Understanding Long Island Sound's 'dead zones'

February 5 2020, by Elaina Hancock

New research provides insight into the "dead zones" that appear in Long Island Sound in the summer. Credit: UConn Photo/Sean Flynn

For the past 25 years, the Environmental Protection Agency and the Connecticut Department of Energy and Environmental Protection have been diligently collecting water samples each month in Long Island Sound (LIS). Recently, the data have been compiled and analyzed, by UConn associate professors of Marine Science Penny Vlahos and Michael Whitney, and other team members, who have begun the task of digging into the data to better understand the biogeochemistry of the Sound. Part of the analysis, called "Nitrogen Budgets for LIS," has been published in the journal *Estuarine, Coastal and Shelf Science*.

Every summer since 1820 or so, LIS has experienced what is called a "dead zone." In the 1970s and 1980s, the annual appearance of the dead zone saw extensive fish kills which drew public attention and spurred action by state environmental agencies.

Dead zones occur when influxes of excess nutrients such as nitrogen, along with warm, still waters, lead to bursts of growth in algal populations and their subsequent decay, says Vlahos.

"Everything in the system is connected. An influx of nitrogen will lead to algal growth, and algae produces organic matter and oxygen that will be consumed by bacteria," she says.

As bacteria growth spikes, the populations use oxygen in the area faster than it can be replaced, resulting in areas of low oxygen, or no oxygen at all. These "hypoxic areas" or dead zones vary in size, but can stretch from the far western part of LIS all the way to the middle portion of the LIS estuary in some years.

This study is the first of its kind to study the complex total nitrogen cycle in the LIS estuary, with the goal to better understand and predict why some years are worse than others.

Nitrogen enters the watershed through freshwater inputs from streams, rivers, and wastewater treatment effluents, as well as through atmospheric inputs. Eighteen rivers drain into LIS, with roughly 70% of the freshwater that drains into the estuary coming from the Connecticut River. Exchange with the open ocean happens primarily with tidal flow through the eastern portion of LIS.

"However, no one knew what was happening to nitrogen once it entered the system," says Vlahos.

Nitrogen can take many forms depending on the source and conditions—as nitrate (NO3), nitrite (NO2), ammonia (NH4), in particulate, dissolved, or gaseous form—which adds even more complexity to understanding the balance of the element in the LIS system.

The researchers estimated fluxes and interannual variability based on monthly measurements. They also calculated the nitrogen stored within LIS.

The results showed that, surprisingly, less than half the nitrogen entering the LIS is exported to the adjacent ocean.

"Sixty percent of nitrogen entering into Long Island Sound is either buried in sediment or is converted into nitrogen gas and leaves the system via the atmosphere," Vlahos says. "Forty percent is exported to the open ocean."

With this initial study, policy makers and researchers can begin zeroing in on other questions that need to be addressed.

"This helps us to start to answer questions about what happens in Long Island Sound. Where does nitrogen get used the most? Where should we concentrate our efforts at reducing nitrogen loads?" Vlahos says.

Understanding this system will prove valuable for coastal planning in coming years as the human population of the region rises, and the effects of climate change become more acute. Extreme weather events such as super storms can churn up sediment, re-injecting buried nitrogen while excessive amounts of storm water entering LIS can lead to large episodic influxes of nitrogen and other nutrients into the system.

These complex systems and processes don't occur in isolation from each other, says Vlahos.

"Waters in Long Island Sound are warming faster than the open ocean and a lot of that has to do with the expansion of the Gulf Stream," she says.

In anticipating these events and how they will impact the region's biogeochemistry, Vlahos says the first step is making decisions about land use that can affect LIS.

Previous studies, for instance, support the idea that hypoxia happened as the human population began to rise in the region, with the start of dead zones coinciding with a period of time of great deforestation. The forests were cleared for agricultural purposes and with forest loss, there was also loss of ecosystem services that forests provide, such as slowing the flow of surface water, and filtering out excess nutrients like nitrogen.

This makes Vlahos hopeful for prospects of addressing the annual dead zones in Long Island Sound.

"If it is human-caused, there is no reason we can't reverse it and bring it back to at least a minimum," she says. "There may be a cost for humans being here no matter what, but where there is a will, there is a way and fortunately we are moving in the right direction."

More information: Penny Vlahos et al. Nitrogen budgets of the Long Island Sound estuary, *Estuarine, Coastal and Shelf Science* (2019). DOI: 10.1016/j.ecss.2019.106493

Provided by University of Connecticut