**Research Statement**

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**Introduction**

I am improving our understanding of how wild nature and humans coexist and interact in human-dominated aquatic ecosystems. I notice patches of wild plants and water, and sometimes animals and microbes too, in urban spaces, agricultural fields, and other places where ecologists typically do not go looking for them, and I figure out what enabled them to establish in those places. Elsewhere, I deduce what limited initiation of life. My detective practices draw primarily on my skills as an aquatic ecologist, but also on many others derived from a very broad liberal arts background; I surprise myself with what becomes useful. My two most important abilities are strong observation and willingness to ask questions. In environments outside the lab or office where non-scientists live and work, those others often know far more about those specific environments than incoming scientists. So, I talk to people; I respect others' knowledge, even if acquired through different empirical means than my own. While the scientific methods I return to apply as a result sometimes appear absurd to the locals, sometimes they learn to appreciate what I'm doing when I show them as I go along. The ultimate result can be disseminated to help others, which can be a source of pride for all. I believe that we will need to do a better job of acknowledging and improving the coexistence and codependency of nature and humanity in order for both to persist in any recognizable form, and my research provides small demonstrations for how we can do so.

**Invertebrate communities in Bishop, California**

While I had grown up playing in both ditches and "real" creeks and wetlands, my first research encounter with ditches occurred during a college summer job. While working in an ecology lab that focused on invertebrates, I got to do a project of my own, and opted to look at benthic macroinvertebrates in the decorative ditches diverted from irrigation ditches diverted from Bishop Creek. I was not sure if I would find anything, but I set out to collect what I could at accessible sites, randomizing within those and creek sites for comparison. Surprisingly, while the invertebrate communities differed strongly by substrate, they were statistically not differentiable between ditches and creeks. This result intrigued me enough that I secured a Kolenkow-Reitz Fellowship from my college to return and expand my sample collection, which yielded the same result, with some seasonal differences. Further analysis suggested that invertebrate communities changed, losing diversity and sensitive taxa, as waters flowed through town, which suggested an urbanization impact. This project suggests that at least in some cases, artificiality need not mean that an ecosystem houses less tolerant organisms. I have written a paper to this effect that I am revising for submission for publication now. This project got me to thinking about all the irrigation ditches in the western U.S., all the ditches generally, and wondering if they, too, harbored communities interacting in complex ways with "natural" ecosystems.

**Conceptual Review of Artificial Aquatic Systems**

My beginning my PhD at Duke's River Center in 2013, funded by an NSF Graduate Research Fellowship, coincided with the USEPA's release of drafts of the Clean Water Rule. Having researched ditches before, I noticed that the then-current draft prioritized the exclusion of most ditches and other artificial aquatic systems from jurisdiction, over all factors that could have resulted in their inclusion, such as tributary status. While I understood, roughly, the political necessity of this choice, I also thought it telling that not just policymakers, but most conservationists and environmental scientists, seemed willing to accept it. It indicates to me that artificiality tends to automatically devalue ecosystems, which I think has affected both science and actual waterbodies. So, I wrote a paper that defines artificiality in terms of degree of human

modification and level of intentionality, the interaction of which predicts probability of regulation; we are least likely to regulate systems that humans have constructed de novo and on purpose as "water." I review the probably vast but basically unknown extent of artificial aquatic systems, and examples of known ecosystem services and disservices they provide, which are probably substantial and below their potential. I suggest process-based alternatives to "artificiality" as an explanation for the poor condition of some artificial aquatic systems, including watershed setting, design, which includes both initial planning and ongoing management and policy, and time for succession and/or naturalization. Finally, I suggest that artificiality influences how people perceive the condition of aquatic systems, which impacts how we manage and regulate these systems, such that low expectations for artificial aquatic systems could be self-fulfilling. This paper is very close to submission for publication, and I hope that other scientists find the frameworks I present to be useful launching points for their own research. I started writing it largely to structure my own dissertation; I am trying to disentangle those drivers of condition of artificial aquatic ecosystems somewhat, in some systems.

**Earth Stewardship Initiative**

I won an inaugural research fellowship in the first Earth Stewardship Initiative project at the 2014 Ecological Society of America conference in Sacramento. In this capacity, I learned about designed experiments, and worked with local and regional stakeholders and landscape architects to propose experimental infrastructure in the Natomas East Main Drainage Canal intended to address several concerns, including salmonid migrations, flood control, aging infrastructure, plant invasion, homelessness and associated encampments, and beaver damming. This experience led me to consider a research style and funding sources I had not before, of working with infrastructure builders to integrate ecological experiments into what they do to address their questions while also generating information useful to conservation and ecological theory. I would very much like to more thoroughly engage with the designed experiment process in future.

**Ditches of the North Carolina Coastal Plain**

I sought to disentangle the influences of setting and some design choices in drainage ditches in the North Carolina Coastal Plain by examining plant communities, morphology, soils, and waters present in forested, agricultural, and roadside ditches. All three types of ditch generally had hydrophytic plant communities, by U.S. Army Corps of Engineer wetland delineation standards, but the actual taxonomic composition of these communities differed significantly among the three types. Mowing of roadside ditches, as suggested by herbaceous vegetation height, influenced plant community composition, suggesting some management influence. Agricultural ditches supported the most herbaceous plants and the most biodiverse plants, and overall, the plant communities resembled those of young wetland restorations in the region. Wetter forested sites had soil carbon comparable to local undisturbed, natural wetlands, but roadside and agricultural sites had relatively little. All sites showed some U.S. Army Corps of Engineers wetland hydrology indicators, and some had substantial flow, blackwater, and other interesting aquatic characteristics. In spite of all of these qualities of interest to aquatic science, almost none of these sites were included in the National Hydrography Dataset or National Wetland Inventory, which supports my suspicion that our inventories of artificial waters with structures and functions of ecological interest are missing a great deal.

**Algal Blooms in the National Lakes Assessment**

The USEPA collected a great deal of data in over 1,000 lakes around the U.S., roughly half natural and half artificial, in surveys in 2007 and 2012. In the report on the first survey, when comparing artificial and natural lakes, they simply concluded that artificial lakes are in worse condition than natural ones. I am using this trove of physical, chemical, and biological data to

understand why their conclusion is so, and really disentangle the drivers of ecological condition proposed in my conceptual review paper better than I could with any dataset I could collect alone, through a structural equations modelin. Preliminary results suggest that artificial lakes decline in quality through the same processes as natural lakes, and that the artificial lakes of the U.S. are simply subjected to greater nutrient inputs than the natural ones.

**Future**

In the immediate future, I am interested in looking more at the ecology of manmade waters or water infrastructure with different age and abandonment histories, as time remains the driver on artificial aquatic ecosystem condition that I have proposed but least explored. Duke's Kenan Institute for Ethics has given me an Anthropocene Farm Fellowship to study this process, in abandoned infrastructure in the Little River Waterfowl Impoundment and surrounding floodplain of the Eno, Little, and Flat Rivers, in summer 2018. This cultural and natural history case study will undoubtedly raise further questions.

Ultimately, I would like to embed myself in a community, both natural and human, where I both live and work, and proceed with asking questions based on that existence. I want to continue to examine human-impacted and –modified ecosystems, and also work with the associated humans, in hopes of revealing space for improvement in condition of all. I want to be part of a dialogue, and not just an outside observer. I also want to continue to educate, to mentor young potential scientists within my work, and to communicate what I'm doing through writing and other media with more than just scientists. I think my greatest impact on the future can be through giving other people a chance to make their impacts too.