The Paper Trail

Conserving Species in a Fragmented World

Editor's Note: In this edition of the *Paper Trail*, two researchers work globally to reverse the fragmentation of forest ecosystems at the local scale. Although they took inspiration from different sources, both were moved early on by what has become known as a dire situation in the preservation of biodiversity. They decided to go to none other than the tropics, which is ground zero for world biodiversity. Today, they conduct much of their research based on the fundamental principles of the Biological Dynamics of Forest Fragments Project. Those who value nature and make a lifelong commitment to protect it have many different backgrounds and take their own road to get there, even a boy who started out wanting to be a zoo biologist.

— *Stephen L. Young*

The Arising Researcher

My motivation for pursuing a Ph.D. was a passion for nature and a deep concern about the accelerating losses of the world's biodiversity. Given that habitat loss and fragmentation are primary causes, I knew that I wanted to focus on this topic for my dissertation research.

Natural systems are invariably complex, yet scientists often reduce this biological complexity into simplified models. Island biogeography theory and classic metapopulation models are two that have underpinned fragmentation research. While these theoretical frameworks advanced a mechanistic understanding of species responses, they also caused early fragmentation research to more narrowly focus on patch size and isolation of habitats, to assume species can respond to these spatial patterns in a similar fashion, and to ignore the influence of surrounding land uses or the "matrix." The limitations of simple models when trying to understand landscape change in real-world systems became overtly clear to me after reading Bill Laurance's paper "Theory meets reality: How habitat fragmentation research has transcended island biogeographic theory" (*Biological Conservation* [2008] 141:1731–1744). Through illustrative findings from the long-run experimental Biological Dynamics of Forest Fragments Project (BDFFP) in central Amazonia, he outlined how habitat fragments do not to function as islands, and how species respond to fragmentation in vastly different ways based on their traits and the surrounding matrix of modified vegetation.

The message to move from "theory to reality" to advance our knowledge on how to mitigate the effects of fragmentation in real-world landscapes truly resonated with me. Biodiversity conservation often targets the preservation or management of species within remnant native habitats, and empirical observations, such those from the BDFFP, underscored to me that the fate of these species hinges upon the land uses that surround them. Yet

Dr. Christina Kennedy in a bauxite-mining matrix in one of her fragmented landscapes in central Jamaica. Photograph by John Hamilton, used with permission.

in most places, the way in which different human-modified matrices hinder or support species is still not well known, nor are the dominant mechanisms (e.g., dispersal, resource provision, disturbance) that underlie their responses. We need to understand both of these aspects more fully to make robust recommendations on how to manage the matrix to conserve biodiversity.

For my dissertation, I worked in central Jamaica: a region that was once dominated by wet limestone forest but currently has less than 30%. Native forests are now restricted to small hilltop remnants on limestone outcrops, with low lying areas converted to agriculture, residential development, and mining for bauxite (strip-mining for aluminum). To disentangle the role of the matrix, I sampled bird communities within fragmented landscapes that had a similar amount and configuration of remnant forests but were dominated by one of the three human land uses. To serve as a reference, I also sampled "pseudo-patches" embedded within intact continuous forest. Similar to the BDFFP, I found that the matrix had an overriding influence on species, in fact, one that was stronger than the originally assumed patch area and isolation. Matrix conditions affected bird community

patterns, occupancy dynamics, movement, and resource use, but again, responses were matrix- and species-dependent. Coupling species response patterns with biological trait information, however, supported an emergence of generalities about which species were most vulnerable to land change and potential dominant mechanisms at play. As is often the case with observational studies, some of my findings followed theoretical predictions while others were a novel surprise.

Now that I have moved on from academia to a conservation organization, I am reminded every day that we are pressed for time to protect nature amidst ever-growing development. And we must act in places around the world that simply lack on-the-ground field data on how best to do so. Thus, we need to use all available tools and information—including ecological principles drawn from long-term experimental stations, like BDFF, additional insights from observational studies, and yes, simplified models too.

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The Established Researcher

I actually just stumbled into becoming an ecologist. I really wanted to be a zoologist—and not just any zoologist, but one who ran and led his own zoo dedicated to saving endangered species.

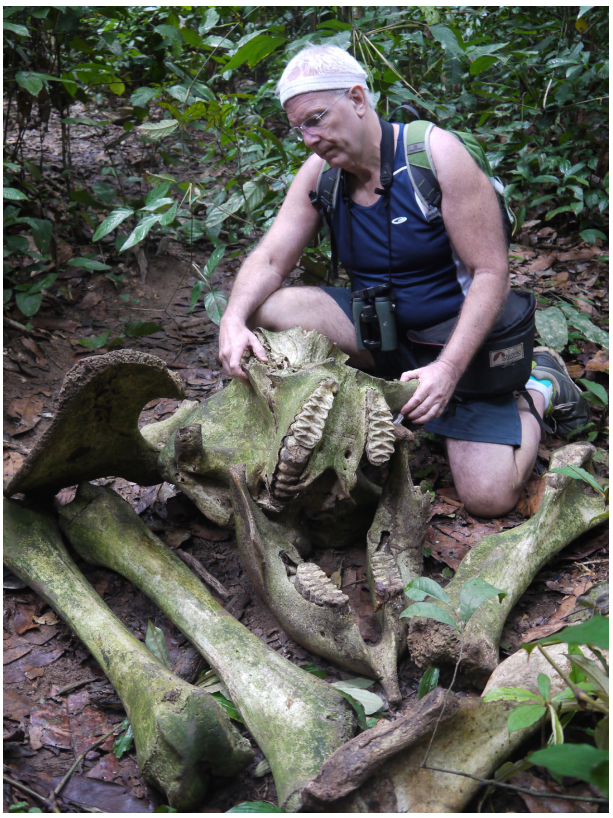
I got this idea into my head at the grand age of 12 years old, not by reading the refereed scientific literature but because my mother gave me a copy of the autobiography "My Family and Other Animals" published by Gerald Durrell, a British naturalist (Penguin Books, 1956). The book is about Durrell's childhood on the Greek isle of Corfu, living in a series of colorful villas with his widowed mother, siblings, and a never-ending stream of creatures—from Quasimodo the Pigeon to Ulysses the Owl and Roger the Dog—that Durrell adopted as personal friends.

Durrell lacked formal training as a scientist but, as a young man, that did not stop him from organizing wild trips to wilder places to catch an entire ecosystem of wild animals. They were intended for zoos, but just as importantly, they were the stars of a stream of books describing Durrell's sojourns.

The activities Durrell engaged in—catching animals from the wild to be housed in zoos for our personal entertainment and enlightenment—would surely be looked down on today. But in Durrell's era, it was akin to having a love affair with nature. He coddled the animals he caught or bought, cured their ills, detailed and tolerated their eccentricities, and in every way befriended them.

While in high school and university, I spent a half-dozen summers working in various zoos and wild animal parks. Eventually, I managed to attain an internship at Durrell's own zoo—the Jersey Wildlife Preservation Trust on Jersey Island, UK—a unique place dedicated to breeding endangered species in captivity. I met Durrell several times—"Gerry," as he was known. He was a quiet man and most clearly at home with his zoo staff and animal charges—though he became more garrulous and smart-arsey while downing his evening Gin & Tonics.

Alas, after seven summers pursuing the dream of zoo biology, I finally realized it was "the right sentiment, but the wrong goal." Saving animals in zoos is like saving a few shiny baubles from Christmas, while tossing away the Christmas tree and everything that holds those baubles in place. Conserving habitats, and maintaining their crucial functioning and connectivity, is the only real solution. So, literally overnight, I decided to become an ecologist and field biologist (Fig. 1). I remember



The author, William Laurance, examining a forest elephant shot by poachers in the Congo Basin; the elephant's face was hacked off to extract its valuable ivory tusks (photograph by Mahmoud Mahmoud, used with permission).

well phoning up my terrific undergraduate mentor, Eric Yensen, at home, quite late at night, with the pronouncement of my transformation. A groggy Yensen said, "We can talk about it tomorrow."

We did talk about it. And the more we talked, the more convinced I became that I needed to study the threatening process of habitat fragmentation for my Ph.D. And I needed to work in the tropics, because that is where species diversity is highest and where habitats are disappearing the fastest. A simple decision, really, for a boy studying at Boise State University, who had never even set foot in the tropics.

Anyway, it all worked out in the end. I did my Ph.D. at UC-Berkeley, studying the impacts of habitat fragmentation on Australian rainforest mammals. Later, I moved to Brazil, where I worked on the world-famous Biological Dynamics of Forest Fragments Project. By then I was studying not just animals but, more broadly, the complex process of ecological decay that plagues isolated ecosystems of plants, animals, and their forest homes. It wasn't, for me, quite the path I'd expected, but then life never does that, does it?

Today, we direly need more scientists and more science, but, ironically, it was a non-scientist who drew me into the fold. Durrell wrote with insight and wit, but with a child's eyes, unclouded by excess detail or theory. It was not "scientific" per se, but it did not matter. Durrell went straight for the heart and soul, and for me, at least, he scored a direct hit. The brother of famed novelist Lawrence Durrell, he had a writer's DNA from the beginning. If you have never read Gerald Durrell, at least skim his "Speech for the Defense," which introduces his first book. Would your scientific writing capture a reader this way?

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