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Disturbance Ecology
— The Tempo and Mode of Biodiversity in the 21st Century

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Most of the goods (e.g. food, fiber) and services (carbon sequestration, water purification) that are provided by nature (**ecosystem services)** – for free – are directly or indirectly related to biodiversity. Nonetheless, human activities, especially **land use change** and **climate change**, increasingly threaten the world's **biodiversity**. In fact, the extent and severity of change associated with humans has become so great that scientists and the public alike now recognize that the earth has entered a new epoch, the **Anthropocene**, and that it may be heralding the sixth mass extinction of species on the planet.

Most people think of climate change in the context of global warming arising from greenhouse gas emissions, or if you live on the coast, in the context of sea level rise. Nonetheless, climate change also influences the frequency, intensity, and severity of various **disturbances** such as hurricanes and storms, floods, droughts, and wild fires. In contrast, land use change originates from the conversion of native habitat (e.g., forests or grasslands) into habitats associated with human endeavors (e.g., croplands, cattle ranches, urban areas). Habitat conversion effectively reduces the area and creates isolated patches of native habitat, thereby reducing local population sizes of native species, enhancing rates of extinction in the native **biota**, and increasing rates of invasion and establishment by introduced species. In general, climate change and land use change can and do affect the abundances and distributions of species throughout the world, and consequently the kinds of species that live together and interact in **ecological communities** that provide vital ecosystem services.

My research and that of my students explores how climate change and land use change affect populations and communities, especially those in the tropics, which harbor a disproportionately large number of species. Our research on bats in Brazil, Costa Rica, Paraguay and Peru has shown that some species benefit from land use change while others suffer from it, and that the composition and configuration of landscapes surrounding sites can significantly affect population densities, community composition, and biodiversity. Our work in the lowland Amazonian rainforest of Brazil has highlighted that reduced impact logging represents an emerging forestry practice that can be sustainable in maintaining the biodiversity of birds and bats while providing economic value to local economies. Conserving the biodiversity of these two groups of flying vertebrates is critically important because of their roles in seed dissemination and flower pollination.

Our research in Puerto Rico over the past 35 years has been continually supported by the National Science Foundation's Long-Term Ecological Research (LTER) Program. We have documented the responses of populations and communities of vertebrates (bats) and invertebrates (insects and snails) to natural disturbances (e.g., tree fall gaps, tropical storms, and hurricanes) and have shown the persistent effects of land use practices that date to before the 1950s and appear even today as legacies. We use a combination of long-term monitoring, large-scale experiments (e.g., canopy trimming experiment that mimics hurricanes, rain reduction experiment that mimics droughts), and quantitative modeling to try to understand how gradual environmental change such as warming, interacts with the increased intensity and frequency of cyclonic storms and affects the biodiversity and ecosystem functioning of the flora, fauna, and microbiota in one of the premier tropical research sites in the world (El Yunque National Forest).

SKILLS *and* KNOWLEDGE

Ecologists and Biodiversity Scientists are as diverse as the organisms and processes that they study. In general, good communication skills – written and oral – are critical, as are good quantitative skills. A passion for nature and an inquisitive mind are essential. In addition, flexible approaches and a willingness to work with others in collaborative ventures is increasingly important. Finally, a background in or appreciation for other disciplines (biological sciences, chemical sciences, physical sciences and social sciences), and a desire to continually learn are the attributes that lead to a successful career and to a fulfilling and fun-filled life.

Meet the Scientist

I have wanted to be a scientist since grade school, when my best friend and I set up a "science" laboratory in his parents' basement, and equipped it with a microscope and chemistry set. I was always attracted to biology, but was not the kid on the block with a bug or rock collection under my bed. Every course in college from genetics to cell biology captured my interest. Nonetheless, I had a hard time deciding on a focus and never really thought much about a career. Two things changed that: a class trip to a forested field station in an undergraduate course in Mycology (Fungal Biology) and subsequent enrollment as a first-year graduate student in three ecology courses at that same field station (Pymatuning Laboratory of Ecology) that included a course in "statistics". In retrospect, these were the essential experiences that provided the inspiration for looking at ecological patterns and trying to find order in what seemed to be overly complex and sometimes unrelated observations. The most pivotal experience in my career was getting to spend two years in the hinterland of Brazil (without any communication with friends or family – other than mail – during the entire period), where I learned to speak Portuguese, experienced life as a "minority" for the first time, became totally immersed in another culture, and learned the meaning of "self-reliance."

WORDS *to know*

Anthropocene—The current geological age in which human activities have a dominant and pervasive influence on climate and environmental processes.

Biodiversity—The variety and complexity of life represented by species at local (e.g., your backyard) to continental (e.g., South America) to global spatial scales. Most simply, it represents by the number of different species in an area, but should also reflect differences among those species in their abundances, functional characteristics, genetic constitutions, or evolutionary histories.

Biota — The plant, animal, or microbial species of a particular region, habitat, or geological period.

Climate Change—The long-term alteration in the distribution of weather patterns that arise from natural or anthropogenic processes. Global warming, ocean acidification, sea level rise and the increased frequency of extreme events, all associated with greenhouse gas emissions, are among the most critical threats to planetary biodiversity and ecosystem services.

Disturbance—An event that alters the structure or functioning of an ecosystem. These events can be relatively discrete (pulse events), such as hurricanes, floods, and wild fires, or more or less continuous (press events), such as global warming or ocean acidification. The frequency, intensity, and spatial scale over which disturbances manifest affect the severity of effects to biological communities and the services that they provide to humans.

Ecosystem Services—Benefits to humans that arise from ecosystem processes and structure. They include provisioning services (e.g., production of food and water), regulating services (e.g., control of climate and pollination), supporting services (e.g., nutrient cycles and oxygen production) and cultural services (e.g., spiritual and recreational benefits).

Ecological Community—A group of species (plants, animals, and microbes) that occur together in an area, and through their interactions with matter, energy, and each other, provide essential ecosystem functions related to the transformation of energy and the cycling of nutrients.

Land Use Change—The conversion of natural habitats (e.g., deciduous forest) to land uses associated with human activities (farmland, urban area) gives rise to fragmentation and heterogeneity in a landscape. Such heterogeneity can be represented by landscape composition, the number and identity of land use types in a landscape, or configuration, the size, shape, and arrangement of patches of various land uses in a landscape.

For Students and Teachers Making Curriculum Connections, see the following:

NIE NEWS IN EDUCATION

Connecticut State Department of Education (CSDE) - Common Core State Standards (CCSS): Mathematics

- CCSS.Math.Practice.MP1 Make sense of problems and persevere in solving them
- CCSS.Math.Practice.MP3 Construct viable arguments and critique the reasoning of others
- CCSS.Math.Practice.MP5 Use appropriate tools strategically

CSDE - Next Generation Science Standards: Scientific and Engineering Practices

- Asking questions and defining problems; developing and using models; planning and carrying out investigations; analyzing and interpreting data; using Mathematics and computational thinking; constructing explanations and designing solutions; engaging in argument from evidence; and obtaining, evaluating, and communicating information.

hyperlinks

https://today.uconn.edu/2017/11/living-edge-not-species/
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