Changes to $\delta^{15}N$ and $\delta^{18}O$ of NO_3^- in response to reductions in anthropogenic N loading

COURTNEY E. SCHMIDT[1] REBECCA R. ROBINSON[1] AND SCOTT .W. NIXON[1]

[1]Graduate School of Oceanography, University of Rhode Island, Narragansett, RI, USA

Anthropogenic nitrogen (N) loading in Narragansett Bay has increased over the last century, prompting upgrades to wastewater treatment facilities to decrease the amount of nitrogen discharged. The upgrade to tertiary treatment – where bioavailable N is reduced and removed through denitrification– has occurred at multiple facilities throughout Narragansett Bay's watershed. Stable isotopes have previously been used as a tracer of nitrogen source; however, no studies have assessed changes to isotopes in Narragansett Bay after upgrades to tertiary treatment. To characterize the potential impact of these upgrades, samples from rivers and WWTFs, and Narragansett Bay were collected in 2009 and 2012, before, during, and after upgrades to tertiary treatment. Samples were analyzed for NO_3^- concentration and stable N ($\delta^{15}N$) and oxygen ($\delta^{18}O$) isotopic compositions of NO_3^-. The shift to tertiary treatment, documented at one WWTF, increased effluent nitrate $\delta^{15}N$ and $\delta^{18}O$ values by ~18 ‰ for both isotopes ($p<0.005$). Across the region, $\delta^{15}N$ and $\delta^{18}O$ values of most rivers increased by 5 ‰ and 4 ‰, respectively ($p<0.01$). This shift toward higher isotope values accompanies a reduction in nitrogen inputs of ~ 20%. The effects of tertiary treatment on the $\delta^{15}N$ of NO_3^- values are not apparent beyond the Providence River Estuary (north of 41.7ºN). Between 2007-2009 and 2011-2012, $\delta^{15}N$ values increased significantly, by 2 ‰, in the Providence River Estuary, but not in the rest of Narragansett Bay (south of 41.7ºN). The lack of change in $\delta^{15}N$ and $\delta^{18}O$ in the Narragansett Bay suggests that either anthropogenically-derived nitrate is consumed by 41.7°N and/or mixing and recycling of nitrate within Narragansett Bay proper overprints any tracer signal. N* calculations show that the bay switches from N-rich to N-limited at 41.7°N for both 2007-2009 and 2011-2012, consistent with the idea that the anthropogenic N input reductions and accompanying isotopic changes are not likely to impact the bay proper.