Earth 2020

An Insider's Guide to a Rapidly Changing Planet

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https://www.openbookpublishers.com

ISBN Paperback: 978-1-78374-845-7
ISBN Hardback: 978-1-78374-846-4
ISBN Digital (PDF): 978-1-78374-847-1
ISBN Digital ebook (epub): 978-1-78374-848-8
ISBN Digital ebook (mobi): 978-1-78374-849-5
ISBN Digital (XML): 978-1-78374-850-1
DOI: 10.11647/OBP.0193

Cover image: *Earthrise* (24 December 1968). Photo taken by Apollo 8 crewmember Bill Anders, Wikimedia, https://commons.wikimedia.org/wiki/File:NASA_Earthrise_AS08-14-2383_Apollo_8_1968-12-24.jpg

Cover design: Anna Gatti

Everyday Biodiversity

Jeffrey R. Smith and Gretchen C. Daily

For many living in the urban century, waking up to a raucous dawn chorus of birds is a near-unimaginable possibility. The shift from birdsong to the alarm clock (and now the smart phone) emblemizes the dramatic transformation of human experience of nature throughout our daily rituals. It underscores how accustomed we've become to the synthetic world we've created, and our growing alienation from the declining biodiversity around us — with wild bird populations in the United States and Canada having dropped by nearly 30% since the 1970s.[1] This is a case of 'shifting baseline syndrome', where we acclimatize to a new 'normal', failing to recognize the ongoing ecological tragedy that is unfolding around us. We go about our daily routines without thinking about the multitude of ways in which biodiversity enriches our lives, what its continued loss implies for our future well-being and how we can intervene to slow, and hopefully reverse, the dramatic global declines of nature in its variety and abundance.

If you're a coffee drinker, your very first sip in the morning connects you to an incredibly complex web of interactions between plants, animals, fungi and the biophysical systems that support them. Coffee, like tea and other domesticated crops, was once an unremarkable plant fighting for survival among thousands of other species. In its native range, it had to compete with other plants for water, sunlight and nutrients, while avoiding being eaten by insects, browsing mammals, fruit-loving birds and the like. It was this constant struggle against potential herbivores that started an evolutionary arms race

 https://doi.org/10.11647/OBP.0193.07

that led to the development of caffeine (and many other culinary delights) as a defensive compound. This evolutionary arms race drove genetic changes that created the plants we know today as *Cafe arabica* and *Cafe robusta.* Through selective breeding, we have further altered coffee biodiversity at its most basic genetic level to improve yield and quality, creating cultivars that are drought and disease resistant, and more desirable in a host of other ways. This process highlights a fundamental attribute of biodiversity; it encapsulates all levels of biological organization from the genes that make up individual species to the ecosystems that support them.

Let's turn our attention back to breakfast, considering the bowl of fresh fruit, jam spread across toast, or orange juice you might have alongside your morning coffee. Almost certainly, these fruits will have relied on pollination carried out by a bee, moth, fly, beetle, hummingbird, bat, or some other living thing. In fact, over 75% of the vitamins and nutrients we consume come from crops with animal pollinators, and our most valuable and nutritious — and most delicious — crops are, by and large, dependent on these creatures.[2] But many of these pollinators are in trouble. There has been a rapid increase in morality in managed honeybee hives, accompanied by widespread reductions in native pollinator abundance and massive declines in insect abundance generally.[3] The reasons for these declines are complex and not fully known, but likely include land-use and climate changes, pesticide use and other forms of pollution.

The global decline of pollinators is symptomatic of a much larger global trend. Since the dawn of the industrial era, species extinction rates have accelerated dramatically. Today, we are losing an estimated 1,000 to 10,000 times more species per year than would be natural under pre-human conditions.[4] And the surviving species are dwindling rapidly, with about 60% of wild vertebrate populations — amphibians, reptiles, mammals, fish and birds — shown to be in decline.[5] Today, in 2020, the total weight ('biomass') of humans and livestock is estimated to be twenty-five times larger than that of all remaining wild mammals.[6]

The trends of declining biodiversity are troubling but not mysterious. We understand the root causes. Earth's wild plants, animals and other life forms are in decline because

of overhunting and overharvesting, converting habitats into ever-expanding agricultural land and cities, and by a litany of indirect impacts, including spreading invasive species, pollution and now, increasingly, climate change. These impacts are not new. Human activity appears to have driven species extinctions for nearly 10,000 years, with much of the megafauna of the North American Continent disappearing concurrently with the arrival of the first human beings. The intensity of these pressures has only increased as our population, per-capita consumption, and technological prowess have grown. These human impacts on biodiversity became particularly notable after the Industrial Revolution when, for example, demand for feathers for the millinery trade drove the passenger pigeon to extinction. Once the United States' most ubiquitous bird, it occurred in flocks of billions that famously could take days to fly over a town.

We have reckoned with dozens of high-profile species at risk of extinction. The thin line between species survival and extinction is perhaps no more evident than in the story of the bald eagle, the national symbol of the United States. Driven to perilously low levels in the 1970s by overuse of the insecticide dichlorodiphenyltrichloroethane (DDT) and other toxic chemicals, this majestic bird presented a true crisis for American conservation, and American society more broadly. Thanks to the Endangered Species Act and other crucial legislation prompted by the first Earth Day in 1970, we have managed to recover bald eagle populations to healthy levels. In fact, the species was removed from the Endangered Species List in 2007, as its populations had sufficiently recovered to viable levels.

While the rescue of the bald eagle is only one success story, it illuminates a pathway for saving the hundreds of other species currently under federal protection. But developing sound management practices becomes more challenging, though not impossible, as we increase the scale of the factors driving species loss, the scope of the species considered, or the complexity of stakeholder relationships. These are the challenges we must face in dealing with climate change impacts on Arctic sea ice and polar bear populations, universal declines in North American grassland birds, or the impacts of wolf reintroduction into the intermountain Western United States. The successes of species-centric conservation from 1970 to today will surely guide the next half-century of conservation efforts to stave off a looming mass extinction. But one thing is certain; the sooner we act to prevent species

declines, the more successful we will be. Moreover, swift action now is likely to save us an immense amount of resources, financial and otherwise, that we would need to invest down the road to achieve the same results.

The loss of biodiversity is not just a matter of disappearing species, but also of radical landscape transformation. There is perhaps no starker example of such transformation than the rise of urban areas around the globe. While accounting for less than 5% of Earth's area, cities now house almost 60% of the human population.[7] Even prior to the rise of 'mega-cities', many of the earliest conservation movements around the world were based on the separation of human-dominated systems and wilderness areas. Beginning in the late nineteenth century with the creation of Yellowstone National Park, protected areas have played a central role in conservation. The basic idea of this approach is to establish areas for nature to thrive beyond human pressures. Research has shown that, while no place is untouched by the hands of humanity, such wilderness preserved are, indeed, essential for reducing the extinction risk of species. The designation of protected areas has only intensified in the wake of the first Earth Day, and we see campaigns for the augmentation of protected areas, with calls for 30% protection by the year 2030.

Yet protected areas will never be enough — increasingly, they are islands, too small, too few, and too remote to support the biodiversity upon which human society depends. This was perhaps one of the most visionary turns of the Environmental Movement of the 1970s. No longer was US conservation focused only upon protected areas; rather, the passage of the Endangered Species Act, the Clean Water Act and the US Clean Air Act underscored the need for biodiversity to be protected in the sea of humanity. This was done not only for the inherent value of biodiversity, but the realization that our own species depends on functioning ecosystems to provide vital life-support services. In cities, for example, green spaces and street trees reduce temperatures in urban heat-islands, purify urban air and attenuate city noise. Moreover, daily exposure to such natural elements has been shown to have manifold benefits to mood, attention span, and memory retention over standard urban or suburban landscapes.[8] And across sweeping landscapes and seascapes, ecosystems produce important goods (such as timber and seafood), essential life-support processes (such as natural pollination and water purification), life-fulfilling conditions (such as beauty,

serenity and inspiration) and preservation of potential future benefits (for example, the conservation of genetic diversity for future use in agriculture or medicine).

Although government action plays a major role in biodiversity conservation, we must also employ other tools going forward. Increasingly, this means engaging with the economic system to create more ecologically-sustainable goods. Consider the refreshing beer you might drink at the end of your long workday. The global beer industry has been long dominated by a few key players. However, with the recent insurgence of small craft microbreweries, the rules of the game are changing quickly. Many consumers are now willing to pay a premium for beer that boasts both a greater flavor profile and a greater corporate sustainability ethos. This sustainability is achieved through a variety of approaches, including the use of spent hops as agricultural feed (rather than sending them to landfill), and partnerships with local conservation groups to secure forests situated upstream of key water supplies. While it is true that some of these actions are being taken to improve corporate 'green' image of the company ('greenwashing'),[9] sustainable business practices are now not only possible, but increasingly profitable. At the same time, we are seeing increasing public scrutiny and boycotts of companies and industries that refuse to incorporate the value of biodiversity into their decision-making. One of the most prominent examples is the refusal of many consumers to buy products containing palm oil — a crop whose rapid proliferation is endangering tropical rain forests around the globe.

Governments at various levels are also increasingly taking the economic value of nature into account. New York City became a posterchild for this movement in 1997 when it opted to secure its drinking water quality by investing in natural capital rather than building a physical treatment plant. The decision was based on economic analysis, showing a capital cost of $6–8 billion for building a water treatment plant, plus annual operating expenses of $300 million, as compared to an estimated $1–1.5 billion, in perpetuity, for habitat protection in the source watersheds about 100 miles north of the city.[10] Twenty years of experience show that the natural capital investment is working, yielding a triple win — safe water for the ten million people living in New York, compensation for a public service long

supplied by farmers and foresters upstream, and protection of many other benefits under the umbrella of safe drinking water. Over the past two decades, this case inspired adoption of similar projects by over fifty major cities in Latin America, a rapidly growing number in Asia, and some now in Africa. Globally, an estimated 25% of major cities stand to benefit from this approach.[11]

Also in 1997, Costa Rica adopted national economic incentives for biodiversity conversation, pioneering a payments for services (PES) scheme that incentivized local farmers to conserve or restore their forests in recognition of the economic returns from increased eco-tourism, carbon storage and water purification (for hydropower — a major export — as well as for irrigation and drinking).[12] This proved to be the beginning of a global trend, with many countries soon establishing similar programs. For example, China launched their own PES program in 1999, enrolling 120 million households in restoring steeply sloping lands for flood protection and water purification.[13] Today, there are over 550 such programs around the globe, with total annual payments of nearly $40 billion.[14] We may thus be witnessing the beginning of a new paradigm, where global economic systems have begun to account for natural capital in order to make wise and sustainable decisions.

As your day finishes, you may find yourself sitting in your back yard or strolling through a local park, enjoying a small vestige of our natural world. It is easy to despair the global decline in nature over the past half-century, yet we can still draw inspiration from the beauty of biodiversity, beyond all of the benefits it provides us in tangible and quantifiable ways. Take a look around as dusk turns to night and you might be fortunate to see some fireflies or lightning bugs. Birds and butterflies have shown us color arrangements that we could only hope to see in the paintings of great masters, while vistas such as the Grand Canyon or the Swiss Alps remind us of the enormity of the world, and ourselves as mere actors in an unfolding play. Planet Earth's species, habitats, ecosystems and landscapes are fundamental to who we are as human beings. We've evolved among them, and have come to appreciate their nuance and beauty in a way that is irreplaceable with the constructs of human hands. If we want to return to a world where waking up to birds singing is the norm

rather than a Hollywood fantasy, and where the next generation has a chance of enjoying similar levels of security and well-being that we experience, we must take bold action, and we must do so quickly.

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