Toxic Nutrients and Legacies of Harmful Algal Bloom Mitigation in Lake Erie

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While seated at my kitchen table in my apartment in Columbus, OH, the site of my dissertation fieldwork, I attended an Ohio Agribusiness conference via Zoom. The theme of the conference was "disruption" and agricultural suppliers and farmers across the state were gathered together for the conference's first-ever virtual event due to the pandemic. Having paid the $150 entrance fee to learn what leading experts had to say about the launch of an environmental governance policy I am following for my research called H2Ohio—a $270 million plan to curb nutrient pollution from farm fields into Lake Erie—I was disappointed to see that the conference's headlining speaker wasn't an agricultural professional of any kind, but a motivational speaker. His talk was titled "The Power of One: How One Attitude, One Action, and One Person Can Change the World" and, as I listened to the man detail the varieties of "disruptions" that the "power of one" could overcome, which ranged from issues of marital strife, to financial woes, shifts in the presidency, regulation, and even climate change, I began noticing similarities between his orientation to life's disruptions and H2Ohio's orientation to the problem of nutrient pollution in Lake Erie—namely, a sincere investment in individualized and accountable action.

Each summer, several hundred square miles of Lake Erie's southwest basin are covered in a toxic pea-green slime that threatens drinking water supplies and depletes oxygen levels within lake waters, causing mass wildlife die-offs. These increasingly common and costly events are referred to as harmful algal blooms (HABs) and, notably, mounting scientific evidence suggests that they are caused by the leaching of nutrient-rich fertilizers, namely phosphorous and nitrogen, applied to farm fields. Additionally, HABs are further proven to be exacerbated by the steady loss of wetlands throughout the region in the wake of settler occupation, which are capable of absorbing excess nutrients released into waterways before they reach lake waters. As life-giving chemicals, phosphorous and nitrogen-based fertilizers are somewhat odd substances to consider from the perspective of waste management. Additionally, when considered as discrete elements, they would certainly not be classified as "toxic" in any conventional sense of the term. However, when manufactured in vast quantities and injected into ecosystems at speeds and scales which are out of sync with delicate ecosystem processes, they can encourage the exponential growth of toxin-leaching algae, like cyanobacteria, which do check most boxes for entry into a discussion (or paper) about toxicity.

Much important work has been done on the topic of toxic designation, from social constructivist approaches which locate dangerous matter between the boundaries of social ordering (Douglas 1966), to those deeply invested in the material specificity of waste particles and their more-than-human itineraries (Hawkins 2018, Hird 2012, Liboiron 2016, Murphy and Shadaan 2020). Considered jointly, these foundational arguments help us see the violence in mantras like "the dose makes the poison" at the same time that they open our analytic gaze to happenings beyond the physical edges of particles or, indeed, *within* the very modes of attunement through which such edges are made sensible. As Michelle Murphy and Reena Shadaan have argued, "worlds built with chemicals…purposively push aside complex reactivity with living and nonliving being…[shaping] the ways toxicology has historically studied them: one by one, as isolated entities of purely technical qualities without context" (Murphy and Shadaan 2020). The question of context is critical to the study of Lake Erie HAB toxins not only because it opens questions about how toxic Lake Erie water is unequally parsed and accessed by coastal inhabitants with varying susceptibilities, but also because it draws our attention to how the problem of HABs is physically, temporally, and conceptually circumscribed such that grounds for meaningful action against the problem can be waged. In my research, I study what "action" within a world "built with chemicals" means and what such actions do as they claim to merely curb HAB growth.

One way in which H2Ohio contextualizes the problem of HABs and, thus, prepares a ground for action, is by drawing a material link with nutrients between farm fields, rivers, wetlands, and Lake Erie. This line often conceives rivers as pipes and wetlands as storage tanks, foregrounding their function within the landscape as mediums of nutrient transfer first and foremost. This contained and seamless pipeline is the foundation to H2Ohio's broader efforts to develop a budgetary model of nutrient inputs and outputs throughout Lake Erie's entire watershed, through which policy makers hope to quantitatively measure the perceived costs and benefits of various nutrient pollution mitigation strategies. In my research, I have been following two groups responsible for organizing the necessary physical and conceptual resources to create such nutrient budgets and monitor their fluctuations in near-real time. On the one hand, I have been conducting fieldwork with agricultural professionals and watershed modelers who are working to calculate the impacts various nutrient "best management practices" have on nutrient run-off from farm fields. On the other hand, I have been working with wetland ecologists who are developing a comprehensive protocol for monitoring how newly restored/constructed wetlands built with H2Ohio funds retain nutrients from Lake Erie waterways such that new and existing wetlands can be (re)constructed to optimize nutrient retention. While the comprehensive budgetary model that these efforts contribute to constitutes one of the most holistic and detailed attempts to calculate nutrient distributions anywhere in the world, it does so on the condition that the phenomenon of HABs be parsed into discrete, measurable, and exchangeable units that, when added together, may equal a whole ecosystem mass balance of dissolved and particulate phosphorus levels in Lake Erie.

By monitoring mass balance inputs and outputs across fields, streams, and wetlands throughout Lake Erie's watershed, it is hoped that the relative impact (i.e. return on investment) from various discrete HAB mitigation strategies can be assessed. While seemingly straightforward, the actual measurement and statistical modeling of such mass balances is rife with uncertainty."Legacy nutrients," for instance, which accumulate in contemporary farm soils at unknown volumes and dissolve into waterways at rates varying from one year to one century, contribute to such uncertainty by posing questions of accountability for HABs at temporal scales beyond contemporary regulatory frameworks. Similarly, the presence of centuries-old underground drainage tile networks, once used by white settlers to convert a vast swampland infamously referred to as the Great Black Swamp into the flat agricultural landscape associated with the region today, introduce additional uncertainties into H2Ohio nutrient budgets by altering farm field irrigation patterns and, thus, rates of nutrient run-off. Given that such drainage efforts coincided with the illegal encroachment of settlers onto Ottawa Nation territories established by the treaty of Detroit in 1807, underground drainage tile networks may be considered as much a technology of settler colonial land dispossession as they are contemporary nuisances to both ongoing nutrient pollution and H2Ohio's effort to track the efficacy of various mitigation strategies.

As one wetland ecologists explained to me, if you were to assume 10 units of bioavailable phosphorus floating down a stream within the Maumee River (Lake Erie's largest water source), it is likely that at least 7 of these particles are legacy nutrients. This means that if 100% of current nutrient best management practices on farm fields were adopted with 100%

efficiency, we would see only a 30% reduction in overall nutrient loading into Lake Erie. In this way, wetland restoration is a compelling HAB mitigation strategy precisely due to its capacity to interface with legacy nutrients and, thus, 100% of nutrient loads flowing down stream. Crucially, however, when nutrient retention rates are calculated for a given wetland, it is impossible to discern if loads are legacy nutrients or nutrients applied to farms during the present season. Additionally, due to a lack of data about what nutrient loads within wetland soils were before restoration occurred, such wetlands are at risk of becoming so nutrient-saturated that they become a nutrient *source* versus sink. Due to this fact, one ecologist on the team likes to think of wetlands as "trash-bags," which can retain nutrients for some time, but not indefinitely. Similar to how trash-bags ultimately must be taken "away," wetland sediments specifically designed as nutrient sinks must also be taken "away" by excavators and replenished with new soil, although where such old sediments go and new sediments come from remain to be seen. This kind of work falls within the broad domain of wetland management, which has an illustrious history in northwest Ohio where some of the country's oldest hunting and fishing clubs have managed wetlands in the interest of waterfowl habitat conservation for centuries. This domain of practices may include spraying herbicide and insecticide for invasive species, mowing grass, applying fertilizers, salting roads, and, most notably, lowering and raising water levels via pumps and in-take gates. While carried out by humans as practices, their accumulative effects through the years have become structural, producing diverse mosaics of wetland habitats amenable to a suite of sought-after bird populations, all of which can be shot and killed in a single afternoon. Curiously, wetland management practices were entirely absent from H2Ohio's 200+ page wetland monitoring plan. It was as if the question of nutrient retention seemed purely structural and thus somehow distinct from the impacts of everyday, mundane practices on the ground. Relatedly, information about surrounding drainage tile networks that may feed nutrient-rich water into H2Ohio wetlands also escaped the monitoring plan's purview.

During a stakeholder advisory group meeting where a team of watershed modelers sought to explain the various aspects of uncertainty within their models, one head of a commodity group raised his hand and shook his glass, saying: "you're telling me, that during big flow events, the river acts like a pipe. But I say, look what happens when I shake my glass. What happens to the tea leaves?" The man was asking about the resuspension of nutrient-laden sediments during high flow events (such as those that follow a storm) and the extent to which such resuspension of legacy nutrients could be contributing to Lake Erie's annual phosphorus loads in addition to excess nutrient run-off from farm fields. While primarily strategic, what the commodity group manager achieves with this line of questions is historical, in so far as it opens new instances of relation into the story of how nutrients move from farm fields to drainage pipes, ditches, streams, rivers, and, ultimately, Lake Erie. In a similar vein, although with different commitments in mind, Elizabeth Povinelli has recently asked "what questions become unavoidable when we begin within the face of history rather than with a claim about ontology?" History, she argues, allows us to see not only the "coming catastrophe," but also what she refers to as the "ancestral catastrophe," a catastrophe which has and continues to occur without resolution, such as the mass genocide and displacement of indigenous peoples from northwest Ohio ground which has since been made into farmlands steeped in logics of colonial relation which today harbor toxic formations anew in the form of HABs.

When nutrient best management practices on farms are promoted as a viable means of HAB mitigation, a curious thing happens to the ground such practices take place upon, its permanence or, rather, its perceived immutability, is instantiated. Or, at the very least, it appears outside the realm of problematization for HAB solutions. Conversely, in the context of wetland restoration monitoring, management practices are excluded from view. Why? Could it be that in breaking and forging ground anew, one must enact the structural? That is, that which endures and remains constant in the face of lesser flux? Thinking with Povinelli, what other ways could we imagine HAB solutions if we were willing to think about nutrient distributions historically, versus ontologically burdened by an immutable ground composed of chemicals void of context? Audra Simpson, in her account of the imposition of heteronormative Victorian rules of descent onto matrilineal systems of Mohawk land governance, has described how this effort entailed rendering the bodies of Mohawk women immaterial and, thus, more susceptible to harm, due to the symbolic weight their bodies held as symbols of "land, reproduction, and Indigenous kinship" (Simpson 2014). What such accounts underscore, is that relative capacities to occupy space with permanence are political achievements vs. mere physical realities (although they are this too). With this insight in mind, implicit or explicit designations of "structural" vs. "practice-based" approaches to HAB mitigation in Lake Erie take on new meaning and can be seen as related to the settler problem of land as much, if not more, than the problem of HABs. Thus, as lines are drawn with nutrients to connect farms, rivers, wetlands, and lakes, and budgets are created to hold individual actors accountable to HAB mitigation efforts, legacy nutrients trouble more than just nutrient load calculations. Lastly, thinking about wetlands as temporally-finite trash-bags or everyday wetland management practices as structuring processes could offer less lethal grounds for thinking HABs historically and with a pointed indifference to toxic settler land claims, which today delimit the political imagination of HAB mitigation strategies in Lake Erie.

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