King County Marine Phytoplankton and Nutrient Monitoring

by Gabriela Hannach and Kimberle Stark

Why are phytoplankton and nutrients important?

Phytoplankton are microscopic plant-like organisms that contain chlorophyll, which is necessary for photosynthesis. They live in the upper layers of oceans, lakes and rivers. An estimated 4,000 species exist worldwide, exhibiting a great variety of size, shape, and pigmentation. Phytoplankton produce a quarter of the world's oxygen and are also a key element in the carbon cycle - their utilization of carbon dioxide is critical in the control of climate change.

Phytoplankton require sunlight and nutrients for growth and are a critical part of the Puget Sound ecosystem as they form the bottom of the food chain. Frequent or persistent phytoplankton "blooms" (a significant increase in organism abundance), however, can be an indicator of eutrophication, which is a process caused by an over-abundance of nutrients - most often nitrogen compounds from manmade sources - that can lead to oxygen depletion when the cells decay and can, in extreme cases, result in dead zones that cannot support aquatic life.

What is King County doing?

The King County Environmental Laboratory and the Marine and Sediment Assessment Group have been collecting and analyzing phytoplankton samples from three central Puget Sound locations since 2008: Point Jefferson, East Passage, and Quartermaster Harbor (see **Map 3**). The phytoplankton sampling component is part of a larger marine monitoring program managed by the Marine and Sediment Assessment Group.

At present, sampling is performed twice a month during the March-through-October phytoplankton bloom season. Nutrients are analyzed concurrent with the phytoplankton samples to provide information on the nutrient chemistry of the water, which is directly relevant to phytoplankton species composition and abundance.

There are several reasons King County monitors phytoplankton in Puget Sound. King County's wastewater treatment plants discharge treated wastewater into the Central Puget Sound Basin. As a clean water utility, the Wastewater Treatment Division (WTD) has a history of continuous improvements to its effluent quality, and has a long history of water quality monitoring to ensure its activities work to protect public health and the environment. WTD therefore has a strong interest in factors that affect water quality, such as nutrients and phytoplankton levels.

***Map 3.** Three Central Puget Sound sampling locations.*

Main objectives of the phytoplankton monitoring program are to:

- assess relative abundance and community composition of the major phytoplankton taxonomic groups at three locations;
- identify dominant phytoplankton species;
- document timing of seasonal shifts in major taxonomic groups; and
- detect long-term changes in taxonomic composition.

Moreover, climate change and population growth are generally recognized as significant stress factors for the health of Puget Sound. Obtaining long-term information on phytoplankton species composition is essential to properly evaluate Puget Sound's ecosystem response and resilience to environmental change.

Given the concerns about water quality and climate, the phytoplankton monitoring program seeks to address relevant questions about the health of the ecosystem and efforts to manage it, such as "Are environmental or anthropogenic changes having an adverse effect on phytoplankton populations, and consequently impacting the Puget Sound food web?"

This monitoring is particularly important because relatively little is known about the overall structure of the Puget Sound phytoplankton community, particularly the annual variability and how variations in nutrient availability affect phytoplankton populations. Most phytoplankton analysis conducted in Puget Sound focuses on those species that cause harmful algal blooms (for example, phytoplankton species that produce toxins) because of their potential impact on recreational and commercial shellfish harvests.

In addition to our ongoing program, we have requested funding to measure phytoplankton abundance more precisely, or quantitatively, in the 2013 sampling season. Having more precise abundance data will be helpful for determining the magnitude of phytoplankton blooms when they occur, such as the recent *Noctiluca scintillans* bloom that was observed Puget Sound-wide, as well as the relationship of these levels and nutrients.

There is an online image library of Puget Sound marine phytoplankton. We hope that this will be a useful resource for researchers and managers in the Puget Sound area as they seek to understand the health of the marine ecosystem. The image library will be available at: http://green.kingcounty.gov/marine/Photos.aspx.

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If you would like additional information on King County's marine phytoplankton program, please contact: Gabriela Hannach (Gabriela.Hannach@kingcounty.gov), or Kimberle Stark (Kimberle.Stark@kingcounty.gov). For the full report go to: http://green.kingcounty.gov/marine/Reports.aspx

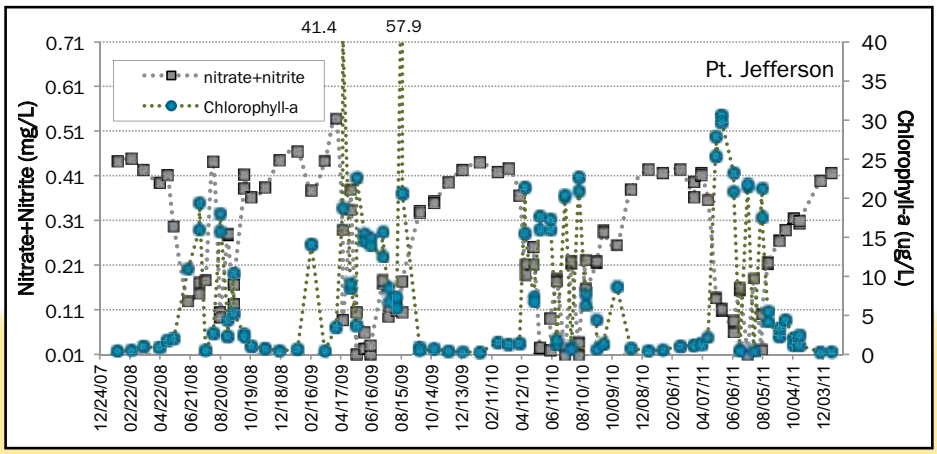

Figure 3. This figure shows the relationship between nitrate+nitrite and chlorophyll-a for monthly surface water samples collected between 2007 and 2011 at Point Jefferson. As phytoplankton abundance increases (indicated by chlorophyll-a levels) nitrate goes down because of uptake and conversely, when phytoplankton abundance is low, nitrate levels are higher.

Findings and Discoveries

To date, a few interesting patterns have emerged:

- A seasonal relationship exists between phytoplankton abundance and nutrient levels, nitrate +nitrite and silica in particular. As phytoplankton abundance increases in the spring and summer, nutrient levels decrease (see **Figure 3**);
- The cold, wet spring in 2011 caused the spring phytoplankton bloom to be delayed until May at the two open water sites. Overall, blooms in 2011 did not follow the typical pattern seen in previous years;
- The delayed 2011 spring phytoplankton bloom affected nutrient levels which resulted in higher than normal nutrients in April due to a lack of uptake by the phytoplankton;
- The bloom season in Quartermaster Harbor starts earlier (February) and lasts longer (through October) than in the main part of the central Puget Sound basin;
- Diatoms (a broad class of phytoplankton that have a rigid silica shell) have dominated throughout much of the sampling season, particularly during the spring bloom (April-June);
- Species composition differs between the northern (Point Jefferson) and the southern (East Passage) sampling sites;
- *Alexandrium catenella*, the species responsible for causing paralytic shellfish poisoning , was the dominant organism in the fall of 2008 in Quartermaster Harbor. However, to date there have been no shellfish closures in Quartermaster Harbor because of the toxin levels produced by this organism; and
- *Akashiwo sanguinea*, the species responsible for thousands of seabird deaths off the Washington coast in 2009, was generally present from late August to early October (except in 2011) but was found earlier in the year and at higher abundances in 2009.

PHYTOPLANKTON PHOTOS

Chain forming diatoms, especially in the genus Chaetoceros (A-D), typically dominate the spring bloom in Puget Sound. Other common chain-forming genera are Thalassiosira (E).


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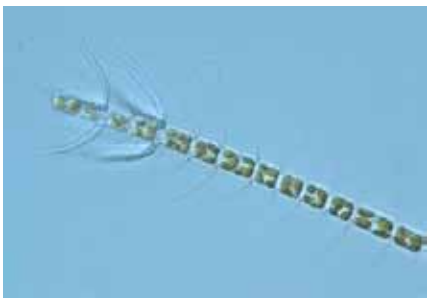
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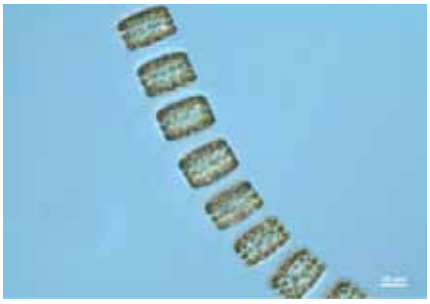
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