Metal Cycling and Bioavailability during Phytoplankton Blooms in South San Francisco Bay

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As the results of this study show, the relationships between algal blooms and trace metals in the San Francisco Bay are complex; algal blooms regulate some metal cycles and some metals regulate algal blooms. Consequently, natural or anthropogenic perturbations of either may directly impact the other and result in dramatic changes in the health of the estuary.

A series of studies on the interactions of trace metals and algal blooms in San Francisco Bay has been completed. The first of those studies showed that some dissolved metal concentrations (i.e., cobalt, manganese, nickel, lead, and zinc) decreased during an algal bloom, and then increased as the bloom decayed – releasing nutrients and metals back into the Bay waters. However, dissolved copper concentrations did not measurably change either during the bloom or its subsequent decay. This is notable because copper was once considered to be at toxic levels in Bay waters. Recent studies, however, have determined that most of that "dissolved" copper is strongly complexed with organic ligands and, therefore, not readily available to the plankton – either as a nutrient or as a toxicant. Our results corroborate that determination.

The second study showed that while total mercury concentrations in Bay waters are not measurably affected by algal blooms, concentrations of methylmercury are. This is notable because methylmercury is the form of mercury that is bioaccumulated to toxic levels in aquatic food chains. Consequently, algal blooms appear to increase the cycling of the toxic form of mercury in the Bay.

The third study showed that phytoplankton species changed during blooms. These changes may be partially due to changes in concentrations of some of the dissolved metals during that period. Conversely, changes in phytoplankton species during the blooms may account for some of the changes in dissolved metal concentrations during that period.

In summary, phytoplankton blooms have been shown to directly influence the concentrations of several metals in the Bay, but not copper – which was once thought to be limiting primary productivity in the Bay. The blooms also accelerate the cycling of methylmercury, which is magnified in fish to toxic levels in the Bay. Finally, metals may influence plankton species during a bloom.

Publications

Luengen, Allison, P. Raimondi, and R. Flegal. Contrasting biogeochemistry of six trace metals during the rise and decay of a spring phytoplankton bloom in San Francisco Bay, *Limnology and Oceanography*, 2007, 52(3): 1112-1130.

Professional Presentations

Flegal, Arthur R. Metals in San Francisco Bay. State of the Estuary, Berkeley, CA, October 2007.

Luengen, Allison, C. Conaway, and R. Flegal. Linking abiotic and biotic mercury reservoirs: Temporal trends and bloom dilution (invited presentation). San Francisco Estuary Institute Fourth Annual San Francisco Bay Mercury Coordination Meeting, Oakland, CA, February 22, 2007.

Luengen, Allison, N. Bloom, and R. Flegal. Mercury cycling during a spring phytoplankton bloom in San Francisco Bay (poster). Eighth International Conference on Mercury as a Global Pollutant. Madison, WI, August 2006.

Luengen, Allison and R. Flegal. Depletion of methyl mercury during a spring phytoplankton bloom in South San Francisco Bay. Northern California Chapter of the Society of Toxicology Spring Meeting, Half-Moon Bay, CA, April 2006.

Luengen, Allison and R. Flegal Interaction between nutrients, phytoplankton blooms, and mercury concentrations in San Francisco Bay. American Society of Limnology and Oceanography Ocean Sciences Meeting. Honolulu, HI, February 2006.

Collaborative Efforts

The research was conducted in collaboration with Dr. Jim Cloern and his colleagues with the United States Geological Survey (USGS). The samples were collected on a USGS research vessel during Cloern's cruises in the Bay, and USGS staff provided ancillary data (e.g., nutrient concentrations) and made the phytoplankton species counts utilized in the research.

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