

US EPA ARCHIVE DOCUMENT

Do phytoplankton use more NH_4^+ or NO_3^- ?

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2004 EPA STAR Graduate Fellowship Conference Next Generation Scientists—Next Opportunities



1. Do phytoplankton use more NH_4^+ or NO_3^- ?

Eutrophication is increasing worldwide and usually begins with increased availability of N to primary producers, primarily as NO_3^- .

- Leads to algal & phytoplankton growth
- Causes eelgrass die-off which leads to loss of fin- and shellfish habitat.
- Decomposition of algae leads to hypoxia/ anoxia which may kill organisms that cannot escape.
- Phytoplankton require N as:
 - nitrate (NO_3^-)
 - ammonium (NH_4^+) **PREFERRED**
 - nitrite (NO_2^-)
 - dissolved organic nitrogen (DON)

2. Site

Childs River is a sub-estuary of the Waquoit Bay system, on Cape Cod, MA. Land-use on the watershed of Childs River includes a large proportion of residential area, as well as other land-cover types, resulting in a land-derived N-load to the estuary more than 20 times the load to a comparable pristine system.

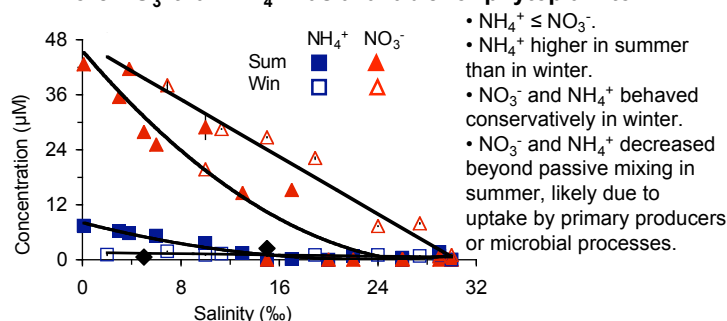


3. Methods We measured concentrations and $\delta^{15}\text{N}$ of NH_4^+ , NO_3^- , and chlorophyll *a*. We compared the $\delta^{15}\text{N}$ of chlorophyll *a*, NH_4^+ and NO_3^- to determine which form of N was used.

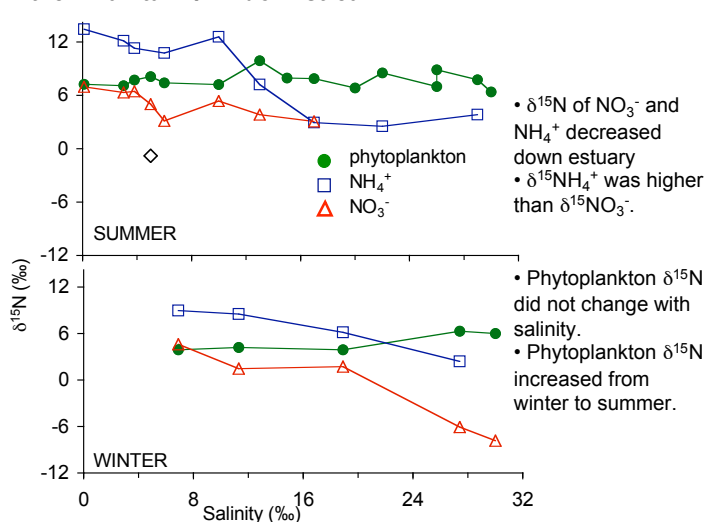
Stable Isotopes:

- Ratio of ^{14}N and ^{15}N varies in different materials
- $\delta^{15}\text{N} = [(R_{\text{sample}}/R_{\text{standard}}) - 1] \times 1000$, $R = ^{15}\text{N}/^{14}\text{N}$ (‰)
- Fractionation (ϵ) is a change in $\delta^{15}\text{N}$ during biological reactions because ^{14}N reacts faster than ^{15}N .
- Phytoplankton take up $^{14}\text{NO}_3^-$ or $^{14}\text{NH}_4^+$ slightly faster than $^{15}\text{NO}_3^-$ or $^{15}\text{NH}_4^+$; ϵ ranges from 4 to 7 ‰ for NO_3^- , 0 to 14 ‰ for NH_4^+

4. More NO_3^- than NH_4^+ was available for phytoplankton



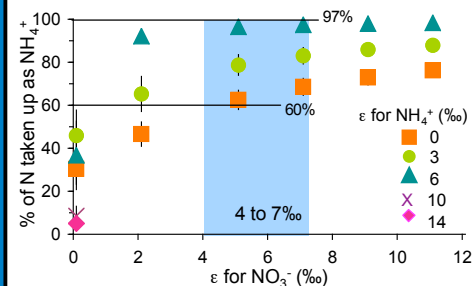
5. Phytoplankton acquired their $\delta^{15}\text{N}$ from NH_4^+ upstream, then maintain $\delta^{15}\text{N}$ downstream.



6. Phytoplankton in Childs River took up most of their N as NH_4^+ .

To determine % contribution of NH_4^+ and NO_3^- to phytoplankton, we used the following equation:

$$\% \text{NH}_4^+ = \frac{(\delta^{15}\text{N}_{\text{NO}_3^-} - \epsilon_{\text{NO}_3^-}) - \delta^{15}\text{N}_{\text{phytoplankton}}}{(\delta^{15}\text{N}_{\text{NO}_3^-} - \epsilon_{\text{NO}_3^-}) - (\delta^{15}\text{N}_{\text{NH}_4^+} - \epsilon_{\text{NH}_4^+})}$$



We varied $\epsilon_{\text{NO}_3^-}$ along the x-axis (0 to 12‰), and $\epsilon_{\text{NH}_4^+}$ by different symbols (0 to 14‰), and solved the equation using our data for $\delta^{15}\text{N}$ of chlorophyll *a*, NO_3^- and NH_4^+ . The blue shaded area shows solutions for values of ϵ for NO_3^- (4 to 7‰) and $\epsilon_{\text{NH}_4^+}$ (0 to 14‰), that are typical of estuarine phytoplankton.

Childs River phytoplankton derived 60 to 97% of their N from NH_4^+ .

7. Conclusions It appears that phytoplankton acquired a significant pool of NH_4^+ upstream which provided an N source for growth and division downstream.

Phytoplankton get most of their N from NH_4^+ , in spite of high NO_3^- in the estuary, so reducing NO_3^- may not solve eutrophication.

* This fellow is sponsored by EPA's STAR or Greater Research Opportunities (GRO) Program.