Natural History of a Silent Forest

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Natural history is a "practice of intentional, focused attentiveness and receptivity to the more-than-human world, guided by honesty and accuracy" (Fleischner 2002). Some interpret this as an ability to identify to species every wildflower in a field or to keep a lifetime phenological field journal or to recall life history facts about mammals. I understand it best as a commitment to observing a single place across seasons and years.

In a time when ecology promotes chasing the next big global review, I want to put in a plug for getting to know one place intimately. Commitment to a place provides the opportunity for unanticipated observations and personal connections, which in turn can lead to novel scientific insights and better conservation outcomes (Billick and Price 2010).

For me, this place is the Mariana Island chain, which is south of Japan, north of New Guinea, and east of the Philippines (Figure 1). First populated around 3600 years ago by the CHamoru people, about 219,000 people live in the present-day U.S. territories of Guam and the Commonwealth of the Northern Mariana Islands.

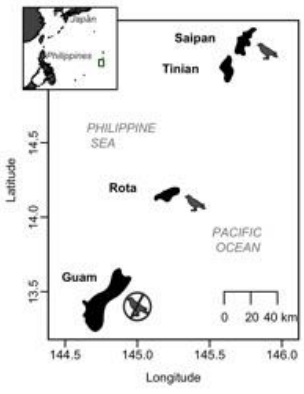

Figure 1. Map of the Mariana Islands.

The Brown Treesnake was introduced to Guam in the mid-1940's and ate its way through the island's birds and bats (Savidge 1987, Wiles et al. 2003). Motivated by a passion for both understanding how the world works and doing my part to leave it better than I found it, I moved to Guam in 2002 to start the U.S. Geological Survey's Brown Treesnake rapid response team. For three years I traveled between islands in the Western Pacific doing outreach about these invasive, nocturnal snakes and looking for new populations. While slowly scanning the trees for well-camouflaged snakes, I couldn't help but notice differences between Guam and islands that still had birds.

The most obvious difference was the sound. On Saipan, the jungle chatters with birdsong, but on Guam, the forests are silent. I started to wonder what would happen to a forest that doesn't have birds; I noticed more spiders there than on nearby islands, but what else was happening?

I headed off to graduate school to complete a Ph.D. in community ecology, with the intention of then transitioning to a career in the conservation non-profit world where I could make a difference on a global scale. The unanswered questions and welcoming people of the Marianas beckoned me back, so I spent my PhD exploring the impacts of bird loss on the forest.

Towards the end of graduate school, I found myself seeking advice from mentors about whether I could have a bigger impact on conservation by pursuing a career in an NGO as I had planned or staying in academia, continuing my research in the Marianas. Taylor Ricketts, an ecologist who at the time was transitioning from a position as director of the Conservation Science program for the World Wildlife Fund back to academia, asked me whether I wanted to be known as the "Guam Ecologist" 20 years down the road, and my immediate reaction was emphatically "no."

While I loved the Marianas, I hoped to have an impact on a larger scale. Plus, I had the impression that one's academic career would suffer if they focused on a single system. The signs pointed towards leaving Guam behind to pursue other options. But there were still a few big questions I wanted to answer in the Marianas, and I was just starting to have an impact on local conservation. So I accepted a fellowship where I could continue my research on the impacts of bird loss.

And then four years later, when I still wasn't quite finished asking questions in this system, I accepted a

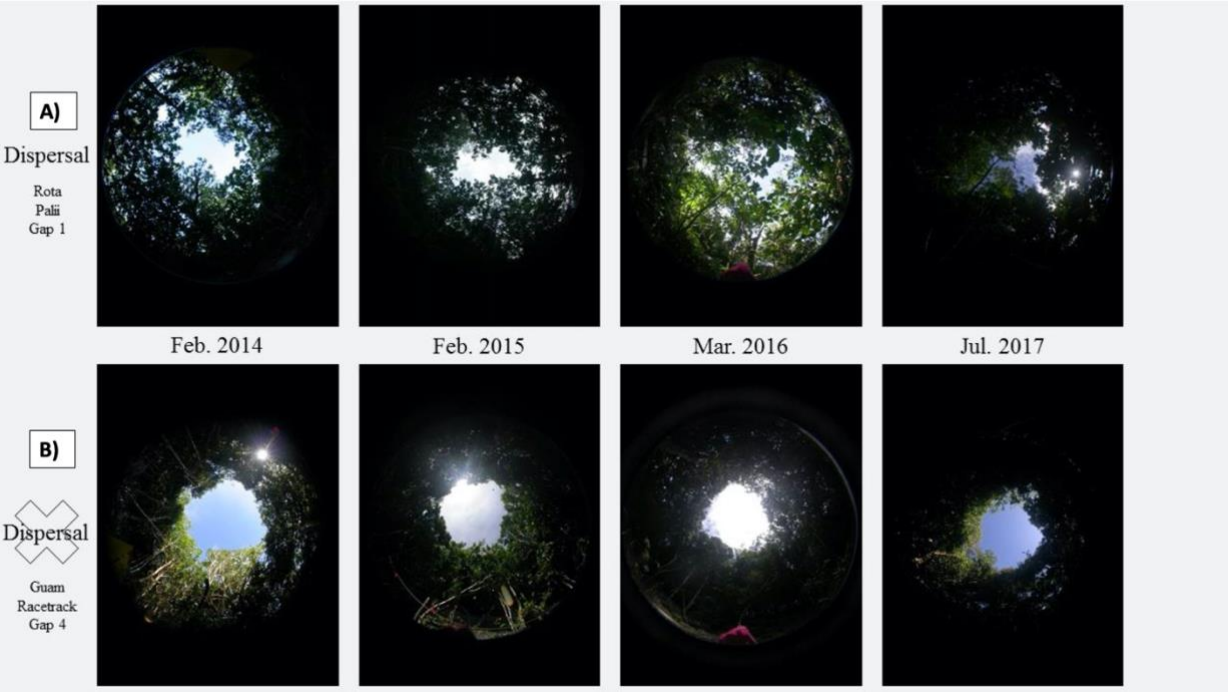

Figure 2. (A) A gap on Rota, with frugivorous birds and bats, demonstrating normal treefall gap closure over 3 years. (B) A gap on Guam, without frugivorous birds and bats, that is still open after 3 years.

faculty position, and started advising my own graduate students pursuing research in the Marianas. And now, I wholeheartedly embrace my place-based research program. As Billick and Price (2010) wrote in the summary of their edited volume on how place-based research has advanced ecological understanding, "sustained place-based research is a powerful way to gain both general and local ecological understanding."

Over the last 17 years, a large part of my team's research has focused on what happens to a forest when it loses all of its frugivores, or fruit-eaters. Because of the Brown Treesnake, four of the native frugivore species are gone, and the other two – the såli (Micronesian starling) and the fanihi (Mariana fruit bat) – remain in tiny populations in one part of the island, leaving Guam's trees without anyone to disperse their seeds.

My graduate school training guided me to look to the scientific literature for help with making predictions of the impacts of disperser loss, so that's where I started. The literature told me that frugivory benefits plants by increasing germination after gut passage (Traveset and Verdu 2002), facilitating a seed's escape from high mortality underneath its parent trees (Janzen 1970) and enabling seeds to colonize new areas (Howe and Smallwood 1982), so I designed field studies to assess those benefits. But two of my favorite projects were inspired not by this secondhand knowledge from the scientific literature but by my primary observations of this "more-than-human world."

First is a project I call "The Experimental Gap Project," which explored the importance of seed dispersal for forest structure. In 2008, I noticed a forest gap at one site on Guam and wondered why it was so big. On each subsequent visit, I wondered why the gap wasn't filling in like gaps do on other islands but instead seemed to be getting larger.

Invasive deer were surely part of the problem, but I hypothesized that bird loss might be another. Without frugivores, I thought, quick-growing pioneer species weren't reaching the gap, and as a result the gap was staying open longer. So, with a grant to test that, we created experimental treefall gaps on Guam and two nearby islands with birds in 2013 and monitored them every year to see what seedlings were growing and how well the gap was closing (Figure 2).

Postdoc Elizabeth Wandrag showed that gaps without dispersers were missing those pioneer species that grow quickly to fill in the gaps (Wandrag et al. 2017). This link between seed dispersal and forest structure was the

result of keeping an eye on the same spot over several years and wondering why it was different.

The second project demonstrates why seed dispersal matters to people. The donne såli, a spicy chili pepper, is a beloved ingredient in local food. People collect and sell donne såli in the markets and celebrate at annual donne såli festivals. Several years after I started studying seed dispersal, a farmer told me that "donne" means pepper and "såli" is the name for the Micronesian Starling, and that the name for the chili pepper is because the "såli plants the pepper."

A light bulb went off: Donne såli seemed more common on Saipan and Tinian than on Guam. Perhaps this was because the birds were gone?

by såli increases germination the most (Egerer et al. 2017). And on Guam, the only place that still has wild donne såli is the small area where the såli persist. Seed dispersal, it turns out, affects both plants and people.

Over the years, my team has learned that a silent forest is one that is less diverse, more open, and less likely to recover from disturbance. A silent forest is home to lots of spiders but no donne såli (Rogers et al. 2012).

Thankfully, that future isn't guaranteed. I am working with many others to bring native birds back to Guam. It is now possible to control snakes using aerial drops of acetaminophen glued to a dead mouse (Engeman et al. 2018). This, coupled with snake fences, may allow us to expand the såli population and watch the forests recover. Perhaps that persistent gap in Guam shown in

Figure 3. Donne såli, the wild chili pepper in the Marianas, is gathered from the wild (A) and made into hot pepper sauce (B).

Monika Egerer, an undergrad at the time, and I collaborated to figure out just how much the donne såli depends on the såli and whether other birds also "plant the peppers." We interviewed donne såli harvesters on Tinian and Saipan, we talked to people on Guam who remember when birds were still around, we revisited the locations of specimens found in the herbarium on Guam, we did feeding trials with birds on Saipan, and we put cameras on donne såli to see which birds came to visit.

We saw a såli fly away with a donne såli in its mouth, true to its name (Fig 3). As one of our interviewees told us, the såli are the farmers of the forest. We found that while multiple bird species eat donne såli, gut passage

Figure 2 will one day be filled and there will be donne såli across the island again. And by turning this conservation nightmare into a conservation success, we may be able to give hope for ambitious conservation projects in degraded systems worldwide.

I will finish with a few parting thoughts. First, paying attention to local natural history benefits ecology and conservation broadly (Louda and Higley 2010). As Vepsäläinen and Spence (2000) write, "useful generalizations are likely to be built only with knowledge and understanding of biological details." We would not have discovered the link between dispersal and forest structure without careful observation and a comprehensive knowledge of the system.

Second, natural history comes in many forms. For me and many other place-based ecologists, it's about spending a lot of time in the same system, observing the same places year after year (Paine et al. 2010). You can't fast-track this process.

Finally, and most importantly, as scientists and conservationists, we must value and invest in the people living within these places we study and protect. It's worth it. I love to stumble upon my favorite shrub, *Discocaylx megacarpa*, with its emerald green leaves and cherry red fruit, in the jungles of Guam. But this pales in comparison to seeing the grad students from the Marianas in my lab use new techniques to explore their home islands and then present their results at a conference, or introducing high school teachers in the Marianas to field research, or bringing students from Guam to Saipan to hear birds for the first time.

I am grateful to the people of the Marianas for welcoming me to their islands and to the other species for sharing their secrets with me. My life and the field of ecology is richer for it.

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