Research Statement

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Introduction

I improve our understanding of how wild nature and humans coexist and interact in human-dominated aquatic ecosystems, including agricultural and urban spaces. I notice patches of wild plants and water, and sometimes animals and microbial activity too, in agricultural fields, residential and commercial areas, and other places where ecologists typically do not go looking for them. Then I figure out what enabled them to establish in those places. Elsewhere, I deduce what limited the spread of life. My detective practices draw primarily on my skills as an aquatic ecologist, but also on many others derived from a broad background; I surprise myself with what becomes useful. My two most important abilities are strong observation and willingness to ask questions. Encouraging my students to demonstrate these skills as well, and collaborating with them to answer their research questions, helps keep my research contributions fresh. In environments outside the lab or office where non-scientists live and work, 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 sometimes appear absurd to the locals, sometimes they learn to appreciate what I do when I show them how and why 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 codependence of nature and humanity for both to persist in any recognizable form. My research provides small demonstrations for how we can do so.

Artificial Aquatic Systems

My work and I owe a great deal to naturally occurring forests, prairies, deserts, oceans, and especially creeks, rivers, wetlands, ponds, and estuaries. The time I have had the great privilege to spend in these spaces built the structure that undergirds my life. That said, like most people, I spend most of my time, even my outdoor time, in spaces less associated with the sublime wild, like backyards, cornfields, roadsides, parking lots, athletic fields, and ditches. These human-dominated environments featured far less in my early learning about science and conservation than did the "natural" ones. Even humans' role in shaping "natural" landscapes, beyond simple degradation, came up relatively little. Much as I have always loved and wanted to protect nature, writing off its less "pristine" manifestations never felt like the best way to value it or our human selves. I owe a debt of gratitude to various early environmental science mentors, who introduced me to environmental history of indigenous and colonial management of nature, allowed me to begin researching life in ditches as part of a college summer job, and demonstrated management of ranchlands for biodiversity conservation and water quality improvement. They began to make research and conservation of human-dominated spaces seem valid, a worthy expression of care for nature, rather than a betrayal.

These ideas crystallized for me in the first year of my PhD in the Duke University River Center in 2013-2014, when I read early drafts of the USEPA's Clean Water Rule, an effort to define waters of the United States more clearly. Having researched ditches before, I noticed that the draft rule prioritized the exclusion of most ditches and other artificial aquatic systems from jurisdiction, over all factors that could have resulted in their inclusion. While I had some grasp of the political expediency of this choice, I also thought it telling that not just policymakers, but most conservationists and environmental scientists, seemed willing to accept the decision, to let artificial waters go. It indicated to me that artificiality tends to automatically devalue ecosystems. This attitude has affected both science and actual waterbodies, through how humans treat them as a result. So, I wrote a paper that redefined artificiality in terms I saw reflected in policy and other indications of value, reviewed the probably vast but basically unknown extent of artificial aquatic systems, and suggested process-based alternatives to "artificiality" as an explanation for the poor condition of some artificial aquatic systems. This paper was meant to challenge

the tendency for low expectations for artificial aquatic systems to be self-fulfilling, and to provide a conceptual framework from which to build with as yet relatively scant empirical work.

I began to test the framework and my ability to explain the condition of artificial aquatic systems in my dissertation research. It included explorations of benthic macroinvertebrate communities in irrigation ditches as compared to creeks from whence they flowed, plant communities and other wetland characteristics of Coastal Plain agricultural, roadside, and forested ditches, and algal bloom formation in artificial versus natural lakes. This research came forth at a fortuitous time in environmental thinking, as conservationists, ethicists, ecologists, social scientists, and other scholars increasingly recognize what many people who have long made their living off the land and water already knew: sustaining human and other life on Earth together requires attention to and understanding of spaces where humans live and work, not just to the vanishingly small area where they do not, as "the environment." Exciting conceptual advances in recent years and decades combine the long-cultivated fruits of both traditional ecological research and efforts to solve problems formerly less categorized as environmental, from agriculture, public health, urban planning, social justice, economics, foreign policy, and so on. Yet there is so much more to do.

I consider myself lucky to have launched in the forefront of this research for water. However, I thus found myself having to answer many basic questions of "what," and some "where" and "when," with little opportunity yet to move into the most intriguing "why" and "how." Particularly where human-made waters are concerned, we still have relatively little idea what waters even exist where, let alone for how long, for what purpose, and under what conditions. We know less still of how we can protect and enhance positive aspects of these ecosystems and minimize the negative, which is my ultimate research goal for them. Even as researchers and time directed to the effort of understanding artificial waters increase, there is still so much to do; initial attention to the matter yields more questions than answers. Everywhere, no matter how urban or rural, wet or dry, people mess with water from early ages onward, for reasons ranging from fascination to the direst requirements of survival. So, there are plenty of human-made and -modified waters to study, literally in everyone's backyards. These waters interface with most everything else humans care about. I am confident that through human waters, I can explore the world for the rest of my life without ever running out of motivations for research.

Designed Experiments, Research through Education, and Community

Early in graduate school, an inaugural research fellowship in the first Earth Stewardship Initiative project at the 2014 Ecological Society of America conference in Sacramento introduced me to the concept of designed experiments, in which ecological experiments are integrated into the construction of infrastructure. In this capacity, I 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 ranging from salmonid migrations to homeless encampments. 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.

Later, by pursuing post-doctoral work in an agricultural engineering department, at Iowa State University, I sought to build my knowledge of how people who shape infrastructure operate. The agricultural focus, on drainage water management in particular, also gave me a better understanding of what more rural land users and policy-makers seek from human control of water, particularly around water quality and avoidance of flooding. I have brought concepts well studied in urban aquatic contexts, such as the central role of flashiness in the human signature on urban streams, to bear on agricultural drainage water management and rural streams. I think I am now well situated intellectually to circle insights from agricultural waters back to waters in more populated areas, and to combine concepts and strategies developed from rural and urban contexts. Most major watersheds include a mixture of land uses, including second growth natural vegetation, agriculture, residences, and commercial and industrial development. So, it makes sense to look at human modifications and influences to waters through both agriculture and construction of hardscapes together, as intertwined efforts.

A more permanent job than my current post-doctoral position would enable me to commit to a place, and develop designed experiments of my own that draw on my urban and agricultural background. I have experience collaborating with county parks and recreation departments, state departments of transportation and of natural resources, corporate research partners, drainage associations, nonprofit conservation organizations, agricultural, biological, and geological research stations and societies, and others to address their needs. Given time, I could develop connections with local equivalents in a new place, and work with them to integrate management options of interest into local ditches, retention ponds, and similar, whose performance I could compare to unchanged infrastructure and natural ecosystems on metrics of interest. Management options could include different seedings and plantings, mowing regimes, water level control structures, substrates, and similar, many with little or no additional cost to current infrastructure maintenance. Response variables could include exit water quality, community composition of various taxa such as wetland plants or invertebrates, water level variability, soil carbon storage, or willingness to pay for recreational amenities. All of these are strategies and metrics I have employed before, but of course I would seek to incorporate local expertise and needs.

On a college campus, I could work with university facilities management staff to develop such designed experiments, and conveniently reap the added benefit of integrating the research into coursework and student research experiences. There is no need to travel every time one wants to practice ecology when one studies human modifications to water, because every campus has them. Easily accessible research sites give students a familiarity that encourages them to develop ideas of their own and build on each other's work over time. Such efforts, both on and near campus, can also serve as loci of community outreach. They can provide direct engagement with research in an already loved place for the local community, both student and otherwise.

Using Existing Datasets and Broader Collaboration

As no researcher can ever collect all desirable data alone, I have also become proficient at finding and using existing datasets. I drew heavily on USGS and USEPA data for structural equations modeling in both my dissertation research, which included a chapter based on the National Lakes Assessment and LakeCat, and a post-doctoral side project on agricultural streams, based on the Midwest Regional Stream Quality Assessment and the USGS Stream Gaging Network. My dissertation research also re-purposed LIDAR data originally gathered by the state of North Carolina to better understand flood risks, and summarized artificial elements of the US National Hydrology Dataset. I have both added to and analyzed others' long term monitoring datasets in my post-doctoral research on agricultural drainage and in stream and wetland restoration monitoring jobs in the US Southeast. My current research efforts disentangle long term effects of shifts in fertilizer use, climate, agricultural conservation practices, and prairie restorations on drainage water nitrate, using data from Iowa State and other Universities, the USDA, and Iowa Environmental Mesonet. I encourage my students to make use of existing data as well. My current undergraduate interns have independent research projects on flashiness of different drainage water management practices based on data originally collected to evaluate nitrate reductions, woodchip bioreactor performance, and long-term drainage export under different cropping systems. While all three interns have experience collecting related data, other people gathered most of the data these students are analyzing. I hope that they learn thus that research is a collaborative enterprise.

In future, I plan to continue to use existing datasets in my research, to supplement data my students and I collect and to allow us to make inferences about larger geographical areas and periods of time than we otherwise could. In addition to expanding my existing uses of government and academic data, in future, I would like to increase my use of citizen science data. In graduate school, I co-developed an elementary school educational program that generated citizen science data. I have contributed extensively to iNaturalist, also useful as an outreach and teaching tool, and citizen science monitoring of intermittent streams. Next, I would like to use iNaturalist and related datasets to better characterize the variety of organisms that use artificial aquatic habitats. I would also like to reaffirm and expand research collaborations and connections with colleagues around the U.S. and world, as on analyzing urban stream gages, that I also delight in sharing with my students. I also hope to develop current discussions with

colleagues on the environmental justice and historical preservation implications of artificial waters into actual collaborative research.

Overarching Goals

I seek 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, especially wet ones, while also working with the associated humans, in hopes of revealing space for improvement in condition of all. I hope to become part of local dialogue, not just an outside observer. I also plan to continue to educate, to mentor budding scholars as part of my research, and to communicate what I'm doing through writing and other media with more than just scientists. My greatest impact on the future occurs through giving other people a chance to make their impacts too.