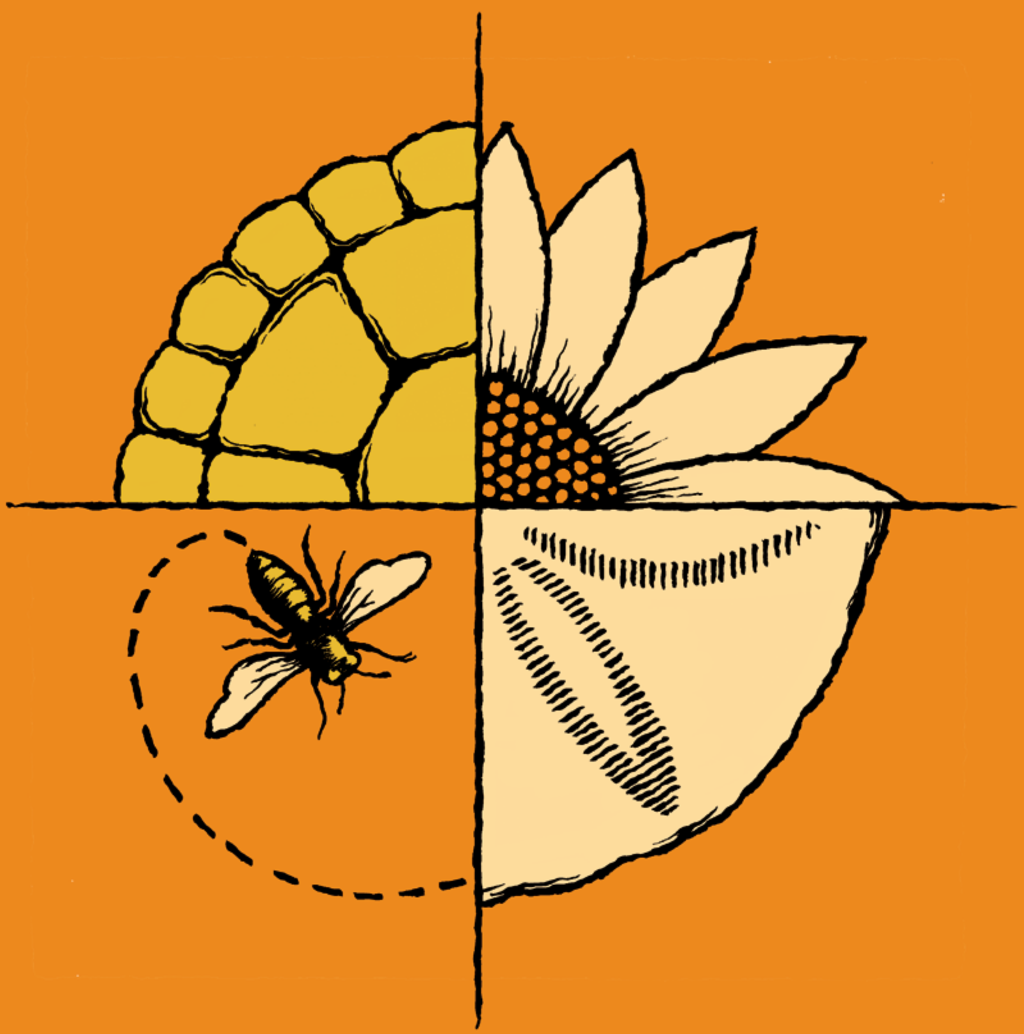
The Post Carbon Reader Series: Biodiversity

Peak Nature?

By Stephanie Mills, LHD



About the Author

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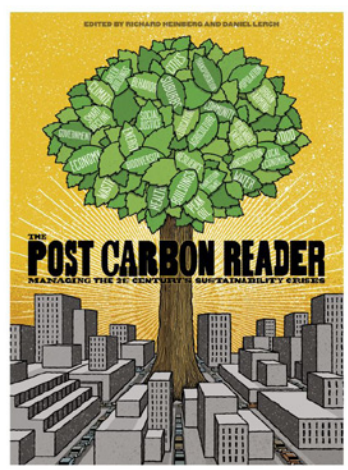

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The first rule of intelligent tinkering is to save all the parts.
—Aldo Leopold

Over the vast spans of geologic time much of Earth's surface has been bared and flooded, dried out and iced over. But since life first appeared in the form of bacterial cells 3.9 billion years ago, it has been proliferating, evolving, adapting, and diversifying (or succumbing amidst all these changes).[1]

Nearly 4 billion years' worth of trial and error, calamity, extinction, coevolution, and symbiosis have produced *biodiversity*: the phenomenal multitude of species on Earth. It's estimated that between fifty million and one hundred million different kinds of microbes, fungi, plants, and animals make up this wild richness of life. Just a single hectare of Atlantic Coastal Rainforest may harbor as many as 450 species of trees, to say nothing of its flowers, insects, mammals, reptiles, and amphibians.[2] Moreover, diversity begets diversity—it's a cumulative process.[3] Earth's current biota may in fact be richer than ever before because over hundreds of thousands of years, the evolution of species has, on average, exceeded extinction rates.[4]

Evolution is the process by which species diversify and descend from other ancestral organisms. Over time, populations of different organisms adapt and flourish in their niches. Natural selection preserves the traits that help species flourish. A critter whose chance markings provide better camouflage in its native environment, for instance, is likelier to survive to produce offspring that may bear those traits forward. Eyes, noses, claws, fins, tentacles, pigments, scales, leaves, buds, needles, pheromones, gestation, metamorphosis, and sensation are among evolution's countless feats. Geographic isolation combined with successful reproduction can eventually give rise to new species, organisms different enough from their precursors that they cannot interbreed.

Ecosystems

Ecosystems are interdependent ensembles of organisms engaged in give-and-take where all beings are in dynamic relation in space and time. They exist at various orders of magnitude, from the microscopic to the planetary. At the grandest scale is Earth's ecosystem. According to atmospheric chemist James Lovelock's Gaia hypothesis, Earth acts like an organism, trending toward conditions favorable to life. Gaia, says Lovelock's colleague Lynn Margulis, is "a convenient name for an Earthwide phenomenon: the regulation of temperature, acidity/alkalinity, and gas composition… the series of interacting ecosystems that compose a single huge ecosystem at the Earth's surface."[5]

Closer in are the distinct microbial ecosystems flourishing in various regions of the human body, from the crooks of our elbows to our lower intestines. The crucial point is that ecosystems—of any size—are made up of interrelated organisms evolving and adapting to their particular environments as communities.

The vast majority of species comprising Earth's biodiversity are wild. Without them we humans would not and could not exist. These wild species provide "ecosystem services" such as food from soil and sea, production and maintenance of oxygen and other gases in the atmosphere, filtration and detoxification of poisons, climate moderation, regulation of freshwater, decomposition of wastes, recycling of nutrients, soil creation, control of pests and disease vectors, and storage of solar energy in food and fuels. They also serve as an immense trove of the genetic information that will allow for future evolution.[6]

The Benefits of Biodiversity

The word *biodiversity* usually conjures up images of fantastically colored rainforest frogs, immense denizens of the deep ocean like giant squid and great whales, and the "charismatic megafauna" of countless nature shows—great beasts like lions and wolves and the hoofed animals like zebra, antelope, elk, and bighorned sheep on which they prey. But, critically, biodiversity also includes myriad inconspicuous beings like bacteria, insects, bats, and rodents, whose roles in the web of life are fundamental. A fourth of the fearsome grizzly bear's annual calorie intake comes from hordes of Miller moths.[7]

Our own calorie intake also depends on insects. About 70 percent of Earth's flowering plants depend on insect pollination. These plants include most of the crop species that provide about a third of the foods and beverages we consume.[8] Many wonderfully elaborate and exclusive relationships—called mutualisms—have coevolved between wildflowers and pollinators. Deeply hidden nectars lure in the long bills of hummingbirds or proboscises of moths. Some tropical orchids draw bees to gather their special scents, and then festoon the insect with pollen to carry away to another blossom. Such wild pollinators—including not only insects but bats and birds as well—are essential to the survival of the plants they've evolved with.[9] But many pollinators are threatened, including the all-important domesticated honeybee. A syndrome called colony collapse disorder began threatening beehives around the world in 2006. Some commercial beekeepers have lost 30 to 90 percent of their hives. In Maoxian, China, one place where honeybees have vanished entirely, hand-pollinating a hundred apple trees now takes as many as two dozen human workers to do the work of two beehives.[10]

In nature there is no waste, but rather death and transformation. Without the ecosystem services of what are called detritivores—critters that dine on organic debris—and other reducers of carrion and leaf fall, we'd be neck deep in corpses and dead vegetation. Vultures, fungi, bacteria, larvae, and beetles are among biodiversity's undertakers, consuming the dead and transforming them into the makings of soil and future creatures. One such wild mortician is the endangered American burying beetle, big as a thumb, which can scent a small carcass from as far as two miles away. The male and female beetles, ace recyclers, cooperate to bury the corpses they find and feed them to their larvae.[11]

All the intricately related functions and life-support services of wild nature are "on so vast a scale that there is no way we could recreate them or are so complex that we barely understand how they work."[12] To replace or synthesize affordable substitutes would be impossible. Beneficial relationships abound. In ponderosa pine forests, for example, chickadees and nuthatches foraging for insect larvae that dwell in cracks and crevices in the trees' bark in effect groom the trees by devouring pests. Pines visited by these tireless avian predators enjoy relatively greater health and growth.[13]

The Wild Roots of Agriculture

Every plant, animal, or insect (like the honeybee) that we depend on for food and fiber descended from a wild ancestor. We are heavily dependent on just a handful of domesticated plants and animals. Nine-tenths of global livestock production is made up of only fifteen mammal and bird species, and three-quarters of our food supply comes from only twelve plant species.[14] Raised in monocultures and selectively bred for hundreds of years, these domesticated plants and animals are much less resilient to parasites and diseases than their wild ancestors. The Irish potato blight of 1845–1852 wiped out the single crop that multitudes of people had come to depend on, helping kill or exile millions. Given such vulnerability, we need to preserve not only the diversity of plants and livestock developed by the farmers and gardeners around the world who bred varieties adapted to their specific bioregions, but also the diversity of the wild lands where these stocks originated as reservoirs of genetic diversity. The wild matrix bordering fields and human settlements harbored animals that maintained ecological balances important to human health. By converting wild land to cropland, and by battling organisms that consume or compete with crops and livestock, agriculture reduces biodiversity. Habitat conversion can eliminate predatory animals, which, relative to their prey, are few in number and not prolific. And in the absence of predators, populations of prey species—some of which, like rodents, can harbor human infectious disease—may irrupt.[15]

The Ground of Being

Whether we live in the town or in the country, our lives depend utterly upon the living soil. Soils, as diverse as the geologies underlying them and the latitudes where they are found, are created as vegetation slowly colonizes bare ground. Plants live, die, and decay to become the humus that will grow other ensembles of plants, also mortal, whose remains will supply yet more nutrients and texture to the earth. Healthy soil is rife with biodiversity, teeming with billions of organisms per cubic meter—galactic numbers of nematodes, earthworms, mites, protozoa, algae, fungi, and bacteria. Together these creatures maintain the soil's structure, regulate the movement of water within the soil, sequester carbon, control plant growth, and provide food and medicine.[16]

Soil that's unprotected by vegetation is vulnerable to erosion. The mudslides that can follow forest clear-cuts and the countless tons of heartland topsoil sent downriver since the plow broke the plains so testify. Thus soil conservation is another crucial ecosystem service provided by biodiversity. Even in seemingly stark, arid lands, living, photosynthesizing communities of organisms called cryptogamic crusts protect desert floors. Composed of algae, cyanobacteria, and fungi, these subtle alliances of communities protect the crumbs of soil where they, the cacti, grasses, mesquite, and other desert plants grow.[17]

Vegetation and precipitation are interdependent: Plants draw soil moisture up through their roots, stems, trunks, and branches and emit water vapor from their foliage. The process, called evapotranspiration, influences cloud formation over landmasses. Thus deforestation generally leads to a decrease in rainfall.[18] "Forests precede civilization, deserts follow," remarked Chateaubriand. Plants sequester carbon dioxide, which, in excessive amounts (along with other greenhouse gases), destabilizes the climate. Hence the biodiversity embodied by forests and other plant communities has provided the tolerable climate and the water cycles that life depends on.

The biodiversity found where land and water meet can make a life-and-death difference for oceanic ecosystems.

Water and Life

Sooner or later, most animals, including us, are drawn to streams, shores, ponds, and rivers. Water is life. Yet as human settlements grow, streams and the never-too-popular swamps and sloughs come to be used as sewers and seen as nuisances. We capture watercourses in culverts, drain wetlands, and fill shorelines.

But the biodiversity found where land and water meet can make a life-and-death difference for oceanic ecosystems and coastal settlements. Marshes, swamps, and everglades filter and clean runoff from the land and help mitigate the intensity of floods, which now affect more people than all other natural or technological disasters combined.[19] Fresh- and saltwater wetlands structurally mediate the encounter between sea and shore in different ways, gentling the forces of floods, waves, and storms.

Tidal marshes and mangrove forests, in particular, provide niches for plants and animals that can take advantage of fluctuating water levels, and varying concentrations of salt. Mangrove trees with all their roots buffer shorelines and are nurseries for commercially important fish. They also provide habitat and nesting sites for birds and host communities of mollusks, like snails, and crustaceans, like crabs. Yet assaults from shrimp aquaculture and logging have eliminated half or more of the mangrove swamps in some countries.[20]

Beyond the coasts and over the ocean horizon, marine biodiversity is in trouble. Coral reefs, "rainforests of the ocean," are created by colonies of calcium-depositing spineless (invertebrate) wonders. In the deep seas, corals provide habitat for other invertebrates like sponges, anemones, and countless fish, as well as for wondrous critters like feather dusters and basket stars.[21] Unfortunately, increased atmospheric carbon dioxide is being absorbed by the world's oceans, acidifying their waters and making calcium deposition more difficult. Some algae—the plant life at the base of marine food chains—also are severely affected by this change in the oceans' chemistry.[22]

Overfishing has catastrophically depleted species like cod, halibut, tuna, and billfish. But by keeping food webs intact, marine reserves—high-seas regions where overfishing and pollution are controlled—help fish populations rebound and support the resilience of the corals those fish depend on. In such reserves, corals are more resistant to the killing effects of climate change.[23]

Climate Change

Phenology studies the recurring periodic phenomena of the wild—the landfall of the first monarch butterfly, the first flowering of the milkweed, the hatching of the first clutch of killdeer. Long-term phenological observations now supply definite evidence of climate change. Distribution of species, the size of their populations, and the timing of migration and mating have all been variously affected. Throughout the Northern Hemisphere, spring is beginning earlier. Pest and disease outbreaks have increased in frequency, especially in forested areas.[24]

Because we human beings—given our high-functioning brains and the technologies we have developed with them—are among the most adaptable animals of all, we may not comprehend that climate change can happen too rapidly for evolutionary adaptation to occur among other, less generalist organisms.[25] Timing can be everything. The direct and indirect effects of climate change, say Stuart Pimm and his colleagues, will result in the extinction of 15 to 37 percent of Earth's species by 2050.[26] One example is the adorable pika, a rabbit relative whose hibernation in its montane scree crevices is being cut short by earlier spring thaws and warmer temperatures. Exposed to intolerable early heating, pikas are running out of higher, cooler elevations to retreat to, and extinction threatens.[27]

Consumption

Virtually every human threat to other species and their habitats is driven by economic growth and by our consumption, be it of food, energy, products, or even scenery. Sustaining what remains of the planet's biodiversity ultimately will require a paradigm shift in economics and far better public understanding of the connections between the things we consume, their places of origin, and the consequences of their extraction and production.

Some threats to biodiversity, like climate change, are planetwide and civilizational. Others are more localized and have particular causes, like the logging of nearly 2 million acres of the northern temperate and Arctic (boreal) forest annually. Some three hundred species of birds breed—and about five billion birds summer—in this vast forest, which stretches from Newfoundland to the Yukon. Two-thirds of the logs extracted from these

rich terrains are pulped for mail order catalogs, facial tissue, and toilet paper.[28]

In an age of extinctions, some forms of consumption—fashions in wild furs, virility medicines made from endangered animals or plants, and gourmet dining on rare fish and game—are blatantly unconscionable. Less elite consumers can help conserve biodiversity by dietary change: eating little or no meat, avoiding palm oil (its cultivation for food and biofuel is converting vast tracts of Asian rainforest to plantations), and selecting shade-grown coffee and organic bananas (whose cultivation is friendlier to tropical environments).[29] Because gold mining causes massive damage to lands and cultures, resulting in millions of tons of waste for every ton of gold produced, refraining from purchasing new gold can be a gesture toward protecting lands, waters, and human rights.

Even if we do diminish our consumption and find more sustainable ways of producing our necessities, a decline in human population is ultimately essential for biodiversity to rebound. A reduction in the number of births per woman to replacement level or less should be the aim. Fortunately, the means to that end coincide with female emancipation: Free and universal access to health services, including contraception, abortion, and maternal and infant care, as well as education and economic opportunities for women all are conducive to smaller families and greater equity and well-being.

Pollution

In the dwindling of fossil fuels there's good news and bad news for biodiversity. Rapid, drastic disruption of habitats with heavy equipment may become prohibitively expensive. Slowing industrial production, and the deepening scarcity of oil as a feedstock for the petrochemical and plastics industries, may mean a decline in the production of persistent organic chemical pollutants. A reduction in the variety and quantity of immortal waste being dumped on the planet would reduce the suffering of countless beings. For instance, gazillions of tiny pellets of plastic called "nurdles" now pervade the world's oceans. Raw plastic is shipped to manufacturers in the form of nurdles, which are about the size of fish eggs. Hapless sea life ingest nurdles (loosed in the wild from spills and careless handling in the plastics industry) as well as other fragments of broken-down plastic (blown out of open landfills, dropped down sewer grates, fallen off ships). This garbage often fatally blocks their digestive systems.[30]

The present ensemble of life forms evolved in the absence of the high levels of noise, artificial light, electromagnetic radiation, radioactive fallout, synthetic chemicals, nanoparticles, and transgenic organisms that have been unleashed in recent decades. These novel phenomena can spell disaster for wild beings. Across North America, city and suburban lights lure a hundred million migratory birds to their deaths annually in collisions with buildings.[31] Nanoparticles cross the blood-brain barrier in vertebrates, genetically engineered crop plants hybridize to create herbicide-resistant weeds, and hormone-mimicking chemicals affect reproductive physiology across a wide range of animals, from alligators to *Homo sapiens*.

In light of such unintended consequences, the precautionary principle should govern the allocation of intellectual and material resources to shaping the technologies of sustainability. This holds that "where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation."[32] ("An ounce of prevention is worth a pound of cure," in the vernacular.)

The Extinction Crisis

As it has grown in numbers and technological might, the human race has become a force of geophysical proportion, on par with the asteroid that struck the Yucatán during the Cretaceous era, dethroning *Tyrannosaurus rex*.[33] Extinction is final. Yet no species is immortal. Extinction has been part of evolution since life emerged on Earth. Over the billions of years of life's history, innumerable life forms have flickered out, sometimes individually, occasionally en masse. Heretofore there have been five extinction events so massive that 50 to 95 percent of all species died out.[34] These mass extinctions all seem to have involved long-term pressures on ecosystems, like ice ages, global warming, or continental drift, combined with sudden catastrophes like volcanic eruptions, gamma-ray bursts, and impact events like the asteroid collision that put paid to the dinosaurs.[35]

The normal rate of extinction is about one in a million species per year.[36] The extinction rate today is between 100 to 10,000 times that. (The numbers vary so because an accurate census of life on Earth is likely impossible. Of the 50 million to 100 million species living on Earth, only about 1.75 million have been described.)[37]

Our species has deforested, plowed, bulldozed, dredged, drained, dammed, polluted, or paved one-half to one-third of the land surface of Earth.[38] "The structure and function of the world's ecosystems," states the United Nations' Millennium Ecosystem Assessment, "changed more rapidly in the second half of the twentieth century than at any time in human history," resulting in a "substantial and largely irreversible loss in the diversity of life on Earth."[39] Because the

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richness of biodiversity is directly related to the extent of wild or undamaged habitat, human activity is causing Earth's sixth mass extinction.

These changes and losses are driven by population growth, increased economic activity, and cultural and technological changes. These variously result in conversion of forests to cropland, intensified fishing, building of more dams and reservoirs, accelerated movement of invasive species around the world, and increased nutrient loading in water bodies (which causes algal blooms and a proliferation of "dead zones" offshore).[40]

Alien Invasions

Conservation biologists rank alien species invasions as second only to habitat loss in threatening the survival of biodiversity. Alien or weedy species are simply "plants [or animals] out of place," by one definition. Transported deliberately or inadvertently to new lands beyond their normal range, these organisms may find themselves free from the predators, parasites, or diseases that formerly kept their numbers in balance. Invasive plants may multiply so plenteously that they outcompete the diverse native flora and end up changing ecosystem processes, indeed changing "the rules of the game."[41] Thirsty alien trees like tamarisk, melaleuca, and eucalyptus, for example, can drastically change the hydrology of their new homes. Invasive animals like the green iguanas, boa constrictors, cane toads, and dozens of other exotic reptiles and amphibians now reproducing in Florida upset the ancient balance of nature.[42]

Once introduced, alien plants and animals are virtually impossible to extirpate. With effort, their numbers can be controlled and new infestations nipped in the bud. Around the shores of the Great Lakes projects to control spreading infestations of the common reed, *Phragmites australis,* are under way. This brawny plant forms dense single-species stands whose rhizomes (rootlike structures) may grow six feet a year, and, when broken up by natural or human action, readily grow into new plants. *Phragmites* colonies degrade wildlife habitat and dry up marsh soils as they spread. Herbicide application, not an activity for amateurs, is considered to be necessary to control *Phragmites*. In areas where the infestations are minor, hands-on community involvement in the monitoring and control of the plant can become part of a cultural commitment to maintaining a region's ecological resilience. (And who knows? Post peak oil, if asphalt shingles are priced out of the market, thatched roofs might make a comeback, creating a demand for *Phragmites*.)

Wildlands Preserves

Biodiversity preservation must undergird serious strategies for transitioning to the post-fossil-fuel world with its rapidly changing climates. This means securing wild places where ecosystems can persist or recuperate. In the near term, saving biodiversity will require strategic intervention, cooperation, and commitment at the international level. There's broad consensus that a global system of ecological preserves and heritage sites must include healthy, representative examples of the planet's many types of ecosystems, or biogeographical provinces, as well as species-rich biodiversity hotspots (see box 8.1).

Conservation biologist Michael Soule nominates habitat fragmentation and degradation, climate change, and the extirpation of large predators as the three major causes of "ecological wounds."[43] This implies that ecosystem preserves not only must be representative, they must be unfragmented, sufficiently large, strategically oriented with respect to climate change, and interconnected.

"One of the few straightforward laws of ecology," writes paleontologist Anthony Barnosky, is "bigger pieces of real estate support more species. This is called the species area relationship... u]se it to predict how many species you might lose if you reduce the size of the real estate that contains suitable habitat."[44] To establish adequately large preserves, landscape-scale restoration, of which we'll learn more later, will likely be necessary. Within biomes or ecoregions, preserves must be connected, particularly along north-south axes to allow for both normal and climate-driven migration. "A parcel of geography," writes Barnosky, "won't preserve a particular assemblage of species if their needed climate at that locus disappears."[45] Thinking big enough for North America, Michael Soule proposes "saving the Spine of the Continent, a 5,000 mile long cordillera extending from the North Slope of Alaska to the Sierra Madre Occidental of Sonora... from the Arctic to the subtropics."[46]

To function naturally, ecosystem preserves must be big enough to support a full complement of plants and animals, including "keystone species." Keystone species are plants or animals that play a pivotal role in their

BOX 8.1

The United Nations' Year of Biodiversity

Recognizing that the threats posed by the loss of the planet's biodiversity are quite as grave as the consequences of climate change, the United Nations declared 2010 to be the Year of Biodiversity. The aim was to produce a binding agreement on targets to curb biodiversity loss at an October 2010 meeting of the 193 countries that have signed the U.N.'s Convention on Biological Diversity.

Source: Stephen Leahy, "Biodiversity: A Tipping Point on Species Loss?" *Inter Press Service News Agency*, January 17, 2010, http://www.ipsnews.net/print.asp?idnews=49964.

ecosystems and often require extensive territories. When they are removed, as with the removal of the keystone of an arch, the whole structure is weakened. Keystone species may be trees whose nuts provide food at a critical time, like the dead of winter, tiding other important members of the community through. They may be habitat-reforming species like elephants, whose foraging and trampling keeps grasslands and savannas open to sustain all the grazing animals that depend on them, or like beavers, whose dams create wetlands, replenish aquifers, and provide habitat for fish, frogs, and waterfowl. When keystone species perish, the ecosystems that pivot on them lose diversity, resilience, and function.

Predators and Prey

Eat *and* be eaten is the first rule of life's game. Biodiversity depends on the dynamic balance between predator and prey species. "The world is green," writes Julia Whitty, "because carnivores eat herbivores." Wipe out predators, which may be seen as competitors vying with humans for economically valuable plants or animals, and ecosystems deteriorate. On the land, these "trophic cascades" (*trophic* means relating to feeding and nutrition) can unfetter populations of hoofed vegetarians like the white-tailed deer and midsized or "meso"-predators like feral and house cats, skunks, raccoons, and foxes.[47] Among their other misdeeds, mesopredators can decimate bird and reptile populations.

The larger herbivores aren't much better, because unconstrained browsing of plants changes everything, including watercourses where streamside vegetation is stripped away. When wolves were reintroduced to Yellowstone National Park, elk backed away from the rivers, and shrubs and trees grew back to shade the water. Cooler water helped trout recover, which gladdened the fly fishermen.[48]

Hotspots

Much of Earth's wealth of species is concentrated in what are called biodiversity "hotspots." Many but not all of these are forested or tropical. Conservation biologist E. O. Wilson's strategy for protecting Earth's remaining biodiversity calls for salvaging the hotspots, protection for lakes and river systems everywhere, identifying centers of marine biodiversity, keeping intact the five remaining "frontier forests"—the rainforests of the Amazon basin and the Guianas region, the forests of the Congo and New Guinea, and the temperate conifer forests of Canada, Alaska, Russia, Finland, and Scandinavia—and ending all logging of old-growth forests.[49]

A more recent (and perhaps too modest) proposal suggests that preserving just twenty-five biodiversity hotspots (under 2 percent of Earth's land) would help protect nearly half of all vascular plant species (these being plants complex enough to have circulatory systems) and more than a third of all vertebrates. The annual cost of protecting and preserving these ecosystems, and doing so in ways that don't alienate or impoverish their human neighbors and inhabitants, would be only a trifling half billion dollars—which is cheap compared to bailing out the global financial system.[50]

In earlier times and cultures, the practice of venerating particular animals or plants as totems or regarding certain places as sacred deeply informed the human sense of landscape and set ritual limits on the exploitation of those beings. The ancient custom in China of setting aside temple groves, for instance, secured the survival into the present of the venerable gingko tree, a plant that evolved 270 million years ago but has few wild stands remaining.[51]

In our day, human calamities have created de facto wilderness preserves. The 151-mile-long, 2.5-mile-wide demilitarized zone between North and South Korea—a no-man's-land since 1953—has become a wildlife refuge where Amur leopards, Chinese water deer, Asiatic black bears, Eurasian lynx, musk deer, and yellow-throated martens survive. Red-crowned cranes winter there, and probably wouldn't survive without its protection.[52] "Eden with a million land mines," one writer calls it.[53]

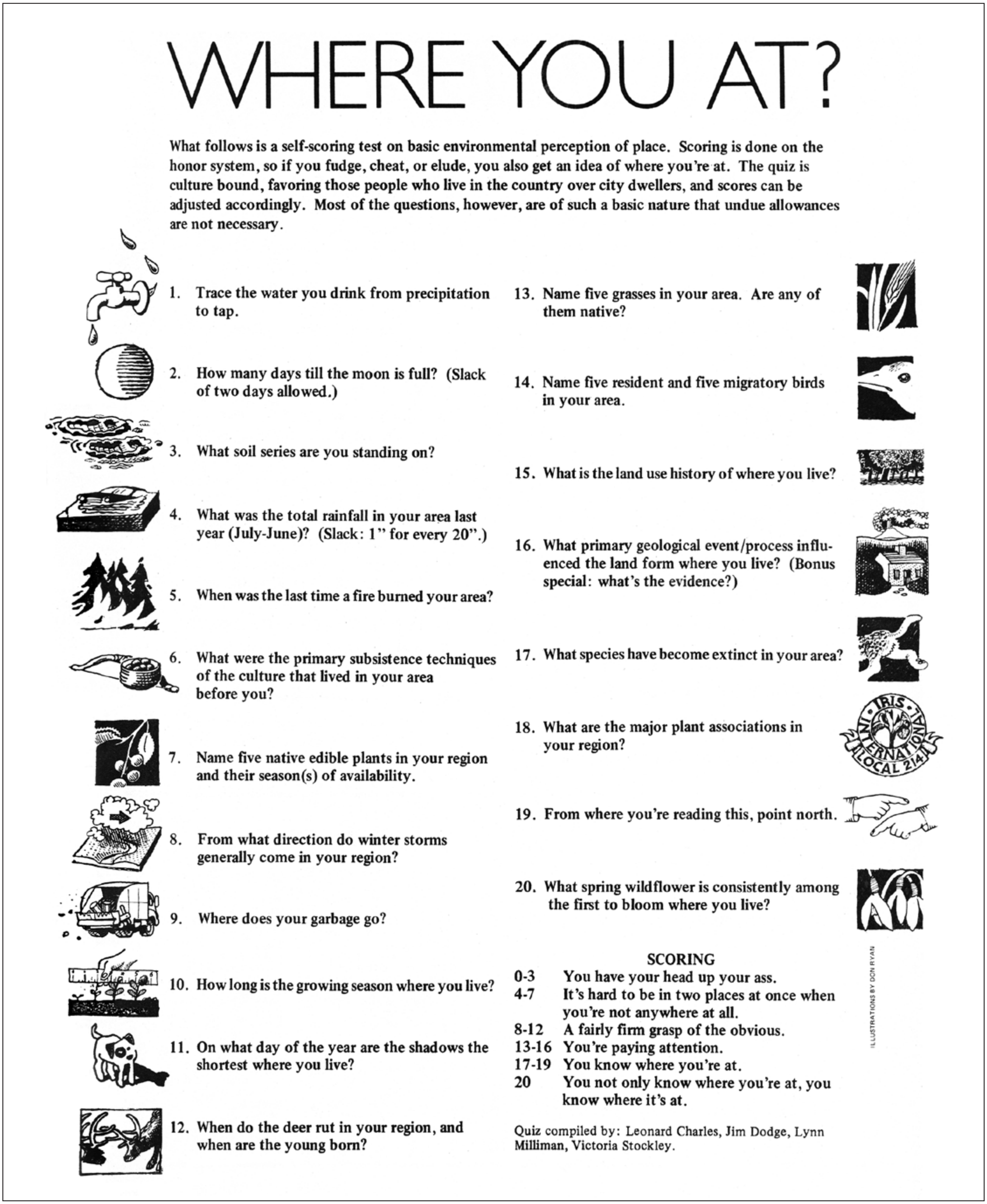
Sense of Place

Among species, *Homo sapiens* is something of a latecomer, having descended from hominid ancestors about 100,000 years ago. (Some other organisms, like the *Triops* tadpole shrimp, have been around in their present form for 400 million years.)[54] Fishing, hunting, and gathering wild foods nourished and stimulated human beings to develop strength, skill, intelligence, and material culture. Reaping biodiversity in the form of game, edible plants, medicinal plants, or useful fiber still is an essential part of daily life for many people around the world, supplementing and enhancing diets and health, and providing food, shelter, and clothing independent of the money economy.

While the industrial era of cheap energy has accelerated urbanization and sprawl, removing humans from natural environments (and vice versa), research mounts that argues the obvious: Optimum human development requires time in the out-of-doors amid green and growing things. Children and adults who spend time in nature—in woods, vacant lots, or even gardens—are happier, healthier, calmer, less prone to obesity, and have a greater ability to focus and reflect.[55] As the late cultural historian Thomas Berry put it, "If human consciousness had evolved on the moon, it would be barren as the moon."

FIGURE 8.1

"Where You At?" quiz. Reprinted from *CoEvolution Quarterly,* winter 1981.



WHERE YOU AT?

What follows is a self-scoring test on basic environmental perception of place. Scoring is done on the honor system, so if you fudge, cheat, or elude, you also get an idea of where you're at. The quiz is culture bound, favoring those people who live in the country over city dwellers, and scores can be adjusted accordingly. Most of the questions, however, are of such a basic nature that undue allowances are not necessary.

1. Trace the water you drink from precipitation to tap.
2. How many days till the moon is full? (Slack of two days allowed.)
3. What soil series are you standing on?
4. What was the total rainfall in your area last year (July-June)? (Slack: 1" for every 20".)
5. When was the last time a fire burned your area?
6. What were the primary subsistence techniques of the culture that lived in your area before you?
7. Name five native edible plants in your region and their season(s) of availability.
8. From what direction do winter storms generally come in your region?
9. Where does your garbage go?
10. How long is the growing season where you live?
11. On what day of the year are the shadows the shortest where you live?
12. When do the deer rut in your region, and when are the young born?
13. Name five grasses in your area. Are any of them native?
14. Name five resident and five migratory birds in your area.
15. What is the land use history of where you live?
16. What primary geological event/process influenced the land form where you live? (Bonus special: what's the evidence?)
17. What species have become extinct in your area?
18. What are the major plant associations in your region?
19. From where you're reading this, point north.
20. What spring wildflower is consistently among the first to bloom where you live?

SCORING

0-3 You have your head up your ass.
4-7 It's hard to be in two places at once when you're not anywhere at all.
8-12 A fairly firm grasp of the obvious.
13-16 You're paying attention.
17-19 You know where you're at.
20 You not only know where you're at, you know where it's at.

Quiz compiled by: Leonard Charles, Jim Dodge, Lynn Milliman, Victoria Stockley.

ILLUSTRATIONS BY DON RYAN

Although you don't have to know the birds or the plants to tell when you're on the front range of the Rockies, in the Mojave Desert, or at the shore of Lake Michigan, learning the flora and fauna of a place can make for a much richer sense of place. This kind of knowledge is vital. As we have seen, Earth is paying a heavy price for modern ecological illiteracy. The transition to a post-carbon, post-growth future means relocalizing and *reinhabiting* certain places, learning where we're at (see figure 8.1).

For many reasons, wonder and pleasure not least among them, we may be turning our attention toward the natural history of our surroundings to form working and supportive alliances with all the other living creatures that make our places what they are. Outdoor education is critical and, when offered, immensely popular. Schoolchildren avidly monitor the minute life in streams to help assess water quality. Volunteers across the country join in annual bird, frog, and butterfly counts, helping to monitor the condition of whole families of organisms.

Given the gravity of the wounds to the planet's ecosystems, future ecosystems are unlikely to resemble those that enlivened Earth during the Cenozoic era, when mammals and flowering plants came to dominance. Still, humanity will need to learn how to reinhabit post-Cenozoic ecosystems and to participate in them rather than living at their expense. Natural history is the original festival calendar. The sustainable cultures to come are likely to take their diets, occupations, themes, calendars, and boundaries from their natural surroundings, just as cultures did before imperialism, industrialization, and globalization. The more biodiversity that remains in our terrains, the more possibilities there will be for discovery, inspiration, and resilience in this geologic era of our doing.

In the Sky Islands wildlands of the southwestern United States and northern Mexico, several hopeful ventures in evolutionary diplomacy are under way. Some ranchers are restoring creeks in these rugged grasslands, reintroducing extirpated species from Sonoran mud turtles to prairie dogs, modifying their range-stocking and grazing practices, and, in some cases, also reintroducing predators like Mexican wolves, mountain lions, and exceedingly rare jaguars. The ranchers know what's at stake: "The loss of one species is usually an indicator of an ecosystem out of balance and a larger domino effect to come, to which cattle will also ultimately fall victim."[56] More than just a good business or environmental decision, the Sky Islands ranchers' actions represent a cultural shift toward appreciating that the land's natural biodiversity has intrinsic value and can ultimately add economic value to diversified ranch or farm operations. These foresighted ranchers understand that by shedding the stockman's historic hostility to predators and managing their lands regeneratively they are strengthening the greater ecosystem on which their livelihood depends.

Restoration

Regaining local knowledge is the practice of ecological restoration: learning about the primal condition of our bioregions' past, assessing their present conditions, envisioning the persistence of their native ecosystems, and then doing the work to ensure it. Full ecological restoration, say biologists, is "nothing less than the reestablishment of a completely functional ecosystem, containing sufficient biodiversity so that it could continue to mature and evolve over time."[57]

Ecological and wildlands restoration is both labor and intelligence intensive. It involves weeding out exotic species, propagating and planting natives, rehabilitating watercourses, protecting recovering areas, and sometimes seeing them gloriously rebound. Restorationists hope to preserve endangered plant and animal species. Communities that have done their natural-historical homework can engage in various forms of restoration work from gathering seeds and propagating native wildflowers to planting and tending native tree species and "de-roading" wildlands. Sensitively planned and locally directed, ecological restoration could be the basis of a planetary jobs program.

The hope of "rewilding" large landscapes follows on such restorative activities as removing roads from lands such as forests and other habitats healthy enough to knit themselves back together once motorized vehicle access is eliminated. If large enough expanses of certain kinds of ecosystems, like prairies, can be reassembled, and natural disturbances like fires restored, then their earlier, richer, more resilient character—not to mention a measure of excitement—can be achieved by reintroducing large animals, like the bison on the plains, to resume their ecological roles.

The basic precepts of protecting, enlarging, restoring, and reconnecting natural ecosystems can be applied at the municipal and even backyard levels as well. Suppose there's a remnant handful of native tree species or shrubs in the backyard or city park. Identifying those plants, learning and celebrating their natural and cultural history, and then working to preserve, protect, and increase their territory would strengthen local biodiversity.

Perhaps there are native bird species in your vicinity whose numbers might increase if properly proportioned nest boxes were provided and feral and outdoor cats removed. Pollinator gardens and nectar corridors can be created to support native invertebrates—like wasps, bees, beetles, moths, and butterflies—providing the flowers they need for nectar, or the foliage their larvae need for food. Landscaping with native plants is multipurpose action for biodiversity. Not only does it increase the population of non-weedy species and increase habitat for smaller wildlife, but, once established, native plant landscapes (which consist of species evolved to be resilient locally) generally require less water and maintenance.

While many of the changes needed to make human communities stable, self-reliant, and carbon neutral will reduce the pressure on natural systems, ecological restoration could enrich and positively transform land uses like farming, gardening, and forestry. By reinstating some richness to damaged lands, restoration might promise future livelihoods for wildcrafters gathering herbs, basketry materials, mushrooms, and other edibles. With careful, concerted action on and help

BOX 8.2

Nature's Right to Life

The Endangered Species Act (ESA) is perhaps the most biocentric law on the books. (Ecuador's new constitution, however, goes further in principle by situating nature's right to continuance at the foundation of governance.) The ESA sailed through Congress in 1973. Intended to prevent extinctions, it mandates certain federal agencies to identify and list endangered and threatened plant and animal species according to strictly biological criteria, without regard to economic considerations, and to conduct programs, which may involve designating and protecting habitat critical for the recovery of these species.[1] It bars federal activities that might threaten listed species or their critical habitat. Its protections extend to private lands, to the oceans, and across national frontiers. Although the government's enforcement of the law has been limited and, depending on who's in power, willfully lax, the ESA has a strong citizen-enforcement provision. This has empowered biodiversity activists to litigate successfully on behalf of endangered species ranging from the polar bear, whose sea ice habitat is threatened by climate change, to the Peterson's milk vetch, a fragile desert flower—and to get millions of areas of critical habitat designated.[2]

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from nature's phenomenal capacity for regeneration, the transition beyond fossil-fuel-dependent industrial civilization to a stable world of flourishing, land-based communities may find our descendants inhabiting a planet that still hosts a wild variety of life and culture.

Naked new volcanic islands born out of the spreading seafloor by and by receive bird, plant, spider, and insect colonists that multiply and are eaten or simply die—all becoming soil to host more variations of form and greater diversity. We can take some comfort from such patterns. Life wants to live. Recovering from mass extinctions is nothing new for planet Earth, although it may take 10 million years or so for such a richly diverse community of organisms to evolve again. For our part, and for the sake of the world to come, we must become a constituency for wild nature and do everything within our power to mitigate the extinction crisis we are causing (see box 8.2).

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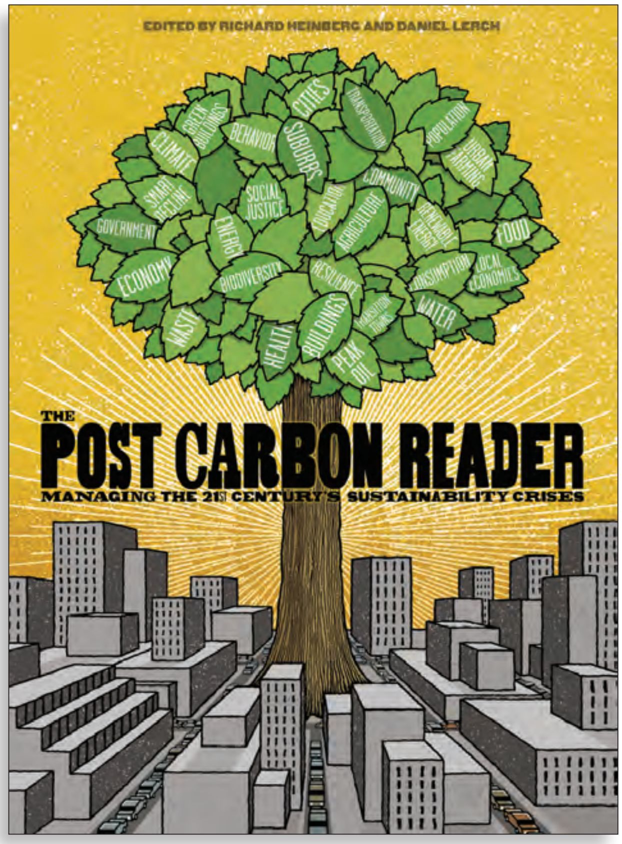

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