Rebecca Barnes

Yale University, School of Forestry & Environmental Studies, New Haven, Connecticut

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The Feasibility of Using Stable Isotopes to Monitor Nitrate Sources to Long Island Sound

Overview

Nitrogen is the limiting nutrient in many estuaries, and the rising availability of nitrogen has led to increased eutrophication in many coastal ecosystems. Estuarine eutrophication is associated with higher rates of algal net primary production, seasonal hypoxia, harmful algal blooms, decreased size of sea grass beds, fish kills, and changes to the plant and animal communities.

The National Estuarine Eutrophication Assessment estimated that 40% of U.S. estuaries are impaired due to eutrophication. In addition to the ecological impacts of this problem, eutrophication affects local economies by leading to shellfish bed closures, decreased recreational opportunities, and loss of fish stocks.

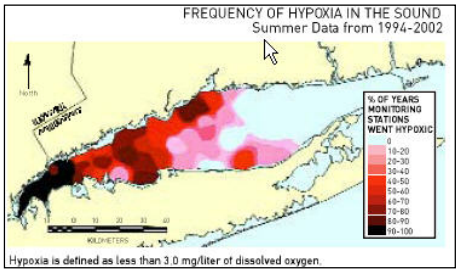

Figure 1: Frequency of hypoxia in Long Island Sound's bottom waters. *Source: CT DEP LIS Water Quality Monitoring Program.*

Long Island Sound's western basin is usually hypoxic from mid-July through September (Figure 1). The hypoxia is associated with higher nitrogen loads and less mixing of oxygenated waters. According to the Long Island Sound Study, more than 60% of nitrogen entering the Sound comes from sewage treatment plants, while non-point sources, including atmospheric deposition, fertilizers, animal waste, and soil microbial nitrification contribute the remaining 40%.

Methods

I will use stable isotope techniques to identify and track both point and non-point sources of pollution in aquatic systems. In the case of NO_3^-,the most bioavailable form of nitrogen, using a dual isotope approach ($\delta^{15}N$ and $\delta^{18}O$) provides valuable source identification information. However, the ranges of isotopic values in the literature for the various nitrate sources (sewage, atmospheric deposition, microbial nitrification, fertilizer, etc.) is currently too large to clearly differentiate among sources. To better understand and define the range of isotopic source signatures I will be sampling at high spatial and temporal resolution.

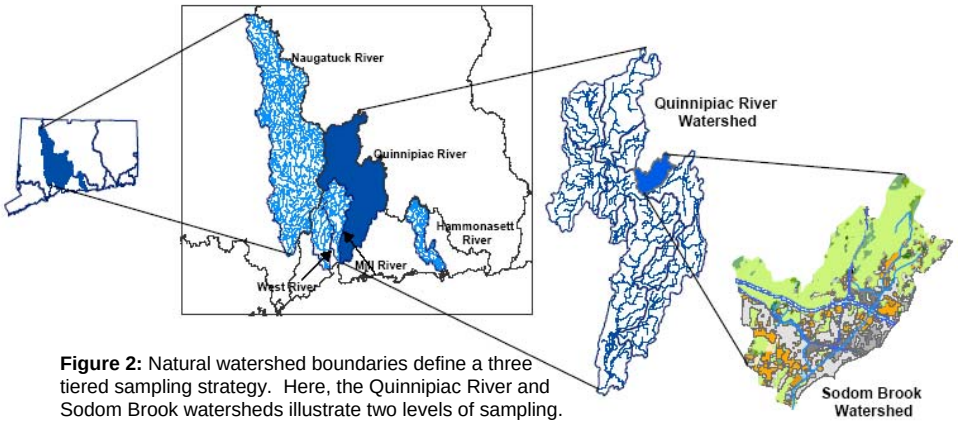

Figure 2: Natural watershed boundaries define a three tiered sampling strategy. Here, the Quinnipiac River and Sodom Brook watersheds illustrate two levels of sampling.

Various chemical indicators of nitrogen loading will also be measured to assess their use in conjunction with the stable isotopes These include NO_3^-, NH_4^+, TON, TOC, chlorophyll and C:N of POM. This suite of measurements will help determine the best strategy (in terms of both time and cost) for detecting watershed nitrogen loading to estuaries.

A question of scale

Watersheds draining to Long Island Sound will be sampled at three different scales (Figure 2):

- Source signatures will be identified by sampling atmospheric deposition, sewage treatment plant effluent, as well as first and second order forested, agricultural, and urban catchments.
- Second & third order tributaries will be sampled to ascertain the relationship between mixed land cover catchments and isotopic signatures.
- Longitudinal sampling will be done along main stems to assess the relative contributions of different tributary sources.

Impact

Long Island Sound

As part of a Comprehensive and Conservation Management Plan, Connecticut and New York agreed to reduce nitrogen loading to the Sound by 58.5% by the year 2014. To effectively manage this problem it is necessary to know the relative importance of various sources.

Other Estuarine Systems

The Pew Oceans Commission identified over-enrichment of nutrients, specifically nitrogen, as the greatest risk for marine life and habitats in coastal waters. Scientists have shown non-point sources are the origin of a majority of the nutrients entering estuarine systems. The ability to quantitatively apportion nitrogen loading to these diffuse sources would aid in the future development of nitrogen management plans.

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