Penn Sustainability Review

Volume 1
Issue 9 *Humans*

Article 7

2-21-2017

First Them, Then Us

Rosie Nagele

This paper is posted at ScholarlyCommons. http://repository.upenn.edu/psr/vol1/iss9/7
For more information, please contact repository@pobox.upenn.edu.

First Them, Then Us

This article is available in Penn Sustainability Review: http://repository.upenn.edu/psr/vol1/iss9/7

WRITTEN BY **ROSIE NAGELE**

FIRST THEM, THEN US

The human case for biodiversity conservation

The words "endangered species" often conjure up an image

of a sleek, striped tiger slipping through a jungle or a muscled polar bear navigating a landscape of fractured ice. The idea of losing these beautiful and inspiring creatures generates genuine feelings of distress and concern. However, it also seems distant: tragic, yes, but without direct repercussions to human life. After all, species extinction is a natural process and the evolution of nature's complexity would be impossible without it. Amid the profusion of dire warnings about environmental change, issues with clear impacts on human life, such as climate change or fresh water pollution, often appear more deserving of our time and resources. However, there is an intimate relationship between the well-being of humanity and the diversity of species on our planet. Moreover, growing evidence of accelerated anthropogenic-induced extinction has begun to reveal the precarious state of this relationship. Recognizing the tangible benefits that diverse species provide could be the key to ensuring that sufficient effort and resources are applied to protecting them.

Biodiversity, the variety of species in an ecosystem, is a critical element of maintaining a healthy environment for humans to live. Biodiversity contributes to an ecosystem's ability to provide stable food sources, purify air and water of contaminants, protect against natural and human-related disasters, and protect against infectious disease.[1] Loss of biodiversity, in turn, disrupts ecosystem stability, jeopardizing the processes that maintain the resources that humans depend on. For example, species extinctions threaten food security both by directly eliminating sources of food and by disrupting ecological processes that facilitate agriculture. Biodiversity has been found to play important roles in nutrient recycling, microclimate regulation, detoxification of chemicals, and the suppression of pests, all of which are processes that influence crop yields.[2] Additionally, species diversity is associated with greater stability of fishery yields, a food source that is rapidly increasing in demand.[3, 4]

Another element of ecosystem health is the provision of clean water, which has become a serious issue to human health as pollution levels increase. A study in the journal *Ecology* by Bracken and Stachowicz found ecosystems with greater species diversity to purify water more effectively than ecosystems with less.[5] More recently, *Nature* published a study of algae in streams that identified niche partitioning as one potential mechanism for this beneficial effect.[6] When more species are present, each species develops a specialized niche, which maximizes the amount of compounds they can process. This finding directly links biodiversity to improved water quality.

Furthermore, a 2012 study in *BioScience* found a direct link between biodiversity and poverty relief.[7] Although poverty alleviation is often associated with development that compromises biodiversity, analysis of the direct ecological services and financial compensation provided by healthy and diverse ecosystems found biodiversity conservation to actually reduce poverty and enhance human well-being.

Although there is much evidence to support the importance of biodiversity to human life, further misconceptions exist over whether or not biodiversity really is decreasing and, if so, whether human activity is responsible. As early as 1999, 70% of biologists expected that 20% of all species that then existed would die out within 30 years due to human activity, but also considered the issue of extinction to be marginalized by the public, government, media, and educators.[8] Since this survey, evidence for the acceleration of extinction rates and, moreover, humanity's role in this shift, has grown. Extinction occurs continuously at a background rate, the rate that species go extinct due to individual interactions.[9] However, other forces such as volcanic eruptions and meteor impacts can increase the extinction rate significantly from the background rate, causing mass extinctions.[10] Human activity is emerging as such a force. For example, a 2007 study in the *Journal of Herpetology* found the current amphibian extinction rate to be 25,000 to 45,000 times the background extinction rate.[11] One of the main threats to amphibians is infection by a chytrid fungus, which has spread dramatically due to human travel.[12] The fungus, native to Africa, is suspected to have begun its global spread through the international trade of the frog *Xenopus laevis*, beginning in the 1930s.[13] Subsequent movement of amphibians and chytrid spores by humans has led this pathogen to become a threat to amphibians worldwide.[14] Like amphibians, birds are also experiencing an elevated extinction rate, an estimated 100 times greater than the background rate, which is largely a consequence of human development of forests and the ensuing destruction of habitat.[15] Researchers have also identified a correlation between human population density and the proportion of threatened bird species per country as well as between per capita GNP and the proportion of threatened mammal species.[16] All of these results point to the presence and activity of humans as a major threat to biodiversity.

Even in cases where the global extinction rate of a species is difficult to determine, data regarding local extinction provides useful information.[17] Species are said to be locally extinct when they are no longer present in a given ecosystem but still exist elsewhere. Local extinctions often result in the disruption of the ecosystem, which can have negative impacts on human communities. A study in *Biotropica* observed the local extermination of gorillas,

chimpanzees, and three species of arboreal frugivores from hunting in Cameroon forest sites to reduce the seed dispersal of the tree *Antrocaryon klaineanum*.[18] Another study in the forests of Los Tuxtlas found that local extinctions of medium and large mammals by hunting or habitat loss caused growth in the rodent population and a subsequent decimation of the small-seeded understory on which the rodents fed.[19] Thus, human activity has been linked to increased levels of both global and local extinctions, resulting in profound changes to the dynamics of species interactions and a disruption of the resources and stability of the ecosystem.

The main ways in which human activities influence extinction are habitat destruction and degradation, overexploitation of plant and animal species, introduction of non-native species, pollution, and global warming. Many scientists consider habitat destruction the leading cause for species extinctions and attribute it to roughly 39% of extinctions of known cause in recent decades.[20, 21] In addition to immediately reducing the resources and territory available for each species, habitat destruction disrupts the geographical connections of species. It is often associated with an extinction debt, a process where species that initially survive the change in their habitat become extinct some time after, even if no further change occurs.[22] This can arise via a variety of mechanisms, such as different survival rates at different points in the lifecycle, increased threat from inbreeding, or decreased connectivity to other populations.[23] Extinction debts have been observed for several species of vascular plants that experienced habitat loss and fragmentation in the Estonian calcareous grasslands, as well as for forest plants following habitat fragmentation in forests in the United Kingdom and Belgium.[24, 25]

In addition to habitat destruction, overexploitation, such as hunting, fishing, or clearing land in excess, is a significant factor for extinction.[26] Overexploitation occurs most for those species that compete for habitat with humans, represent a danger to humans, or have a valuable body part, such as the ivory tusks of elephants. Overexploitation is attributed to nearly a quarter of known extinctions in recent decades.[27] One of the most notable examples of extinction via overexploitation is the passenger pigeon. The passenger pigeon was one of the most abundant birds before humans began to hunt it, which, in conjunction with habitat fragmentation, led to its extinction.[28]

Introducing non-native species also poses a threat to biodiversity as the exotics outcompete the natives for resources or decimate native populations via predation or parasitism. For example, the extinction of many island-endemic birds is attributed to predators, such as rats, that were introduced by humans.[29] As in the case of the chytrid fungus, human travel and activity has transported numerous diseases to new populations, leading their populations to severely decline, sometimes to the point of extinction. For example, the extinction of *Rattus macleari*, a species of rat endemic to Christmas Island, has been attributed to the introduction of *Rattus rattus*, the black rat, which carried fleas that hosted a nonnative pathogenic trypanosome, to the island.[30] This issue highlights the threat globalization poses to species diversity by introducing harmful competitors, predators, or parasites.

Humans are also responsible for increasing levels of environmental pollutants, such as chemicals and pesticides, which contributes to species decline and extinction.[31] Such contamination especially threatens predators higher on the food chain through biological magnification—the increase in concentration of toxins with each step in the food chain.[32] Furthermore, the combination of multiple anthropogenic threats exacerbates the negative effect on the species, especially when in combination with climate change.[33] Thus, there are many avenues through which species are threatened by anthropogenic activity. As humanity's demands for land, food, and material rise, failure to change the way we interact with our environment will have heavy repercussions on species diversity and consequently on our own lives.

> ***We must consider how to prevent anthropogenic-induced accelerations of extinction from undermining human society.***

Despite evidence for biodiversity's importance to human life and its accelerating decline due to human activities, the media continues to portray extinction as a trivial environmental issue, pointing to the five previous mass extinctions and evidence that 99% of all species that have ever lived are now extinct.[34, 35, 36] An article by Michael Copeland in the *Wall Street Journal*, for example, dismissed not only the dangers of general species extinctions, but also the concern of a sixth mass extinction on the basis that extinction has always occurred and is ultimately inevitable.[37] Stephen Gould responded to this criticism of species conservation efforts by explaining the different scales that need to be accounted for when considering extinction. He does not deny that on a geological scale of millions of years, all current species will go extinct and biodiversity loss from mass extinctions can be recovered. However, he points out that on the scale of the human experience, individual extinctions are significant.[38] Humanity depends on sufficient biodiversity, so destroying it will negatively impact our civilization regardless of the overall effect millions of years from now. Ultimately, the earth will recover from the extinctions that we are causing, but human society will likely suffer in the meantime. Therefore, protecting endangered species is not an extraneous environmental issue, but one that has direct relevance to the security of human life.

Recognition of species extinction as a critical environmental issue, rather than just as a matter of morals or aesthetics, may be the key to establishing effective strategies to address it. In his speech to pass the Endangered Species act in 1973, President Nixon called biodiversity "a many-faceted treasure, of value to scholars, scientists, and nature lovers alike" that "forms a vital part of the heritage we all share as Americans".[39] This quote suggests that biodiversity's only value is in our awe, admiration, and study of it. It says nothing about how the human population physically depends on it for life. This failure to acknowledge the true and immediate worth of biodiversity may contribute to the generally recognized failure of the Endangered Species Act, which has suffered from anti-environmental propaganda and a lack of funding. Obtaining greater funds and support requires recognition of biodiversity's ability to provide for the needs of society.

If its relevance to human well-being and health is properly appreciated, species conservation has the potential to greatly improve living conditions for people across the globe. Biodiversity influences important issues such as food and water security and must be preserved to help relieve suffering caused by these issues throughout the world. The growing body of evidence for humanity's direct role in accelerating species extinction through destruction of habitat, overexploitation, and introduction of disease suggests that we have the capacity to curtail extinction rates by changing our actions. Permanently halting species extinctions is neither possible nor necessary, but we must consider how to prevent anthropogenic-induced accelerations of extinction from undermining human society. Our role in species extinctions as well as the importance of biodiversity to human life must be acknowledged in order to take action to maintain biodiversity and the ecological services it provides.

Rosie Nagele is a sophomore in the College majoring in Biology. She also plan to minor in Creative Writing and Environmental Science.

CITATIONS

[1] Patricia Balvanera et al., "Quantifying the evidence for biodiversity effects on ecosystem functioning and services," *Ecology Letters* 9, no. 10 (2006): 1146-1156, DOI: 10.1111/j. 1461-0248.2006.00963.x.

[2] Miguel A. Altieri, "The ecological role of biodiversity in agroecosystems," *Agriculture, Ecosystems & Environment* 74, no.1 (1999): 19-31, DOI:10.1016/S0167-8809(99)00028-6.

[3] Bradley J. Cardinale et al., "Biodiversity loss and its impact on humanity," *Nature* 486, no. 7401 (2012): 59-67, DOI:10.1038/nature11148.

[4] Food and Agriculture Organization of the United Nations, "Fish consumption reaches all-time high," last modified January 31, 2011, http://www.fao.org/news/story/en/item/50260/icode/.

[5] Matthew E. S. Bracken and John J. Stachowicz, "Seaweed diversity enhances nitrogen uptake via complementary use of nitrate and ammonium," *Ecology* 87, no. 9 (2006): 2397-2403.

[6] Bradley J. Cardinale. "Biodiversity improves water quality through niche partitioning," *Nature* 472, no. 7341 (2011): 86-89. DOI:10.1038/nature09904.

[7] Will R. Turner. "Global biodiversity conservation and the alleviation of poverty," *BioScience* 62, no. 1 (2012): 85-92.

[8] American Museum of Natural History, "National Survey Reveals Biodiversity Crisis – Scientific Experts Believe we are in Midst of Fastest Mass Extinction in Earth's History" [Press release] 1998, http://www.mysterium.com/amnh.html.

[9] Carl Zimmer and Douglas John Emlen, *Evolution: Making Sense of Life* (Greenwood Village, CO: Roberts, 2013).

[10] Zimmer and Emlen, *Evolution: Making Sense of Life*.

[11] Malcolm L. McCallum, "Amphibian decline or extinction? Current declines dwarf background extinction rate," *Journal of Herpetology* 41, no. 3 (2007): 483-491.

[12] Jason R. Rohr et al., "Modelling the future distribution of the amphibian chytrid fungus: the influence of climate and human-associated factors," *Journal of Applied Ecology* 48, no. 1 (2011): 174-176. DOI: 10.1111/j.1365-2664.2010.01891.x.

[13] Ché Weldon et al., "Origin of amphibian chytrid fungus," *Emerging Infectious Diseases* 10 (2004): 2100-2105, DOI: 10.3201/eid1012.030804.

[14] Ohio Department of Natural Resources, "Chytridiomycosis (Amphibian Chytrid Fungus Disease)," accessed December 2, 2016, https://wildlife.ohiodnr.gov/portals/wildlife/pdfs/ species%20and%20habitats/chytrid.pdf.

[15] Stuart Pimm et al., "Human impacts on the rates of recent, present, and future bird extinctions," *Proceedings of the National Academy of Sciences* 103, no. 29 (2006): 10941-10946. DOI: 10.1073/pnas.0604181103.

[16] Jeremy T. Kerr and David J. Currie, "Effects of human activity on global extinction risk," *Conservation Biology* 9, no. 6 (1995): 1528-1538, DOI: 10.1046/j. 1523-1739.1995.09061528.x.

[17] Nigel E. Stork, "Re-assessing current extinction rates," *Biodiversity and Conservation* 19, no. 2 (2010): 357-371, DOI: 10.1007/s10531-009-9761-9.

[18] Benjamin C. Wang et al., "Hunting of mammals reduces seed removal and dispersal of the afrotropical tree Antrocaryon klaineanum (Anacardiaceae)," *Biotropica* 39, no. 3 (2007): 340-347, DOI: 10.1111/j.1744-7429.2007.00275.x.

[19] Rodolfo Dirzo et al., "Size-Related Differential Seed Predation in a Heavily Defaunated Neotropical Rain Forest," *Biotropica* 39, no. 3 (2007): 355-362, DOI: 10.1111/j. 1744-7429.2007.00274.x.

[20] David Tilman et al., "Habitat destruction and the extinction debt," *Nature* 371 (1994): 65-66, DOI: 10.1038/371065a0.

[21] Brian Groombridge, *Global Biodiversity: Status of the Earth's Living Resources* (London: Chapman & Hall, 1992).

[22] Tilman, "Habitat destruction and the extinction debt."

[23] Kristoffer Hylander and Johan Ehrlén, "The mechanisms causing extinction debts," *Trends in Ecology & Evolution* 28, no. 6 (2013): 341-346, DOI:10.1016/j.tree.2013.01.010.

[24] Aveliina Helm et al., "Slow response of plant species richness to habitat loss and fragmentation," *Ecology Letters* 9, no. 1 (2006): 72-77.

[25] Mark Vellend et al., "Extinction debt of forest plants persists for more than a century following habitat fragmentation," *Ecology* 87, no. 3 (2006): 542-548, DOI: 10.1890/05-1182.

[26] Laura Faye Landweber and Andrew P. Dobson, *Genetics and the Extinction of Species: DNA and the Conservation of Biodiversity*, (Princeton, NJ: Princeton University Press, 1999).

[27] Groombridge, *Global Biodiversity*.

[28] Enrique H. Bucher, "The Causes of Extinction of the Passenger Pigeon," *Current Ornithology* 9 (1992)1-36, DOI: 10.1007/978-1-4757-9921-7_1.

[29] Tim M. Blackburn et al., "Avian extinction and mammalian introductions on oceanic islands," *Science* 305, no. 5692 (2004): 1955-1958, DOI: 10.1126/science.1101617.

[30] K.B. Wyatt et al., "Correction: Historical Mammal Extinction on Christmas Island (Indian Ocean) Correlates with Introduced Infectious Disease," *PLoS ONE* 3, no. 11 (2008): 1-9, DOI: 10.1371/journal.pone.0003602.

[31] Miguel A. Altieri, "The ecological role of biodiversity in agro31 Landweber and Dobson, Genetics and the Extinction of Species.

[33] Nigel E. Stork et al., "Vulnerability and Resilience of Tropical Forest Species to Land-Use Change," *Conservation Biology* 23, no. 6 (2009): 1438-1447. DOI:10.1111/j. 1523-1739.2009.01335.x.

[34] "National Survey Reveals Biodiversity Crisis – Scientific Experts Believe we are in Midst of Fastest Mass Extinction in Earth's History."

[35] S. J. Gould, "The golden rule—a proper scale for our environmental crisis" *Natural History* 99, no. 9 (1990), 24-30.

[36] Zimmer and Emlen, *Evolution: Making Sense of Life*.

[37] M. D. Copeland. "No Red Squirrels? Mother Nature May Be Better Off," *Wall Street Journal*,1990.

[38] Gould, "The golden rule—a proper scale for our environmental crisis."

[39] R. M. Nixon, Endangered Species Act, 1973, http://www.ecology.info/ endangered-species.htm.