Scavia Donald (Orcid ID: 0000-0002-2784-8269)

Time to pick up our heads and look inland

Donald Scavia
Professor Emeritus
University of Michigan
scavia@umich.edu

This is the author manuscript accepted for publication and has undergone full peer review but has not been through the copyediting, typesetting, pagination and proofreading process, which may lead to differences between this version and the Version of Record. Please cite this article as doi: 10.1002/lob.10342

Author's note: Much of this material was published originally in The Conversation: *"Industrial corn farming is ruining our health and polluting our watersheds"* and *"How your diet contributes to nutrient pollution and dead zones in lakes and bays."*

Every year in early summer, we forecast the extent of hypoxia and harmful algal blooms in the Gulf of Mexico, the Chesapeake Bay, and Lake Erie. This year the outlook was not good (http://scavia.seas.umich.edu/hypoxia-forecasts/), and unfortunately most of the forecasts were born out. Gulf hypoxia approached record size at roughly 18,000 km^2. Chesapeake Bay's July hypoxic volume of 8.2 km^3 was in the top 20% of the past 20 years. And Lake Erie is likely to reach or surpass its previous record of over 40,000 metric tons of potentially toxic algae (Figure 1).

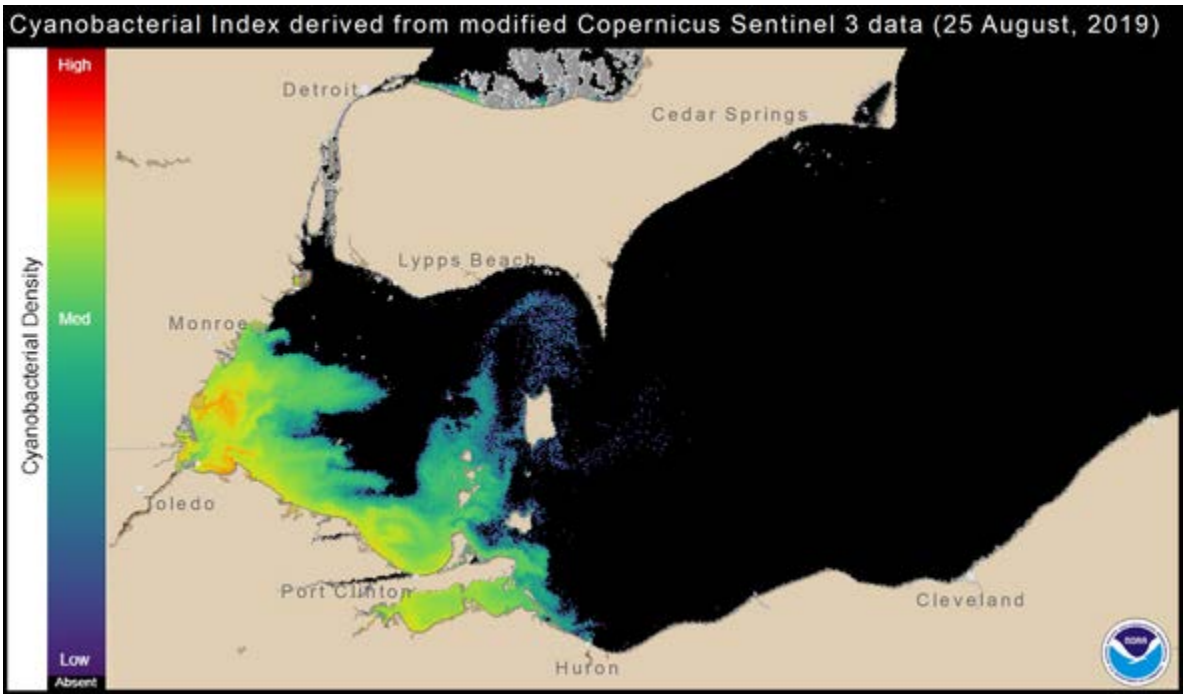


Figure 1. Lake Erie cyanobacteria bloom on August 25, 2019. Color spectrum based on satellite detection of cyanobacteria. Grey indicates clouds or missing data. The estimated threshold for cyanobacteria detection is 20,000 cells ml^{-1}. Taken from NOAA Lake Erie Harmful Algal Bloom Bulletin, August 20, 2019, Bulletin 18.

The key drivers of this year's outcomes are winter and spring rainfall considerably above normal. This winter was the wettest on record, and May was the second-wettest month on record. More rain means more flooding and runoff carrying heavy loads of nutrients fueling algal blooms and hypoxia. The end results often include fish kills, closed beaches, drinking water alerts, and loss of coastal property value. This July was also the warmest on record, and as the climate continues to warm the problem is likely to get worse. Most climate models forecast increased precipitation, especially intense spring rains, for most of the Midwest, the Great Lakes basin, and the mid-Atlantic. It is also clear that this problem extends well beyond these three iconic systems and has been around for decades (NRC 2000).

As limnologists and oceanographers, we spend most of our careers exploring how oceans and lakes respond to drivers, and for hypoxia, harmful algal blooms, and other symptoms of eutrophication, the drivers come from land. Yet, we spend most of our time with our backs to the land. This viewpoint suggests more of us should look to both proximate and ultimate causes of these problems, and advocate for solutions.

Treading water

After decades of upgrades in municipal and industrial treatment, nutrient loads now come primarily from diffuse sources, often dominated by industrial row crop agriculture, especially corn. The main policy tool currently available to combat nutrient losses from agricultural lands is the Farm Bill, enacted about every five years, that funds voluntary conservation. Between 1995 and 2015, it provided almost $32 billion in conservation incentive payments. While water quality would likely be worse without these programs, both nutrient loads and their impacts have increased or held grudgingly steady in these three systems (Figure 2).

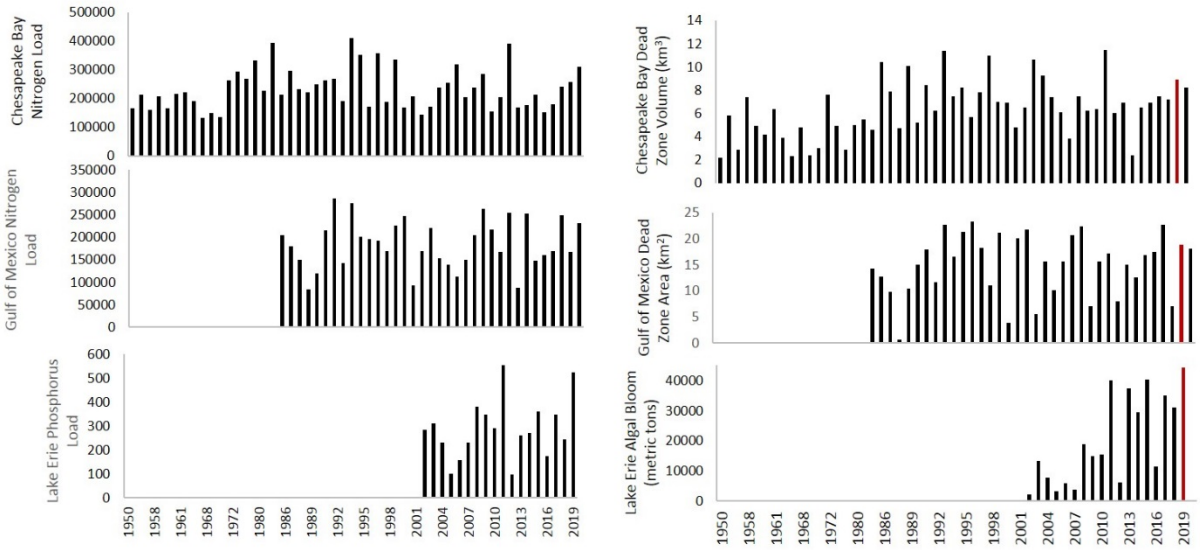


Figure 2. Relative nutrient loads, hypoxia, and harmful algal bloom trends (2019 forecasts in red). Data are reproduced from http://scavia.seas.umich.edu/hypoxia-forecasts/, with original sources from USGS, Nancy Rabalais (LUMCON/LSU), the Chesapeake Bay Program, Rick Stumpf (NOAA), Laura Johnson and Nate Manning (Heidelberg University).

Replacing industrial corn

While these conservation programs are important, and some new practices like two-stage ditches could improve nutrient management, watershed models suggest that these conservation practices would have to be implemented at unprecedented - and unlikely - scales to be effective (e.g., Scavia et al. 2017). The challenge is even more daunting when recognizing that, in many cases, agricultural soils are already laden with excess nitrogen and phosphorus. This is not to say that we should abandon implementing best management practices where they will do the most good. But as concerned scientists, we need to step back and look at the larger system within which these watersheds operate, and advocate for broader change.

For example, if making industrial corn production more efficient and implementing programs to reduce runoff are not likely to be enough, then perhaps there is just too much corn. Simple math suggests that reducing and/or replacing industrial corn production with less leaky crops would help. But one cannot expect farmers in these watersheds to forgo income to others, which given current markets, would certainly happen. So, reducing or replacing industrial corn requires a national, multi-pronged agenda. In my view, we should be advocating a shift away from industrial-scale corn production through partnering in three integrated national movements.

First, we should support policies that stop putting food in our gas tanks. Current US energy policy calls for so much ethanol that it consumes 40% of the US corn production. This large-scale diversion of corn has raised prices, distorted markets, and had serious negative impacts on

food choice and availability globally. This change would, of course, be politically difficult as long as presidential primaries start in Iowa. But, coupled with other strategies, it should be a component.

The second strategy is to encourage the private-sector to use its influence over the agricultural supply chain to demand corn raised through more sustainable practices. While the marketplace does provide healthy alternatives and food from sustainably grown crops, these are not generally within reach, geographically and financially, to the vast majority of consumers. So, we need mass market leaders to help make them more available. Some progress is already being made. For example, Walmart, the country's largest grocer, collaborated with food and beverage suppliers and their supply chains to reduce the impact of fertilizer on 14 million acres of US farmland, *albeit* a small fraction of the 915 million acres. Companies including General Mills, Cargill, Kellogg, and Coca-Cola partnered within the Field to Market Alliance of grain suppliers, agronomic experts, and farmers to measure fertilizer use and identify opportunities for improvement. While it is not clear how much these efforts can shift the supply chain toward more sustainable agriculture at national scales, it is a start, and we should support it professionally and through our individual purchasing power.

The third strategy – probably the most difficult, but arguably the most effective – involves our diet. We need to join environmental and human health advocate efforts to change the American

diet. A federal advisory board on nutrition standards recommended food labels that address the environmental impact of food production in 2015, but Congress squelched that proposal. At the same time, the one-two punch of ubiquitous high fructose corn syrup and ever-increasing meat consumption are causing troubling human health issues, ranging from childhood diabetes and obesity to heart disease. And because over 40% of US corn goes to corn syrup and animal feed for the increasingly meat-consuming population, these diet choices also drive the nutrient pollution problem.

If Americans were to move closer to the lower-meat Mediterranean diet, there would be a dramatic reduction in the demand for fertilizer (Townsend et al. 2003). While a stretch at first, this idea has gained momentum with the growth of the alternative meat industry. The success of startups like Beyond Meat and Impossible Foods is luring giants like Tyson and Perdue into the game. One recent market analysis suggests that plant-based "meat" will surpass animal sources globally by 2040 (Gerhardt et al. 2019), and some producers are even struggling to keep up with demand for plant-based meat alternatives, particularly in China (Vigdor 2019). Recent analyses connecting reduced meat consumption to both positive environmental effects and improved health (Willett et al. 2019) should provide additional incentives for change, and others are laying out comprehensive global pathways to more sustainable agriculture designed to both feed the world and protect and restore natural ecosystems (Searchinger et al. 2018; Clark et al. 2018).

Call to action

As oceanographers and limnologists who study and care deeply about rivers, lakes, estuaries, and oceans, it is incumbent upon us to advocate for better policies to protect them. A comprehensive plan that addresses energy policy, health and nutrition, environmental protection, and market-shaping initiatives from the private sector isn't a quick or easy process. But little else has worked over the past decades, and working with advocates for sustainable energy and healthier diets on this combined agenda could improve the health of both people and the environment.

References

Clark, M, J. Hill, D. Tilman. 2018. The Diet, Health, and Environment Trilemma. Annual Review of Environment and Resources, 43:109-134. https://doi.org/10.1146/annurev-environ-102017-025957

Gerhardt, C. G. Suhlmann, F. Ziemβen, D. Donnan, M, Warschun, H-J Kühnle. How will cultured meat and meat alternatives disrupt the agricultural and food industry? ATKerney: https://www.atkearney.com/retail/article/?/a/how-will-cultured-meat-and-meat-alternatives-disrupt-the-agricultural-and-food-industry. Accessed 8-21-19.

NRC 2000. Clean Coastal Waters: Understanding and Reducing the Effects of Nutrient Pollution. National Research Council, Washington, DC: The National Academies Press. https://doi.org/10.17226/9812.

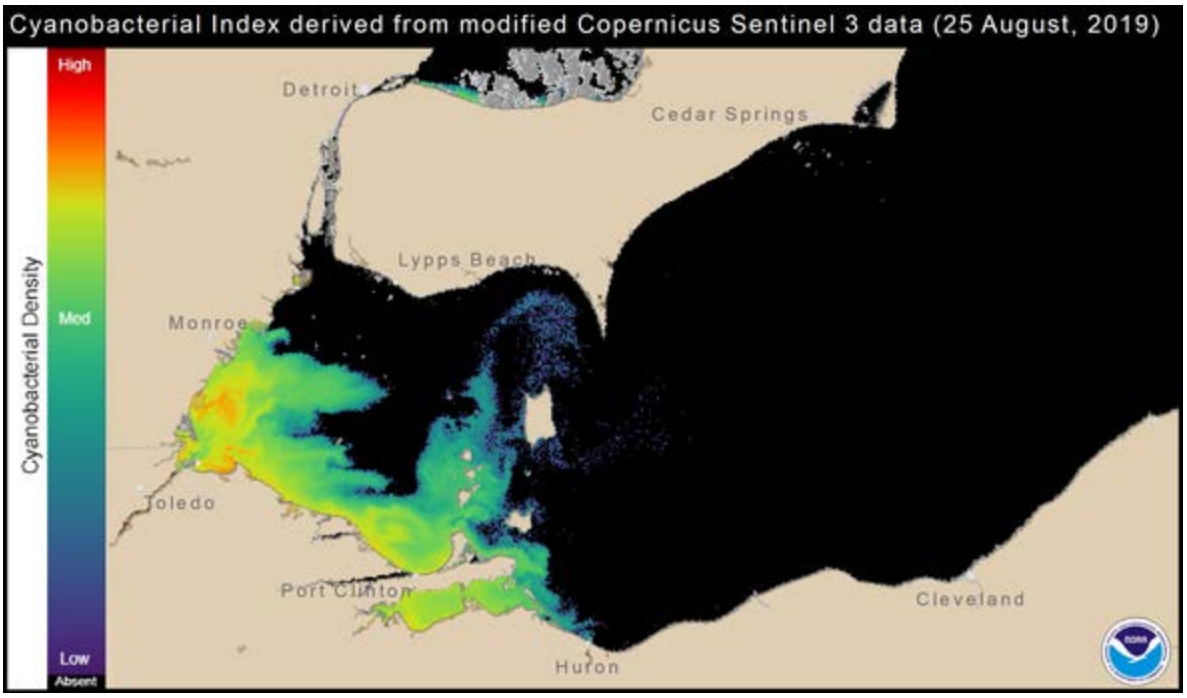
Scavia, D., M.M. Kalcic, R. L. Muenich, J. Read, N. Aloysius, I. Bertani, C. Boles, R. Confesor, J. DePinto, M. Gildow, J. Martin, T. Redder, D. Robertson, S. Sowa, Y-C Wang, H. Yen. 2017. Multiple models guide strategies for agricultural nutrient reductions. Front. Ecol. Environ. 15: 126-132. https://doi.org/10.1002/fee.1472

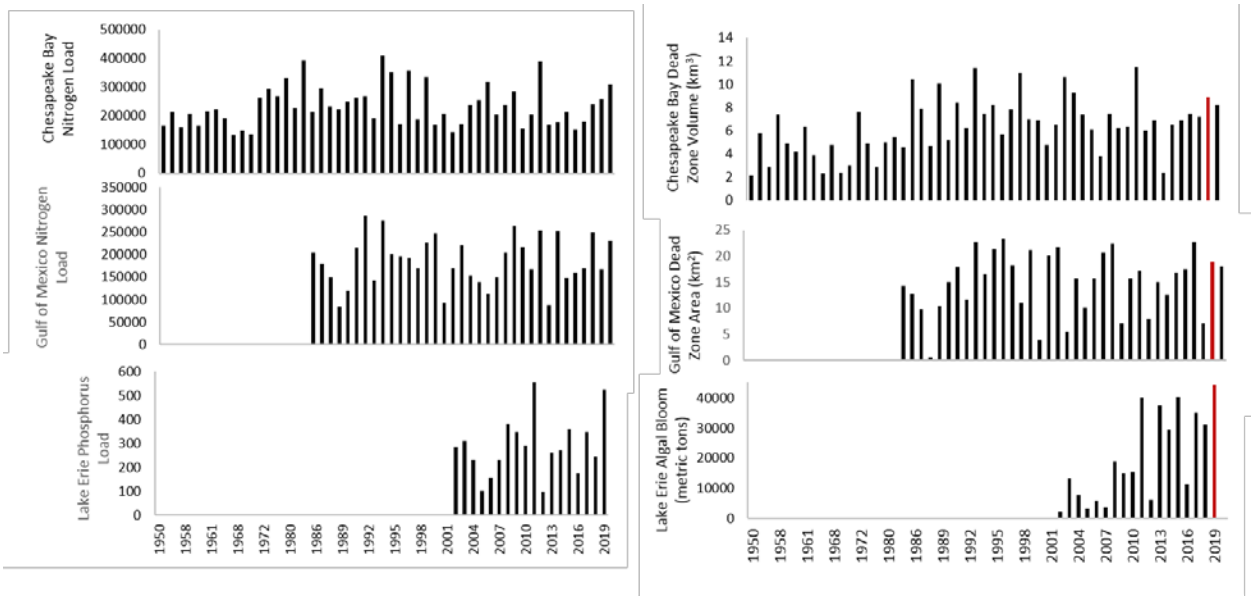
Searchinger, T. R. Waite, C. Hanson, J. Ranganathan, P. Dumas, E. Matthews. 2018. Creating a Sustainable Food Future: A Menu of Solutions to Feed Nearly 10 Billion People by 2050 (Synthesis Report). World Resources Institute, https://www.wri.org/publication/creating-sustainable-food-future#main-content.

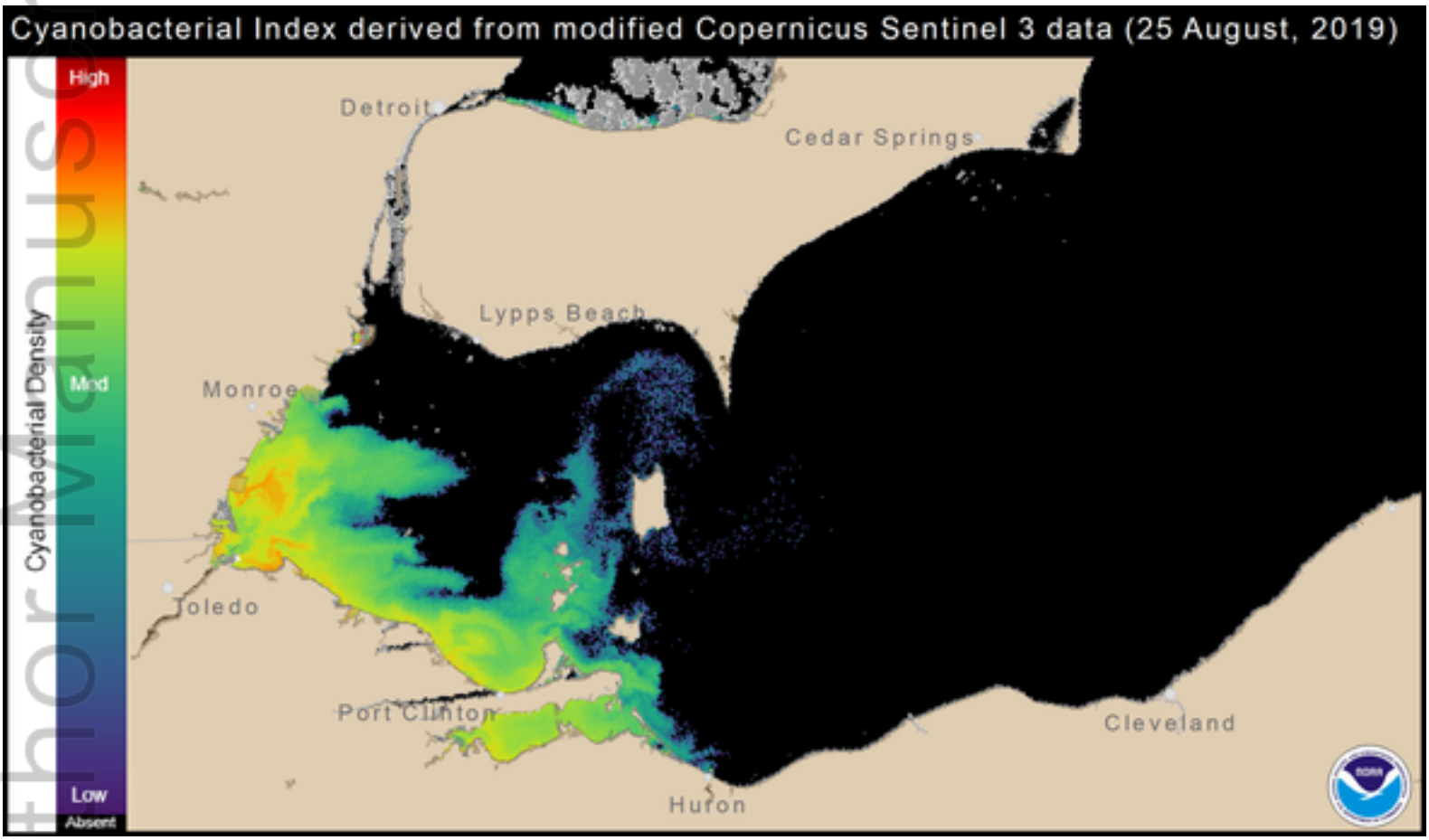
Townsend, et al. 2003. Human health effects of a changing global nitrogen cycle. Front. Ecol. Environ. 1:240-246.

Vigdor, N. 2019. Mission impossible? Maker of plant-based burger struggles to meet chain's demand. New York Times, June 15, 2019.

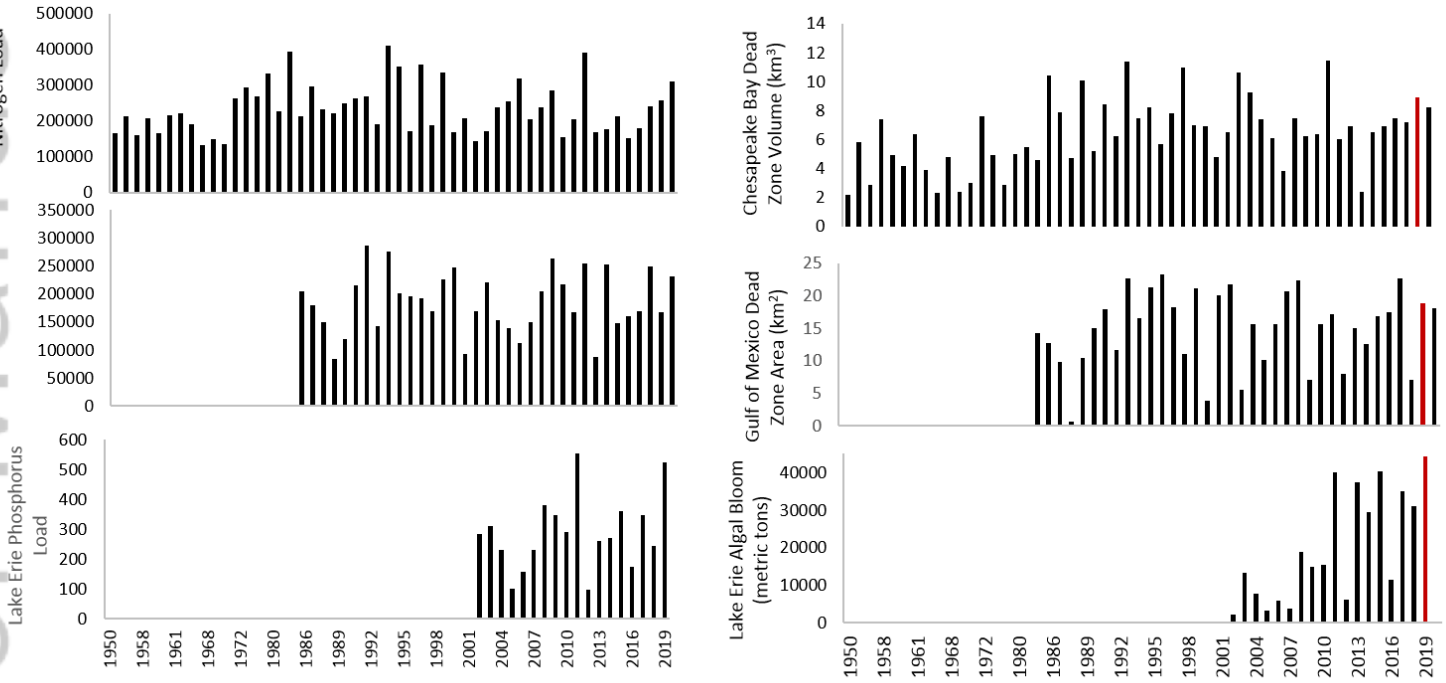
Willett, W. et al. 2019. Food in the Anthropocene: the EAT-Lancet Commission on healthy diets from sustainable food systems. The Lancet 393:477-492. https://doi.org/10.1016/S0140-6736(18)31788-4







LOB_10342_Figure 1.png



LOB_10342_Figure 2.png