Sea Grant California

Phytoplankton and bacteria nutrient use: impacts of nutrient loading on the base of the food web

Calla Schmidt, Delta Science Fellow

BACKGROUND

Treated municipal wastewater contains a form of nitrogen known as ammonium. When discharged into waterways, this ammonium may alter phytoplankton (algal) communities and potentially degrade available food resources for zooplankton and other organisms.

It is theorized that high levels of ammonium limit the growth of larger phytoplankton (most notably, diatoms) by inhibiting their uptake of nitrate, a nutrient which supports cell growth.

Since diatoms are a preferred food for many organisms, limited diatom growth could affect the whole food chain, and potentially contribute to the decline in some fish species in the San Francisco Bay-Delta.

PROJECT

This project investigates the sources of nitrogen (e.g., wastewater treatment effluent, agricultural runoff, dissolved organic matter or river inputs) in phytoplankton samples collected downstream of a wastewater treatment plant on the lower Sacramento River and along a gradient in ammonium and nitrate levels from the Sacramento-San Joaquin River Delta to Suisun and San Pablo bays (see map on reverse side).

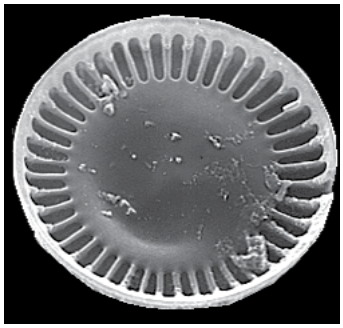
The work is the first step in quantifying the potential impacts of ammonium on the food web, and linking water quality to the transfer of nutrients into the food web. The research will also help scientists determine the relative importance of decomposing bacteria in producing ammonium vs. man-made sources.

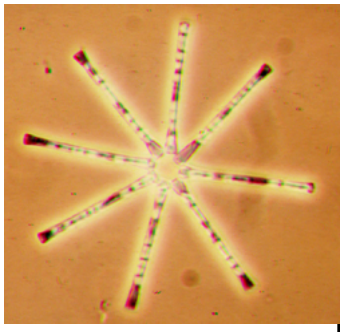
To address these ideas, the research is testing three main hypotheses:

1) As ammonium concentrations rise, phytoplankton switch from using nitrate to ammonium as a primary source of nitrogen.

2) Diatoms are more sensitive to increases in ammonium concentrations than smaller phytoplankton species.

3) Bacteria that decompose organic matter are an important source of ammonium in the San Francisco Estuary.





High levels of ammonium are theorized to limit the growth of larger phytoplankton by inhibiting nitrate uptake. Diatoms common to the river that may be impacted include *Cyclotella* spp (top) and *Asterionella formosa*. PHOTOS: Great Lakes Sea Grant Extension Office and National Park Service, U.S. Department of Interior

Calla Schmidt collects water samples on the Sacramento River.
PHOTO: Jennifer Lehman

"My project is about trying to figure out how much ammonium affects the base of the food chain. It's a first step in understanding the influence of treated municipal wastewater on food webs."

-Calla Schmidt, Delta Science Fellow

PROGRESS

The work to date focused on using stable isotope analyses to track the degree to which phytoplankton in the estuary absorb ammonium vs. nitrate and the sources of these nutrients (e.g., wastewater treatment plant effluent, agricultural runoff or river inputs).

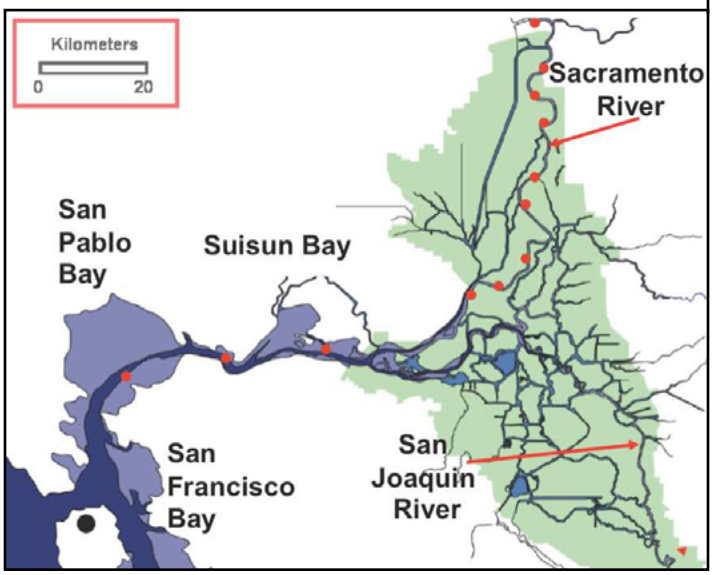
Much effort has been given to improving techniques for separating phytoplankton from bulk organic matter samples, using flow cytometry prior to conducting stable isotope analyses. The fellow is also trying to use flow cytometry to obtain bacteria samples from bulk debris; however, this is proving difficult due to the low mass of individual bacterium.

Bulk organic water samples are easier to collect in the field than separate phytoplankton samples. It is also hoped that the organic matter might provide a robust proxy for extracted phytoplankton, and if this were the case, historical archives of organic matter samples could be used to reconstruct a timeline of the sources of nitrogen at the base of the food web over the course of the pelagic organism decline.

The fellow's preliminary results suggest that phytoplankton do indeed have a different isotopic composition than the bulk organic matter, and the fellow is currently analyzing additional samples to determine whether a consistent relationship between the two can be found, which would make it possible to "correct" the bulk organic isotope signature into a proxy for phytoplankton.

If no such relationship can be found (i.e., the bulk organic matter proves to be a poor proxy), the fellow will collect new, isolated phytoplankton samples and use stable isotope analyses to track the sources and transfer of nitrogen to the base of the food chain.

Calla Schmidt gathered water samples from the Sacramento River and sites downstream from Suisun Bay. The map below shows the sampling locations as red dots.
FIGURE: Calla Schmidt



MANAGEMENT APPLICATIONS

The results of this research will help managers determine the processes that drive oscillations in nitrogen isotope signals in organic debris collected in the delta and quantify the relative uptakes of nitrate and ammonium by phytoplankton and bacteria. This is a key step in understanding how water quality (i.e., effluent discharges) affect nutrient dynamics in the estuary and, by extension, food web dynamics.

Results could have significant implications for managing nutrient pollution into the Bay-Delta watershed, in terms of identifying what management practices would do the most to protect the food web.

RESEARCH MENTOR
Carol Kendall, U.S. Geological Survey

COMMUNITY MENTOR
Peggy Lehman, California Department of Water Resources

PRESENTATIONS

Schmidt, C.M., C. Kendall, S.R. Silva, M.B. Young, & A.E. Parker. (2012) In-situ measurement of ammonium utilization by phytoplankton and bacteria to determine the impacts of nutrient loading on the base of the Delta food web. Bay-Delta Science Conference, Sacramento, Calif.

Schmidt, C.M., C. Kendall, S.R. Silva, and M.B. Young. (Planned for December 2013) Tracking ammonium utilization by phytoplankton to determine the impacts of nutrient loading on the base of the delta food web using stable isotope techniques. American Geophysical Union Fall meeting, San Francisco, Calif.

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