DOMINION

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Human Futures

Nearly everyone looks to the future with some degree of misgiving. Our feeling that something is wrong transcends the usual "things were better in the old days" and even goes beyond simple millennial jitters. The decades-old threat of nuclear holocaust, though somewhat diminished by recent East-West détente, is still with us, underlain by a less focused malaise: worry that the world is running out of resources, that pollution is mounting, and that competition for remaining resources and simple lebensraum among the mounting hordes of human beings will lead to terrible consequences.

These problems are serious. Studies conducted by the Club of Rome, the WorldWatch Institute, and similar organizations are replete with scary statistics of burgeoning population and depleting resources. There is no question that we must face up to these problems—and no doubt in my mind that if we can face the terrific task of confronting these issues immediately, we can survive the immediate future.

Biology has little to say about these immediate problems; they are,

instead, preeminently social issues. Even population control, at least in the short term, is a social rather than a biological issue. And though I take a look at these immediate, pressing issues in this chapter, I will have little to say about them as we probe more distantly into the future.

It would be natural for an evolutionary biologist such as myself to focus, instead, on the long-range evolutionary future of our species. And it is fun to do so—especially for me, who disagrees so strongly with standard prognostications. It turns out that one's basic views on how the evolutionary process works—and how it has shaped the evolutionary histories of all species, especially those of our own lineage over the past 4 million years—determine in large measure what one thinks will happen as the evolutionary ages roll by.

It is the midrange ecological future that concerns me most. We have reached our present precarious position as an outcome of an ecological evolutionary course on which our ancestors embarked at least 2.5 million years ago. And our deep evolutionary history—hence our deep evolutionary future—is a story of shifting positions vis-à-vis our approach to the natural world and its component ecosystems. It is this ecological side of the human story that tells us what is happening now and what our remote evolution is likely to be. But we won't have that remote evolutionary future unless we navigate the intermediate-range ecological future of the next several millennia.

First Things First: Surviving the Immediate Future

What is going to happen as we turn the millennial corner and plunge headlong into the twenty-first century? Paramount in nearly every prognosticator's mind for the short term is simple *survival.* The world

is beginning to look bleak to people with varying perspectives and political persuasions.

It is every generation's seemingly irresistible temptation to pronounce the world's imminent demise. To make matters worse, we are indeed approaching the millennium, and all sorts of dire warnings, biblically based and not, will soon swamp us. Rational minds never pay much heed to the old litanies of gloom and doom. Why should we think that it is any different now? Is there anything special we can point to about the world and the human condition that differs all that much from any other point in human history?

Indeed there is. The difference is *population. Human* population. We are now some 5.7 billion strong and climbing. Ten thousand years ago, we forever altered our relation with the world's natural ecosystems when we adopted agriculture and a settled existence. All of us, that is, but the few indigenous peoples still living as hunter-gatherers. They are as threatened—culturally as well as physically—by the explosion in numbers of agriculturally based peoples as surely as are the vast majority of the millions of species of plants, fungi, animals, and microorganisms.

But that's not all. Ten thousand years ago there were between 1 and 5 million people on the planet. There was plenty of room to expand and move, and resources seemed endless. Now we suddenly see that we are a global species. There are other species, to be sure, nearly as widespread as we. Most are human commensals and parasites: the indispensable (though, in certain strains, morbid and even lethal) *Escherichia coli*, the famous intestinal bacterium. Or *Drosophila melanogaster*, beloved fruit fly of genetics labs, which, like Black and Norway rats, have accompanied humans nearly everywhere.

But none of those species is like *Homo sapiens, our* species, when it comes to its relation with other elements of the natural world. All of the world's species—save our own—are broken up into relatively small

subdivisions—local populations that are integrated into local ecosystems. Populations of *Drosophila melanogaster* are far more concerned with the (largely human-altered) local ecological conditions they encounter than they are with far-flung populations of other *D. melanogaster.*

Not so with agriculturally based humanity. Through a 2.5-million-year-long process of substituting cultural for purely biological approaches to living, we have turned our attention from local ecosystems as we go about the daily business of living. We are concerned, instead, with ourselves—meaning, in this case, not so much our personal selves but *each other.* We are an incredibly inner-directed species—the first of its kind on the planet. Based on agriculture and extraction of mineral and other forms of natural wealth from the earth, our entire economic behavior hinges on transactions among humans. Hunting—now confined for the most part to marine fisheries and whaling, and to the harvesting of natural timber stands—remains among the very few exceptions.

We have long been social, and our basic approach to living with nature has long been an attempt to distance ourselves, to use our cultural capacities, our technologies, to afford shelter and increase our abilities to exploit natural resources. How does becoming global change a picture that has been in place for 10,000 years—with elements going back at least 2.5 million years?

The answer lies in what Yale historian Paul Kennedy calls the "Malthusian trap." Rev. Thomas Malthus looms large in the annals of evolutionary biology. It was Malthus's *An Essay on the Principle of Population as It Affects the Future Improvement of Society,* first published in 1798, that supplied a key ingredient to both Charles Darwin and Alfred Russell Wallace, codiscoverers of the principle of natural selection.

Malthus pointed out that if left unchecked, human populations will

increase exponentially. Darwin and Wallace grasped the principle and saw that it applies to all species, not just humans. In his *On the Origin of Species by Means of Natural Selection* (1859), Darwin uses elephants to drive the point home: If, he supposes, one starts with a pair of elephants, and if one assumes a reproductive rate of six offspring per elephant over a 60-year interval, in the short span of 750 years there would be 19 million elephants. If left unchecked, the world would soon be standing-room-only with elephants! Clearly, they saw, something is holding in check the explosive potential that lies within each species. The world is not wall-to-wall elephants. Nor is it wall-to-wall anything—except some microorganisms and, increasingly, human beings.

But there is one big difference between elephants (and all other species) and humans—when it comes, that is, to figuring Malthusian limits. All species, including our closest ancestors and living relatives, that have so far graced the earth—with the very recent exception of ourselves—live as relatively small populations disseminated into a variety of ecosystems. It is the local ecosystem that sets the upper bounds on how big populations can get, and the total number of individuals within any species is simply the total number of such limited populations. Stepping outside the confines of local ecosystems, as our species began to do 10,000 years ago with the advent of agriculture, released us from these primordial constraints on our numbers.

Most population experts see our numbers stabilizing naturally sometime during the mid–twenty-first century. While estimates vary at when and at how much, 14 billion seems to come up often as the predicted stabilized number of humans on the planet. But why will there be stabilization at any number? Simply because, instead of stepping completely away from the natural world, we have instead redefined our position in it: We have become a global species, one that—uniquely—interacts as a single unit with the rest of the global system.

It is as if our species has become one single gigantic population. So we will have natural limits imposed upon us after all, and the trick to divining our ecological fate boils down to estimating whether we will stabilize before we end up destroying too many of the world's remaining ecosystems. We may well not stabilize before we have fatally compromised the "ecosystems services"—the carbon, nitrogen, and phosphorous cycles, the production of oxygen and other resources on which we shall always depend.

Which gets us back to the Reverend Malthus's original musings. Malthus was concerned solely with human population. Malthus worried about what would happen when, as seemed to him quite likely, population growth would begin to outstrip the agricultural capacity of society. Famine, pestilence, disease, anarchy—and death. His outlook was grim.

But somehow, society—British society in particular—evaded the Malthusian trap. In *Preparing for the Twenty-first Century* (1993), Paul Kennedy tells us why: Migration was still very much a viable option, and the nineteenth century saw waves of emigration triggered by crop failure (as in the Irish potato famine and emigration of the 1830s and 1940s). Then, too, there was a second "Agricultural Revolution" when crop rotation and other innovations vastly improved agricultural productivity. And then there was the Industrial Revolution itself, which, especially after its effects began to trickle down into the working classes, tended to dampen reproductive rates. Industrialized nations in general have shown declines in birthrates—to levels, at any rate, far below those of "developing" nations.

Was Malthus wrong? Certainly not; unforeseen circumstances merely bought the world a little time. The point about our global distribution and our current 5.7-billion population is that we won't so easily evade that Malthusian trap this time around. To begin with, there is no longer any place to run to. Immigrants have been resented

and resisted for millennia, but the fresh waves of illegal aliens seeking refuge in the United States—land of "give me your tired, your poor"—and the public outcry against them are only going to increase.

The population problem is exacerbated by the increasing disparity of distribution of wealth. The division between "haves" and "have-nots," which has sharpened markedly in the last decade within the United States, has well-known reverberations in crime and social unrest. The disparity among nation-states works on a grander scale—but much to the same effect. With mass migration no longer the viable option it was in immediate post-Malthus times, the have-nots will indeed increasingly succumb to famine and all its attendant horrors. Recent events in Africa are a mere adumbration of things to come. The only alternative—if things are left to run their predictable course—will be warfare.

There are, of course, optimists who resist the gloomy tidings, most of them economists with an unbridled faith in the development of markets and wealth. Julian Simon, economist at the University of Maryland, has taken delight in tweaking the Malthusian-inspired analysts transfixed by the horrors they see lying just around the corner. The future will be better than ever, Simon predicts. Population is not a threat, since it is humans themselves who create wealth. The more people born the better, since chances increase that brilliant, creative ones will be born: People who will lead us away from the brink; people who will find ever more ways to avoid the Malthusian trap.

And that *is* the way most of us who devoutly wish that things were *not* going to hell in a handbasket (and that means most humans) traditionally see us avoiding the Malthusian trap. Energy crisis? No problem, "they" (meaning scientists and their funding politicians) will find an alternative source. Except after the bouts with gasoline shortages in the 1970s evaporated, it was back more or less to business as usual—with little in the way of concerted governmental policy or

industry-supported research and development to address the problem. Energy research once more became, if not exclusively, at least in large measure the domain of the individual visionary.

Kennedy sees little hope this time that technology will provide the same sort of respite from the Malthusian trap that it provided two hundred years ago. I agree. Unlike the earlier days of the Industrial Revolution when new technologies were developed precisely in those societies where famine loomed, today's advances are coming in the developed nations—and not in the emerging nations of the "third world" where the problem is most acute.

Then there is the problem of resources—*natural* resources. Ecologist Paul Ehrlich, a longtime champion of the environment and advocate of stabilization of human population, locked horns with economist Julian Simon over the immediate future. Putting their money where their mouths were, Ehrlich and Simon made a bet, one which at first glance seemed rather bizarre. Ehrlich bet that the price of copper would rise on the commodities exchange over a five-year period, while Simon predicted the price would actually drop. Simon won the bet.

Beyond the wager lay deeply conflicting views—not only of the short-term human future but of what drives the human social system in the first place. Ehrlich, as an ecologist, knows all too well that resources ultimately dictate population size. There is a ceiling on numbers of individuals within a given population that can be sustained by available resources. Malthus all over again.

Simon, for his part, is keenly aware that human ingenuity time and again overcomes apparent obstacles. Anthropologist Marvin Harris, in his *Cannibals and Kings*, makes a convincing case that humans have, time and again, confronted "energy crises" and won—with a major cultural innovation that not only pushed back the Malthusian trap each time, but in several instances directly contributed to an immedi-

ate increase in human population since the "carrying capacity" of the environment was greatly expanded at each event. Thus the initial Agricultural Revolution 10,000 years ago enabled a settled existence, a more or less reliable food supply—and populations immediately expanded as a result. Ehrlich lost his bet because he agreed to measure the effect of diminishing, nonrenewable resources—which is what mining of metallic ores amounts to for humans on this planet—by consulting prices on the commodity exchange. We are indeed running out of precious metals, and so many other natural commodities. But we are far from running out of clever ways to increase efficiency in locating and exploiting these diminishing resources.

But was Ehrlich really wrong? Of course not. He was merely outfoxed. There is no question that we are as limited by resources as any other species on earth. Malthus was right. But what are the limits? Where does the ever diminishing supply of energy resources—nourishment for our bodies, fuel for our engines, plus the matériel for the production of goods—catch up with us?

The specter of running out of essentials first caught up with me in the early 1960s, when Columbia University geologist Rhodes Fairbridge matter-of-factly announced that the world would run out of recoverable petroleum by the mid-1990s. He based his estimate on simple measures of the volumes of the world's great sedimentary basins, and the amount of known reserves in well-explored regions. Fairbridge, it turns out, was a bit too pessimistic: Again, increased efficiency in both exploration and exploitation tactics have staved off the day. But at the present rate of consumption, it can't be too long before we *do* run out of oil. When will that be? The latest prediction is that, with no increase over present rates of consumption, we shall have exhausted known petroleum reserves by the end of the twenty-first century.

Virtually every item in the natural resources inventory is similarly

limited. We are cutting down our old-growth forests, in the northern, temperate climes as well as in the tropical rain forests. In principle they are renewable—but not unless we let nature take its course, leaving substantial tracts untouched and allowing cutover areas the centuries or possibly even the millennia they will need to recover completely. There is no sign that humans are willing to do that.

Fisheries and whaling, the last vestiges of substantial food production directly from natural ecosystems, are notoriously depleted. They, too, are in principle renewable, and moratoria on whaling and taking certain species of fish have indeed occasioned the replenishment of harvestable stocks. But the overall outlook is bleak.

Most biological resources are renewable. The problem with their impending exhaustion is one of social planning: regulating harvesting to match renewed growth—an aspect of "sustainable development." Even here, there is a concept of equilibrium—stability in rate of harvest that implies, ultimately, stability in demand—which further implies, if it does not absolutely require in all cases, stability in human population growth. Renewability of biological resources cannot go on in perpetuity in the face of unrestrained population growth. We will use up the resources—and then there will be none.

Oil, coal, and natural gas are an important exception, for they take millions of years to form and accumulate into exploitable deposits. Nonorganic resources, like metallic ores, are another issue entirely. They are nonrenewable for the most part for the rest of the history of the earth. And then there is an intermediate class of resources: inorganic compounds—many vital to life—that are produced by living organisms. Free oxygen, vital to all living things but a few species of bacteria, is replenished daily by the photosynthetic plants and microorganisms of this planet.

Exhaustion of resources need not, in each instance, spell doom for *Homo sapiens*. We are adept at finding alternative resources, of getting

by without accustomed supplies. But the loss of each resource drives another nail into the coffin. The question, once again, is: How long will it take? How much can we lose before humans themselves become severely affected? If we ourselves don't put on the brakes to our expanding population soon, it will be done for us—through the exhaustion of resources, the disparity of their distribution in the world, and the social unrest that will surely follow.

How long before disparity in distribution and loss of supply of resources takes its toll? The answer is a few decades, if things persist the way they have been going—and especially so long as our global population continues to expand at its present rate. But maybe not. Maybe there are a few centuries—depending, once again, on what technological fixes can be applied to once again stave off the Malthusian trap.

The point is that our short-term future lies squarely in the arena of human social interaction. Can we control the population? Can we avoid the inevitable disastrous consequences of overpopulation plus national and international disparities in the distribution of wealth? Are there indeed new technological fixes? And can humans live in an increasingly overcrowded and degraded physical environment? These are not so much biological as profoundly *social* issues. Biology comes in when people starve to death—or kill each other off—and there only at the most trivial level: the actual existence of single individuals. It is social decisions that will decide, and for the most part control, the dynamics of the human future in the next few centuries. Malthus applies, but through a complex filter of human social interaction.

I think it is important to recognize this distinction between the immediate and longer-term human futures. The immediate future is overwhelmingly internalist, dependent as it is on human thought and social action. The next few centuries are sure to be rough. For the rest of this book, I am going to make the assumption that our species will pull through them. And we will do so with a population of some

10 billion with no horrendous cutback in between. But if we are to do so, we absolutely must get a grip on our out-of-control population growth.

Population lies at the heart of our ecological future as well. This second, midrange aspect of our future—already growing in importance and absolutely critical if there are to be successful succeeding centuries and millennia for our species—hinges on our role in nature. We are not as independent, and certainly not as self-sufficient, as we seem to like to think we are. We have, as I have already remarked, altered our position in nature. But we haven't really left it.

The environmental movement is gathering strength. There are immediate concerns, for we ourselves are, largely unwittingly, driving thousands of species extinct each year—as many as 27,000 species (three an hour!), according to Harvard biologist E. O. Wilson. Species are reduced in numbers, and driven over the brink of extinction, largely as an accidental side effect of human utilization of the environment: Agriculture, forestry, and industrial fallout destroy whole ecosystems and poison the atmospheres and oceans.

Human inner-directedness has made us slow to pick up on these concerns. Indeed, the very same Julian Simon who thinks that more people will actually improve the collective economic life of the body politic disparages the notion that we are indeed causing the next big wave of mass extinction—and, in any case, disputes that it matters at all to future human existence even if it should prove to be true.

Part of the problem here is confusing the immediate inner-directed concerns within our species with our environmental problems. Utilization of resources, to be sure, does link the two issues. But they are not the same: The issue of disparity of consumption of resources has profound implications for our immediate survival as a species—meaning the conflicts that are bound to arise. But it also has implica-

tions for the relation between humans and an increasingly degraded environmental system in which we live.

It is decidedly not obvious to all of us, living in the last decade of the twentieth century, that a mass extinction of the majority of nonhuman species would be seriously detrimental to the future of humanity. Our ancestors knew how much they depended upon other species populations within local ecosystems, but we don't live as they did. And we do not depend on local ecosystems—or even on the earthly biosphere, the global ecosystem—in the same way our ancestors did. Those of us who see the degradation of ecosystems and the extinction of species as a direct threat to the human future must make a clear case that the mass extinctions of the geological past are real phenomena, and that we are in the midst of a human-engendered extinction spasm right now. And we must be prepared to detail how this latest extinction spasm will eventually have profound implications for the future of humanity.

As we try to delineate the midrange ecological future of *Homo sapiens*, our job will be to see to what extent our species really does interact with the global biospheric system. We are still very much a part of nature, but our global inner-directedness—the tight network of economic interaction within our species on a global basis—has altered our stance toward the natural world. We now interact with the world as a single economic entity—something no species has done before.

This new stance toward nature means that there is a two-way interaction going on. We can see one way very clearly: We are profoundly affecting the global environment. Everyone agrees on that point. The other direction is less obvious: The global environment—its species, its physics, and its chemistry—has a profound effect on us. The more we harm that environment, the more we put ourselves at risk. I return to these themes in more detail, especially in the final pages of chapter 6.

The dissonance between unregenerate optimists like Julian Simon and environmentalists like Paul Ehrlich stems partly from the different time scales they are looking at, and partly from the fact that our most pressing immediate problems are internal and social. But looming right around the corner—the not-too-distant midrange future—the *ecological* future hinges on the very concerns that environmentalists raise.

Human population really does link the short-term, inner-directed concerns of our immediate future with the slightly longer-term prospects for human existence. If overpopulation and the disparity of distribution of resources pose the most immediate threat of social upheaval, they also lie at the heart of our ecological future. Destruction of ecosystems and extinction of species are direct effects of "development." Ehrlich was right: There really is a fairly simple cycle of more mouths demanding more food; more food produces still more mouths, which demand still more food.

Economists like Julian Simon are quick to point to the decline in birthrates in industrialized nations. Raise the standards of the world's underdeveloped nations, and birthrates will level off. A pipe dream, of course. Industrialized nations consume something like twenty-seven times per capita the amount of resources consumed in third-world nations. As Paul Kennedy points out, there is little real prospect for underdeveloped nations across the board to assume such standards. And environmentalists point out that the twenty-seven-fold disparity in consumption of resources really means that the effective population size of an industrialized nation is twenty-seven times greater than its actual head-count—an equalizing factor when it comes to comparing populations of wealthy with impoverished nations. Industrialized nations are every bit as much a part of the population problem as are the poor ones.

So our midterm ecological future is linked, through population