End of the Wild

The extinction crisis is over. We lost.

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For the past several billion years evolution on Earth has been driven by small-scale incremental forces such as sexual selection, punctuated by cosmic-scale disruptions—plate tectonics, planetary geochemistry, global climate shifts, and even extraterrestrial asteroids. Sometime in the last century that changed. Today the guiding hand of evolution is unmistakably human, with earth-shattering consequences.

The fossil record and statistical studies suggest that the average rate of extinction over the past hundred million years has hovered at several species per year. Today the extinction rate surpasses 3,000 species per year and is accelerating rapidly—it may soon reach the tens of thousands annually. In contrast, new species are evolving at a rate of less than one per year.

Over the next 100 years or so as many as half of the Earth's species, representing a quarter of the planet's genetic stock, will either completely or functionally disappear. The land and the oceans will continue to teem with life, but it will be a peculiarly homogenized assemblage of organisms naturally and unnaturally selected for their compatibility with one fundamental force: us. Nothing—not national or international laws, global bioreserves, local sustainability schemes, nor even "wildlands" fantasies—can change the current course. The path for biological evolution is now set for the next million years. And in this sense "the extinction crisis"—the race to save the composition, structure, and organization of biodiversity as it exists today—is over, and we have lost.

This is not the wide-eyed prophecy of radical Earth First! activists or the doom-and-gloom tale of corporate environmentalists trying to boost fundraising. It is the story that is emerging from the growing mountain of scientific papers that have been published in prestigious scientific journals such as Nature, Science, and the Proceedings of the National Academy of Sciences over the past decade.

The Real Impact

Through our extraordinary capacity to modify the world around us, we human beings are creating a three-tiered hierarchy of life built around human selection. The great irony here is that this anthropogenic transformation of the biosphere springs as much from our deliberate efforts to protect and manage the life around us as it does from our wanton disregard for the natural environment.
At one extreme we are making the planet especially hospitable for the *weedy species*: plants, animals and other organisms that thrive in continually disturbed, human-dominated environments. (I borrow this term from David Quammen's seminal *A Planet of Weeds*.) Many of these organisms are adaptive generalists—species that flourish in a variety of ecological settings, easily switch among food types, and breed prolifically. And some have their needs met more completely and efficiently by humans than by Mother Nature. In the United States, for example, there are five times as many raccoons (*Procyon lotor*) per square mile in suburban settings than in corresponding natural populations in "the wild."

From dandelions to coyotes, weedy species will enjoy expanding populations, spatial distribution, ecological dominance, and opportunities for further speciation into the far future. Many of these species have become so comfortable living with us that they have been labeled pests, requiring stringent control measures: the common (Norway) rat (*Rattus norvegicus*) and white-tailed deer (*Odocoileus virginianus*) come immediately to mind.

Living on the margins in ever-decreasing numbers and limited spatial distribution are *relic species*. Relic species cannot thrive in human-dominated environments—which now nearly cover the planet. Facing the continual threat of extinction, relic species will linger in either ecologically marginalized populations (e.g., prairie dogs and elephants) or carefully managed boutique populations (e.g., pandas). Most, including the Sumatran rhinoceros (*Dicerorhinus sumatrensis*), the California condor (*Gymnogyps californianus*), and virtually all of Hawaii's endemic plants, will require for survival our permanent, direct, and heavy-handed management, including captive breeding and continuous restocking.

Other relics, such as rare alpine plants, may survive in isolated patches through benign neglect. Over time they will experience progressive genetic erosion and declining numbers, and will rapidly lose their *ecological* value. In essence, they will be environmental ornaments.

But a large fraction of the non-weedy species will not be fortunate enough to have special programs to extend their survival or will be incapable of responding to such efforts. These are the "ghost species"—organisms that cannot or will not be allowed to survive on a planet with billions of people. Although they may continue to exist for decades, their extinction is certain, apart from a few specimens in zoos or a laboratory-archived DNA sample.

Some, such as the East Asian giant soft-shell turtle (extirpated except for one left in the wild) and the dusky seaside sparrow (extinct), are incapable of adapting their highly specialized needs rapidly enough to keep up with human-induced pressures. Others we intentionally try to eradicate. Although they are now protected, wolves and black-tailed prairie dogs in North America were once hunted for extermination as part of federal and state animal-control programs (and unofficially, they still are). In Africa, the lion population has plunged from
over 200,000 in 1980 to under 20,000 today due to preemptive eradication by livestock herders.

Still other prospective ghosts we simply consume beyond their capacity to successfully reproduce—for food, for commercial products, or as pets. Recent reports suggest that we have consumed 90 percent of the stocks of large predatory fish, such as tuna and swordfish, in the world’s oceans. And while 10,000 tigers live as private pets in the United States, fewer than 7,000 live in the wild throughout the world!

A great many of the plants and animals we perceive as healthy and plentiful today are in fact relics and ghosts. This seeming contradiction is explained by the fact that species loss is not a simple linear process. Many decades can pass between the start of a decline and the collapse of a population structure, especially where moderate-to-long-lived life forms are involved.

Conservation biologists use the term "extinction debt" to describe this gap between appearance and reality. In the past century we have accumulated a vast extinction debt that will be paid, with interest, in the century ahead. The number of plants and animals we "discover" to be threatened will expand out of control as the extinction debt comes due.

Thus, over the next hundred years, upwards of half of the earth’s species are destined to become relics or ghosts, while weedy species will constitute an ever-growing proportion of the plants and animals around us. By virtue of their compatibility with us, weedy species can follow us around the planet, *homogenizing* (in both plausible interpretations of the word) the biosphere by filling in the spaces vacated by relics and ghosts. More and more we will encounter on every continent remarkably similar, if not the very same, species of plants, insects, mammals, birds, and other organisms.

**How Did We Get Here?**

Although we have been aware of species losses for decades, only recently has it become apparent that the biotic world as we have known it is collapsing. The causes, varied and complex, fall into three broad disturbance categories: landscape transformation, geochemical modification (pollution), and biotic consumption and manipulation. Each reflects some aspect of human-induced manipulation of the environment, as these examples from the news show:

- New housing developments in Scotland will destroy critical habitat for Britain's threatened red squirrel (*Sciurus vulgaris*), which has disappeared from most of its former range.
- Logging and agricultural development have reduced the distribution of Chile's famed national tree—the monkey puzzle tree (*Araucaria araucana*)—to three small areas of the country, where it is vulnerable to fire and illegal logging.
• A new dam in Belize will flood vital habitat for rare species of jaguars, macaws, and crocodiles in a valley linking to wildlife preserves.
• Biologically active quantities of common over-the-counter and prescription drugs (e.g., Prozac) are ubiquitous in European and North American urban and suburban waste waters, where discharge to streams and rivers wreaks havoc on aquatic animal endocrine systems.
• Polar bears endure body concentrations of PCB and other industrial toxins hundreds of times higher than those of animals living where the pollutants are emitted, thousands of miles away.
• Eighty percent of Caribbean corals have died off in the past two decades from diseases fuelled by nutrient pollution from municipal waste-water treatment plants and agricultural runoff flooding into coastal waters.
• Demand for "bush meat" in Africa (which sells for 30 percent of the price of farmed meat) is now outstripping supply, seriously depleting wildlife populations in general and great apes in particular. Meanwhile the international trade in bush meat and animal parts is growing exponentially, fetching prices many times those in domestic markets.
• During the past two years half of the world's remaining Amur tigers (Panthera tigris altaica) were wiped out by trophy hunters, leaving fewer than 300 animals in the wild—ensuring the extirpation of the species.
• Collecting freshwater and marine fish for the aquarium trade reduces wild populations of targeted species by 75 percent in commercial collection areas.
• Cheatgrass, introduced into North America around 1900, has displaced native vegetation across broad areas of rangeland in western North America, devastating the local ecology. A prolific annual of low nutritive value, cheatgrass dries up early in the season, fueling extensive range fires that wipe out native plants and leave little food or shelter for wildlife.
• Native aquatic food webs in South America are being destroyed by the introduction of the North American bullfrog (Rana catesbeiana)—a voracious predator.

When these factors—development, agriculture, resource consumption, pollution, alien species, etc.—are considered separately, the problem seems quite manageable. Sprawl can be fixed with smart growth. The demand for agricultural land and high-intensity farming can be dampened through dietary changes. Natural resource over-consumption in logging, hunting, fishing, and the exotic pet trade can be reduced through education, regulation, and policing. And the proliferation of alien species can be stopped through better laws and inspections. But this is a gross simplification: the appearance of tractability is created only by taking the causes one at a time.

Consider the plight of a simple, undemanding, and modestly adaptable creature: the California tiger salamander (Ambystoma californiense). These amphibians live most of the year underground in upland fields and woodlands. Each winter they migrate thousands of feet to their natal breeding pools to find mates and lay eggs. After several weeks of carousing they return to their underground burrows in the surrounding uplands.
The key to the breeding success of these salamanders is the ephemeral nature of the pools. The pools exist as dry depressions for six months of the year. Then, as heavy spring rains flood the region, these shallow basins fill with water, creating vernal pools. Tiger salamanders have come to rely on these temporary pools because, since they are dry part of the year, they cannot support naturally occurring fish populations. Thus, the salamanders' eggs are relatively safe from predation. As the eggs hatch, the larvae find themselves immersed in a bath of food: the water is bursting with millions of planktonic organisms. The salamander larvae grow rapidly—and they need to, because with the rains gone the pools dry up quickly, and unless the juvenile salamanders mature and move out into the surrounding terrain they will die. And so it has been for millions of years.

But not anymore. Today the California tiger salamander is disappearing. First, the upland habitat where it lives is prime real estate for residential, commercial, and agricultural development. Between 50 and 75 percent of its native habitat has already been lost, and more than 100 development projects are pending in the remaining areas. Woodlands are cut down and fields plowed up to make room for houses, lawns, schools, shopping centers, and roadways. Many vernal pools themselves are simply filled. Where pools are spared bulldozing they are pressed into service as roadside storm basins to collect runoff from lawns, roads, and driveways—water saturated with fertilizers, herbicides, pesticides, and heavy metals. The nitrogen and phosphorus in the runoff stimulates massive algal blooms that drives oxygen levels in the pools down to deadly levels, suffocating a large proportion of the animals. High concentrations of herbicides and pesticides in the runoff kill many juveniles and, in lower doses, alter metabolic chemistry in ways that bizarrely change sexual development, immune function, and even limb development. Even setting aside local sources of contamination, the water in the pools is increasingly laden with a cocktail of toxic compounds (e.g., the herbicide atrazine) that are not used locally. Blowing in from industrial and agricultural sites many hundreds of miles away, these endocrine-disrupting compounds significantly reduce breeding success and foster grotesque developmental abnormalities.

Then there is the army of alien species—bullfrogs, crayfish, and other predators—that have been introduced intentionally into the landscape. These voracious hunters consume huge numbers of salamander larvae and juveniles, further decimating the tiger salamanders. In some instances, non-native salamanders (former pets) have been released into local pools, reducing breeding success and posing the risk of hybridization. And fish are frequently added to the temporary pools to devour mosquitoes during the wet season. While this makes life more comfortable for nearby human inhabitants, it exhausts the young salamanders' food supply.

But the assault does not end there. The regularity of spring rains is being replaced by recurrent three- and four-year droughts. Several generations of tiger salamanders therefore never emerge to replace the animals lost to natural and unnatural causes. In the past, tiger salamanders persisted despite climate variations by virtue of wandering individuals who trundled aimlessly through
networks of wetlands until they chanced upon new vernal pools and restarted the population. But that is no longer possible because the matrix of connecting wetlands has been eliminated, and habitat fragmentation makes the chance encounter with a car tire many orders of magnitude greater than an encounter with either a suitable mate or a suitable habitat.

Finally, where residual populations of tiger salamanders have survived despite the odds in still isolated locations, they have become a target of the pet trade. Children are paid 25 cents per salamander to collect these highly prized animals, which are then sold for $15 a piece in U.S. pet shops and for more than $200 overseas. In fact the global trade in "exotics" such as tiger salamanders is growing explosively, especially for reptiles and amphibians. Probably one in a thousand salamanders survives the commerce and perhaps one in a thousand of these survives a few years in captivity.

This story is neither fictional nor unique. It is, in fact, the rule. One could tell similar stories of the red-crowned crane (Grus japonensis), the leatherback sea turtle (Dermochelys coriacea), the Lesothan succulent Aloe polyphylla, and most other species in decline. Relic species generally face an overwhelming web of threats that are impossible to disentangle.

Further complicating the picture are two meta-disturbances: global climate change and economic globalization. Climate change will make many areas inhospitable to their present inhabitants. Entire biotic communities will be evicted: coastal wetlands will be permanently submerged, many cloud forests will dry out, some dry savannas will become lush while others become deserts. Studies suggest that the types of climate shifts we can expect over the next century are well within the experiential history of most species that have survived the last two million years. In the past, most could have moved to new regions. But today only weedy species have the capacity to migrate and reestablish thriving populations in new habitats, which invariably are human-disturbed areas. For the rest, there is either no place to go because acceptable habitat has been reduced to a few isolated patches surrounded by a sea of human development. There is no way for non-weedy species to get to potentially more suitable locations (if they exist) hundreds of miles away because of interposed cities, roadways, subdivisions, shopping centers, and airports.

Economic globalization exacerbates the species-loss problem in several ways. Globalization increases the demand for natural resources in remote and undeveloped regions. In locations previously occupied by subsistence villages, labor towns spring up to support foreign timber and mining operations. As foreign capital flows into undeveloped regions it inflates the price paid for local goods, thereby increasing incentives for over-exploitation to feed the lucrative export market. Timber from the Malaysian and Indonesian rainforests bought and paid for by Japanese firms brings a much higher return than the same lumber sold in local markets. Over 80 percent of these rainforests have now been logged, with the consequence that the orangutan population is now less than ten percent of what it was decades ago.

Perhaps most importantly, the booming trade of the globalized economy accelerates the pace of alien species being transported around the globe. Breaking down economic barriers effectively breaks down geographic, ecological, and
biotic barriers as vast numbers of plants and animals are shipped worldwide to support the pet and horticultural trades. Although presently only about five percent of these aliens take hold and flourish in their new environs, five percent of an exploding number is itself a large number. (As a reference point, 25 percent of the vascular plants in the United States today are alien species.)

Unintended introductions of alien plants, animals, and other organisms are even more threatening since authorities make no attempt to screen out truly harmful organisms. Alien pests, parasites, and predators take an increasingly high toll on native ecosystems. As ships and planes shuttle between continents carrying unprecedented volumes of cargo, they cart with them a growing roster of stowaway organisms. The Asian long-horn beetle (*Anoplophora glabripennis*), for example, invaded the United States in 1996 encased in wood crates from China or Korea. Spreading through New York and Chicago, they decimated local trees, especially maples. Since then, adult beetles have been intercepted at 17 U.S. ports.

Thus, climate change and economic globalization are powerful agents of human selection that amplify and make irreversible the traditional and localized human disturbances that undermine biodiversity.

**Why There Is Nothing We Can Do**

As our awareness of the extinction crisis has grown, we have taken some ameliorative actions. In the United States we have imposed rules upon ourselves to try to halt the loss. The U.S. Endangered Species Act prohibits the taking, harm, or harassment of some 1,300 plants and animals designated by the U.S. Fish and Wildlife Service. Some critical habitats of these species are also protected. In addition, 44 of the 50 states have some form of state-level endangered species act of their own, through which they try to protect locally threatened species.

Since the early 1990s the European Union has had its Habitat Directive, which makes it illegal to kill or harm about 700 protected species or to disrupt 168 specially designated habitats. Approaching the problem from a different angle is the Convention on the International Trade of Endangered Species (CITES), which, as the name implies, is an attempt by the international community—presently over 150 countries—to limit the global trade in threatened species. About 30,000 plants and animals are on the CITES list. Thousands of species are added annually.

Meanwhile, nations, acting individually and through international conventions, have attempted to set aside biologically valuable landscapes and ocean areas as wildlife refuges and bioreserves. More than ten percent of the earth now has some form of protected status. The Parsa Reserve in Nepal covers about 500 square kilometers and offers sanctuary to a range of creatures, including 300 species of birds. The Northwestern Hawaiian Islands Coral Reef Ecosystem Reserve, encompassing over 400,000 square kilometers of ocean, protects about 70 percent of the coral reef ecosystems in the United States. Over 7,000 marine species are associated with this area, of which 25 percent are found nowhere else on the planet.

Recognizing that governments have limited political and fiscal resources, nongovernmental organizations have moved to impede the flow of species loss
through land protection, public education, litigation, and policy advocacy. The Nature Conservancy claims to have helped to preserve over 117 million acres of wildlife habitat over the past 50-plus years. In the United States the Center for Biological Diversity, Defenders of Wildlife, and others use the courts to force recalcitrant government agencies to implement and enforce existing conservation laws and regulations.

A casual reading of the news would suggest these efforts are paying off:

- By 1939 the number of whooping cranes (*Grus americana*) in the United States had declined to 18. Thanks to captive breeding, today there are over 300 whooping cranes, with 180 living in the wild. In an astounding effort, humans piloting ultralight aircraft taught a novice flock how to migrate from Florida to Wisconsin.
- The population of Puerto Rican crested toads (*Peltophryne lemur*) has tripled to 300 over the past 25 years thanks to captive breeding in U.S. zoos and restocking in the wild.
- A recent survey of tigers in India's Sunderbans Forest suggests that the preserve’s population is stable and may even reflect an increase in cubs.
- The last remaining patch of Kneeland prairie penny-cress (*Thlaspi californicum*), found in only one California county, will be saved with a ten-year, $300,000 conservation effort.

Perhaps if we dedicated a few billion dollars more, increased cooperative efforts among governments, expanded the system of bioreserves walling off biodiversity hot spots, cultivated sustainable economics among local communities, and reduced human consumption habits we could save the earth’s biota. Unfortunately, such efforts are far too little and far, far too late. In fact these and similar apparent success stories reflect a much more insidious process that is reshaping the living earth. Our most common tools for preserving biodiversity—prohibitory laws and regulations, bioreserves, and sustainable-development programs—are themselves powerful engines of human selection, tweaking (for our pleasure) but not fundamentally altering the outcome: massive species loss. **Prohibitory regulation.** Virtually by definition all regulatory efforts at species protection and recovery are focused on relics and (unknowingly) ghosts, which have no chance of true recovery. Occasionally there are extraordinary exceptions, such as the American alligator, which having been almost extirpated is once again abundant. But our very few alleged successes are nothing more than manifestations of the growing dominance of human selection in evolution. The very notion that we could regulate ourselves out of the extinction crisis—that government could force the wild to remain wild—is based on a fundamentally false premise: that the causes of species extinction are finite and reducible and that the number of true threatened species is reasonably limited. When the U.S. Endangered Species Act was recrafted in the early 1970s, wildlife experts naively believed that at most a few hundred species would require protection. Although the current U.S. list of domestic “endangered species” tops 1,300, the list would contain almost 5,000 entries if politics did not prevent it. (Species may be placed on the U.S. Endangered Species list only after a biological review by the U.S. Fish
and Wildlife Service. Practically all such reviews these days are initiated by petitions from environmental groups. The Bush administration has halted these reviews, claiming it has run out of money.)

More to the point, the great irony is that the U.S. Endangered Species Act is the very institutionalization of human-driven evolution. We decide which species get on the list for protection and which are kept off. We decide which habitats of listed species will be labeled critical. We decide the recovery goals: how many of a given plant or animal should be allowed to persist, in how many "populations," and where they should (and should not) be distributed across the landscape. The official recovery goal for wild bison is for a total population in the low thousands, not their original numbers in the tens of millions. The wolf recovery plan envisions several dozen packs confined to carefully delineated refuges in a few key states, not free-roaming wolf packs in every state that would reflect their true former range. And the government still shoots both species if they wander off designated lands. Recovery goals for plants (for which the U.S. Fish and Wildlife Service spends less than five percent of what it spends on animals) are limited to restoring populations in the locations where they are presently growing as relics and ghosts, not to restoring their former range.

Similarly, International Whaling Commission rules, CITES, and other international conventions convert human values into biotic structure; they are not regimes designed for ecological restoration. How many minke whales are sufficient to allow hunting? How many zoo requests for gorillas should be honored? Fundamentally, the determination of which species make it onto these protection lists and the timing of those listings is more about what appeals to us in an aesthetic and charismatic way and economics than about pivotal ecological roles and biology. Pandas get lots of attention and support; the many thousands of disappearing aquatic invertebrates do not.

Although legal prohibitions and strict enforcement can preserve some relic species at the margins and temporarily forestall the extinction of ghost species, they cannot prevent or even slow the end of the wild. Regulation, then, does little more than transform nature into a product of the human imagination.

Refuges and preserves. Biologists and ecologists have long recognized the limitations of species-specific preservation and have lobbied instead for the creation of protected areas that would shield ecosystems and all the plants and animals within. The idea behind refuges, bioreserves, and the like is to somehow wall off the wild from the harmful disturbances of humanity. Set aside 20,000 acres, limit human activity, and allow nature to proceed unhindered in its special space. And for a while this appears to work. But this too is largely an illusion. The refuges and bioreserves we set aside are no more than our paltry conception of an ecosystem, and the species within their boundaries are in most instances part of the extinction debt and all the while in decline.

As they exist today, bioreserves are the proverbial barrel in which fish are more easily shot: three quarters of the deaths of large carnivores in bioreserves are caused by people. The failures of this approach are only now becoming obvious. Direct and indirect human encroachment into bioreserves is relentless and, with ever expanding populations in the developing world, unavoidable. Mexico's Montes Azules Biosphere Reserve, North America's last remaining rain forest,
extends across 820,000 acres and is home to half of Mexico's bird species. Having already lost a quarter of its tree cover in the last 30 years to illegal logging by local residents (which Mexican authorities have ignored) the park has become a magnet for those looking for land to clear and till. In Africa and Asia, bioreserves have become the preferred hunting grounds for poachers and bush-meat traders: that is, after all, where the animals are! Bioreserves will always be too small and too isolated from each other to accomplish their stated goal of preserving the wild as it is today. Embedded in a matrix of human habitation—cities, towns, farms, mining and logging operations—they cannot be insulated from broader human disturbances in the region, even if their own boundaries remain inviolate.

Consider one of the world's favorite eco-tourist destinations: the Monteverde Cloud Forest Preserve. This ecologically significant area covers more than 30,000 acres and hosts more than 2,500 plant species, 100 mammalian species, 400 bird species, 120 reptilian and amphibian species, and thousands of insects. The problem is that the cloud forest appears to be drying out. Deforestation is the apparent cause, but not from logging in the preserve. Rather, the clearing of lowland areas outside the preserve for agriculture is causing changes in the local patterns of fog and mist formation, thereby altering cloud formation up in the preserve. Thus, despite strong protections within its boundaries, the cloud forest may soon lack its defining feature: clouds. And the multitude of species that depend on that moisture will go the way of the extinct golden toad.

This weakness in the call for specific ecosystem preservation becomes all the more apparent in the context of climate change. The creation of a network of isolated, independent bioreserves assumes that the global environment—in particular the global climate—is relatively static. For the past 11,000 years this would have been a fair assumption. But this has changed. Climate models project far cooler and wetter weather during the critical winter months in what are now the most important Monarch-butterfly wintering grounds in Mexico, the Monarch Butterfly Bioreserve, which will become unlivable to the insects over the next few decades. Similar problems confront many of Europe's protected birds. Lastly, by concentrating species within a limited geographic area, bioreserves increase the vulnerability of relic species to catastrophic, unrecoverable losses from natural disasters, epizootic diseases, war, and so on. During the summer of 2003, for example, fires in Brazil's two refuges that are home to the Brazilian Merganser duck (Mergus octosetaceus) wiped out 70 percent of one of the 53,000-square-kilometer parks while decimating large parts of the other and may lead to the creature's extinction. Only 250 existed before the fire.

Ultimately the transformation of wilderness into a patchwork of static bioreserves is just another tool of human selection—the antithesis of the wild.

*Sustainable communities.* Much has been said and written about sustainable communities as a social approach to easing the extinction crisis. Sustainability has been something of a crusade for the UN, various international agencies, and many nongovernmental environmental organizations. The argument goes that if local communities could learn to live within the carrying capacity of their environs, the pressures on terrestrial and marine ecosystems would be eased. And of course this is true.
But in the context of the extinction crisis, sustainable development is an anthropocentric resource-use policy, not an ecological model. Consumptive demand measured against resource supply, not ecosystem function, determines the limit of sustainability. What is the maximum amount of mahogany, or tuna, or leopard pelts that can be harvested and still allow projected human demand for the product to be met for the foreseeable future? The demands of the ecosystem are not truly part of the equation.

In addition, for sustainable development to have an impact on conservation it must be tied directly to local demand, where the costs of overexploitation are borne by those who benefit from it. This makes sustainable economic programs a moving target because communities grow. As medical services and standards of living improve, the size of a community, its economic aspirations, and its demands for resources grow. What was sustainable for a Kenyan village in 2000 will not be sustainable in 2020. The collapse of Africa’s wildlife populations in the face of the bush-meat trade is just one example.

Moreover, if there was ever a hope for this strategy, even at a limited level, economic globalization destroyed it. Consider what might be regarded as an exemplar of sustainable development: Brazil-nut harvesting in the Amazon. Originally the idea was to protect the rain forest by creating a local economy based on the collection and sale of Brazil nuts. Initially this was quite successful. But today, local residents in the Brazilian Amazon harvest over 45,000 tons of nuts from the forest floor each year, yielding some $43 million in global trade. Unfortunately, nut gatherers harvest so many nuts that few if any seedlings are taking root. As aging Brazil-nut trees die off, they will not be replaced. Global demand for this environmentally friendly and sustainable crop drives the harvest and has made it unsustainable in the long term.

Similarly, the depletion of global fish stocks shows the basic flaw in the sustainability strategy. Local fishermen fishing for the local market are not depleting the stocks. The problem is the rise of global markets to satisfy the demands of people remote from the fishing grounds. Gross disparities in wealth between those who supply (low-wage labor) and those who demand (high-wage developed societies) ensure that sustainability will be a function of maximum bearable price, not ecological balance.

The notion of sustainable communities, then, is not about the wild. It is about long-term economic efficiency and the wise use of natural resources.

Wildlands. The wildlands concept is fantastic in both senses of the word. This idea, advocated by those in the deep-ecology movement, has two main components. First, national populations would be resettled into tightly drawn sustainable enclaves. In the United States, for example, huge, formerly ecologically significant areas such as Florida and the Rocky Mountains would be depopulated and restored to a natural state. About 50 percent of the United States would be converted into an expansive set of connected wildlands, surrounded by extensive buffers. Human access to this half of the country would be prohibited. Similar wildlands could be created on every continent.

Second, extensive social engineering would be necessary to alter land use and consumption patterns. The goal would be to reduce the ecological footprint of humanity so that much of the planet could be free from human exploitation.
In theory this strategy could reduce the slide of ghosts and relics into oblivion if it could be implemented immediately and universally. It would be a form of global ecological zoning that would significantly lessen the influence of human selection in the excluded regions. Wildlands would enable species and populations to adapt to climate change. As an ecologically centered strategy it is most likely the only approach that could truly reduce the scale and scope of the biotic collapse that is already underway.

Yet the notion that upwards of seven billion people could live hobbit-like with nature is hard to accept. With the right social framework we might have been able to do it modestly in 1304, but not in 2004 and certainly not in 2104. Global society is moving rapidly and inexorably in the opposite direction. To be fair, advocates of wildlands acknowledge that, owing to enormous social, political, and economic hurdles, their vision would be at minimum a 100-year undertaking. The problem, of course, is that the end of the wild will already be complete.

**Genetic engineering.** Each year some of my students suggest that genetic engineering can end the cascade of species loss. Why can’t we store DNA and, once the technology matures, bring all the species back and release them into the wild?

This kind of *Jurassic Park* thinking ignores the fact that all of the factors that contributed to species loss will remain in place and probably become even more powerful. If 95 percent of desert-tortoise habitat has been developed and its primary diet of herbs, grasses, and desert flowers is no longer available in 2004, exactly where will our reengineered tortoises live in 2030? At best they could exist as genetic relics in a zoo. The miracles of genetic engineering cannot alter the fact that the wild will cease to exist even if we can individually manufacture each of its constituent parts.

**A Reason to Do Nothing?**

We cannot prevent the end of the wild. Absent an immediate 95-percent reduction in the human population (a truly horrendous thought), we cannot change our current course. This leads us to the question, If we are unalterably moving to a world in which half the currently existing species will be relics or ghosts, why should we continue to do anything to preserve biodiversity? Why not rescind national and international laws protecting endangered species, eliminate bioreserves, and let the unfettered market determine how and where we consume natural resources? By bowing to the serendipitous elements of human selection in setting the course of biotic development and evolution we could happily bulldoze, pave, or grass over every square inch of the planet in the pursuit of human progress. But it is not that simple.

This why-bother strategy would greatly magnify the scale, scope, and destructive consequences of the end of the wild. First, it would effectively bifurcate the earth’s biota into two groups: weedy species and ghost species, the latter subsuming virtually all relics. And in this respect the number of lost organisms would surely shoot well past the 50-percent threshold noted earlier, while the time scale would contract to decades rather than a century-plus. Indeed, even weedy species could face serious threats in this environment. The American crow and the blue jay, for example, have already seen their numbers
decimated in many areas of the United States as a consequence of the invasion of the alien West Nile Virus, which first struck in 1999.

Second, this human-selected biosphere will not necessarily be a human-friendly one. Without direct management many species that we view as key natural resources, such as timber trees and marine fish stocks, would be consumed out of existence. The invisible hand of the market is all too invisible when it comes to the exploitation of natural commodities. The multiple collapses of once bountiful Atlantic and Pacific fisheries—which are now regulated, albeit poorly—represent just a taste of what would happen without any controls in place. (The North Atlantic, for example, has less than 20 percent of the fish it held in 1900.) The destructive effects would rebound through the economies of many nations. Certain types of ecosystems and biotic communities, such as tropical rain forests and wetlands, might completely disappear. Thirty-five percent of the world’s mangrove swamps—essential breeding habitat for many marine fish species—have already been lost, and the rate of destruction is accelerating annually. Surviving ecosystems would be impoverished and would fail to provide the range of services (e.g., water purification, flood and storm damage control) that we depend on.

Third, this approach would almost certainly increase the predominance of pests, parasites, and disease-causing organisms among the weedy species. Already today white-tailed deer populations in the United States (and Britain) have been allowed to grow virtually unchecked. There are now over 350,000 deer-auto collisions a year in the United States (50,000 in the U.K.), resulting in over 10,000 serious injuries to motorists, 150 human deaths annually, and billions of dollars in property damage. (By comparison there have been fewer than 50 confirmed human killings by mountain lions in the United States in the past 100 years.) In Britain there are about 50,000 auto-deer collisions, 2,400 human injuries, and 20 deaths. White-tailed deer, moreover, are an essential vector for the highly debilitating Lyme disease, which is spreading rapidly in the eastern United States. Indeed, many human pathogens and diseases are likely to flourish in this environment, finding it easy to skip around the world from country to country as was the recent case of the SARS virus.

Fourth, the global spread of invasive species would explode if left unchecked. Ecological concerns such as biotic homogenization aside, the economic toll would be disastrous. The economic harm caused by the 50,000 non-native invasive plants, animals, and other organisms already in the United States is approaching $140 billion per year. Florida’s government alone spends $45 million annually battling invasive species, which cause some $180 million in agricultural damage. The why-bother approach, moreover, would kill off a large proportion of the relic species in the wild that have particular psychological importance (existence value) to humanity: elephants, gorillas, whales, owls, and hawks, and other charismatic animals. From a humanist standpoint the quality of life on earth would plummet.

In the end, the notion that we could let nature take its course in a world so dominated by humanity is as dangerous as it is self-contradictory. Like it or not, nature now works for us. If humanity is to survive and prosper on such a planet
then we have no choice but to at least try to manage the fine details of the end of the wild.

Since we cannot possibly restore relic and ghost species to their former status, nor do we have the knowledge to pick evolutionary winners and losers, we should focus on two core concerns: (1) safeguarding future evolutionary processes and pathways and (2) preserving ecosystem processes and functions.

We should begin with a massive and sustained two-decade global effort, reminiscent of the International Geophysical Year, to map systematically and dynamically the earth's biota. Only about 20 percent of the earth's species have been formally described. We need to know what is here, how it lives, what it does, and what is happening to it in order to prepare for what will be lost. More significantly we need to understand the intricacies of genetic and functional relationships among species—especially for relics and ghosts—to understand how evolutionary and ecological processes will be altered.

This means recording not just what species exist, how they look, what they do, and how they are linked together, but also what is happening to them as populations, as communities of populations, and at the landscape level. Undoubtedly this will be expensive, but spending $100 billion over the next decade to understand fully the dimensions of the accelerating biotic extinction on Earth will have infinitely greater significance for humanity than scratching at the surface of Mars for signs of remotely hypothetical billion-year-old bacterial extinctions.

Meanwhile we must move away from the haphazard strategy of protecting relic and ghost species in isolation. Specifically, we can begin to think about trans-regional schemes for building meta-reserves. These would be non-contiguous assemblages of terrestrial and aquatic sanctuaries and proto-sanctuaries, significantly larger than current bioreserves. Sites would be selected to protect broad ecosystem functions and processes in a dynamic environment rather than species-specific habitat needs or singly-defining (highly peculiar) ecological characteristics. In other words, these meta-reserves would involve the designation of multiple and disparate terrestrial and aquatic refuges, many of which could have future, but not current, special biodiversity value. Each meta-reserve would be modeled around an one or more existing core biodiversity hot spots and a constellation of satellite sites, with the expectation that climate change and other human disturbances are likely to shift the ecological processes and habitat values of current biodiversity hot spots among these sites. The satellite sites of these meta reserves would periodically receive (by our doing) biotic community transplants as experimental "migrations" as abiotic characteristics such as rainfall change. The goal—admittedly a gamble—would be to avoid mistakes like the Monteverde Cloud Forest Reservation.

For these meta-reserves to operate properly, three conditions will have to be met. First, plant and animal populations within these meta-reserves will have to be actively and heavily managed at all levels — exactly the opposite of how we think about present-day bioreserves. Ecosystems cannot be conserved by benign neglect. We must determine population levels within the meta-reserves as well as when and where plants and animals should migrate among meta-reserve sites. We must determine when it is time to introduce new genes into a species, as we
are presently doing with the Florida panther. Restricted-range and sessile species would require our explicit intervention to disperse them to potential new habitat areas.

Second, meta-reserves would need highly porous wildlife boundaries within a broad network of corridors and connections (e.g., forest tracts and wetlands) allowing wildlife to move freely and stochastically to new areas. Movement, migration, and colonization are the goals of meta-reserves, not imprisonment. These corridors would be buffered by wide swaths of landscape where ecologically compatible agriculture and heavily regulated resource use were allowed.

Third, given the above, substantial human and financial resources would have to be devoted to continuous management and rigorous enforcement, or else these efforts will be futile. Annual global spending on ecosystem protection (including acquisition) is just over $3 billion (the price of two B-2 bombers). In order to nudge the end of the wild toward a more human-friendly outcome, we need to spend ten times that much to compensate for the unintended impact of human selection.

In this context the issue of alien plant and animal species becomes problematic. On the one hand the intentional and unintentional movement of species among the continents can be a dangerous and harmful manifestation of human selection. Controlling the flow of exotic parasites, pests, and predators will increase the cost of global commerce and disrupt short-term profits. But it will save far more in the costs associated with trying to eradicate destructive alien pests such as the zebra muscle or the Formosan termite.

On the other hand, in confronting the end of the wild, the notion of meta-reserves implies that the intentional transplanting of alien species might be desirable from an evolutionary perspective. If climate change and development are going to render some regions unsuitable for certain species, should we transplant them out-of-region to where they might thrive? For example, the Puerto Rican coqui (Eleutherodactylus coqui), a tree frog, is under increasing pressure from development and pollution at home. But in Hawaii (where they were illegally transported) they are thriving. Habitat substitution in the face of dynamic environmental change is not the same as biotic homogenization. Should we oppose it or employ it?

Finally, prohibitive policies such as the U.S. Endangered Species Act and CITES need to be kept in place and strengthened. Although they are at best stop-gap measures, they buy time for us to examine the ecological roles of relic and ghost species and assess the impact of their loss. Perhaps more significant is their moral imperative. Like the Ten Commandments, they remind us who we could be. They make us examine our own behavior and obligations as the planet's stewards while giving pause to the brazen and needless destruction of species in our own backyards.

The end of the wild does not mean a barren world. There will be plenty of life. It will just be different: much less diverse, much less exotic, far more predictable, and—given the dominance of weedy species—probably far more annoying. We have lost the wild. Perhaps in 5 to 10 million years it will return.
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Recommended reading


Gret Wulf et al., “Ecological Footprint to Recent Climate Change,”