable range of options, including the existence of resources necessary for living a lifestyle that is appropriate given one's cultural history; and (2) sufficient equality of access to local resources so that individuals actually face a true range of choices as they formulate strategies for living in their local communities.[14]

This distinction allows us to argue that what we owe the future, and what we owe people of lands disrupted by cultural colonization, is not just *options*, but realistic *opportunities* which require access to adequate resources. These definitions can therefore provide a bridge between ecophysical and social models. Maintenance of options, definable as measurable, physical characteristic(s) of ecological communities, becomes a necessary, but not sufficient, condition of sustainability. My approach, therefore, apparently differs from that of many commentators who have, much like weak sustainability theorists among economists, assumed that opportunities (to acquire wealth and consume goods that result in individual welfare) can be adequately protected by maintaining a fair savings rate (see, for example, Rawls 1971). A second necessary (and, jointly with options, sufficient) condition is a set of democratic institutions that guarantee equitable access to those resources. According to this set of definitions, then, the requirements of ecophysical sustainability can be specified in measurable, physical terms, while the social aspects of sustainability refers to open, democratic institutions affecting resource sustainability.

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CONCLUSION

I have argued that persons in developed nations have significant moral obligations to cultures which have become trapped in the demographic transition because the process that created, and continues to create, our wealth is the same process that has shattered traditional cultures and with them their traditional institutions to control access to resources and limit growth. This process, although analogous to the ecological and evolutionary processes of invasion, colonization, and adaptation of a species to a new environment, is too rapid to allow other elements of the community to co-adapt. What is wrong in the treatment of less technologically developed cultures by more developed ones is that the option of their traditional lifestyle is abruptly removed from their choice set without, in many cases, obtaining their consent. On an individual basis, some members of traditional societies adapt, and may even thrive. Others—the vast majority—do not, and die out or fall into poverty. The successful ones adopt a new cultural and, eventually, personal identity; those who fail can be understood as having lost their cultural identity and their personal identity, failing to make the transition to a new lifestyle and a new sense of who they are.

I have proposed a generally applicable framework of analysis for discussing large-scale impacts of human exploitation of the environment on other humans, including both cross-cultural and cross-generational impacts. This framework, although preliminary, shows promise to clarify the link between population control and environmental protection, and may warrant further discussion because it promises to link human impacts on ecophysical systems directly with the human value of freedom of opportunity.

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NOTES

1. See Kavka (1981) for a helpful comparison of our obligations to people of distant lands with obligations to future generations.
2. It is a controversial historical question how much Native American populations, only observable by European settlers decades or centuries after first contact with explorers, were already reduced by an earlier wave of communicable diseases. The question, then, of the size of pre-contact populations, which must be answered in order to compare those populations with today's, is virtually unanswerable today. It is no doubt true that the aboriginal populations were considerably smaller than modern populations, but the size of that disparity can only be a matter of speculation. Another question, more conceptual and ethical in nature, is whether any inherent value should be placed on the ability of a culture to support larger human populations in a given area. This question has led, in the literature on utilitarianism, to a controversy whether we have an obligation to maximize *total* or *average*, utility. See Norton (1982) for basic references and a brief discussion of this problem in the context of intergenerational environmental ethics.
3. See Kennedy (1993) for a discussion of why some countries, their societies, and their economies are much better able to make the transition to the world economy and world competitiveness than others.

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4. Cronon (1991) has continued his analysis of how economic development in the New World was accomplished through aggressive development of infrastructure by tracing the development of Chicago as a transportation center for the exploitation of nature.
5. See Leopold (1979) for a brilliant and prescient evolutionary analysis of environmental problems. This article (written in 1923 and published posthumously in 1979) anticipates—briefly, but precisely, the theory of sustainability as adaptability; this theory guides the movement known as "adaptive management" (see Holling 1978; Gunderson, Holling, and Light 1995; Lee 1993; Norton 1996; Norton and Steinemann [under review] Walters 1986). Leopold, interestingly, links this management approach directly to the tradition of thought called American Pragmatism (see Norton 1988; 1996).
6. I continue this analogy, recognizing that the human species is both importantly similar to, and also importantly different from, other species. I hope these analogies can illustrate both the ways in which human invasion and colonization is similar to, and different from, the ecological processes of invasion and colonization.
7. Traditional, migratory societies that have followed regular migratory routes to gain access to, and protect resources, are not placeless in this sense, because their practices are adapted to several places as part of their territorial and place orientation.
8. This formulation of the harm provides an answer to the point that many tribal people, especially the young, opt to buy into the new culture. The fact that youngsters choose Levi jeans freely does not change the fact that they and their peers have been deprived of an opportunity to choose (and perhaps integrate jeans into their new culture on their own terms) a traditional lifestyle that connects them to their past.
9. I am aware that there have been many discussions of the historical accuracy and the true message of Hardin's elegant analogy. My concern, here, is so abstract that these fine points are not relevant. As will become clearer below, I am interested in Hardin's analogy as an abstract model—as a concrete guide toward a semantic interpretation of formalistically defined concepts.
10. See Vitouszek et al. (1986) for one attempt to quantify a similar ratio—the comparative scale of all forms of human expropriation to total terrestrial productivity.
11. This idea of comparative scale, which measures the "size" (= "throughput") of an economic activity in comparison to its physical resource base, has been developed by Daly and Cobb (1989).
12. It could, of course, be argued that development offers new options to replace traditional ones and that these new options are adequate to compensate individuals for their loss of traditional options; or it could be argued that a developing economy will naturally replace raw options based on raw-resource-based options with others more suitable to a "mature" economy, options such as industrial or high-tech jobs, and that loss of traditional options are actually a boon to traditional societies. These arguments raise complex and difficult problems that cannot be resolved here. See Norton (1999) for a preliminary discussion of this complex issue.
13. Of course it is also possible that a democratically organized society can over-exploit resources in the present, allowing relatively equal access in the present, but destroying options and opportunities that will be important in the future. See Ludwig, Hillborn, and Walters (1993) for a pessimistic evaluation of this possibility.
14. For a more detailed analysis of this possibility, see Norton (1999).

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