National Estuarine Research Reserve System

Estuary Data Mystery

Title: Can scientists predict patterns in phytoplankton abundance?

Reserve, State: South Slough Research Reserve, Oregon

SWMP Stations: Water Quality (WQ) Charleston Bridge

Parameters: Chlorophyll a, water depth

Start and End Dates: January 22 to 24, 2009, June 2002 to December 2019

Data: Available and easy to graph at *nerrsdata.org*

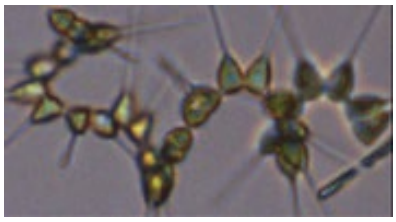


Figure 1: Image of microscopic phytoplankton

Background Information: Estuaries like South Slough are teeming with microscopic plants called phytoplankton (figure 1) that drift around in the water. Phytoplankton are an essential source of food in coastal food webs, so it is useful to understand how abundant they are. Scientists can monitor approximately how abundant phytoplankton are by measuring chlorophyll a, a pigment made by organisms that photosynthesize. At the South Slough Reserve, scientists use instruments called sondes to measure chlorophyll, water depth, temperature, pH, turbidity, dissolved oxygen, and salinity to learn about the water conditions in the estuary. The abundance of phytoplankton, and therefore the amount of chlorophyll a, in the estuary can vary widely over the course of a day, week, or year.

Investigate This: How do chlorophyll a levels change over time? Review the water depth and chlorophyll a concentration at the Charleston Bridge sonde, located close to the mouth of the estuary, for January 22-24, 2009, and July 22-24, 2009. What patterns do you notice? Compare the graph for January (figure 2) with the one for July (figure 3). Notice that the scale of the y-axis is different for the two plots.

Figure 2: January 22-24, 2009 (blue line is chlorophyll a concentration; green is water depth – shows high and low tide)

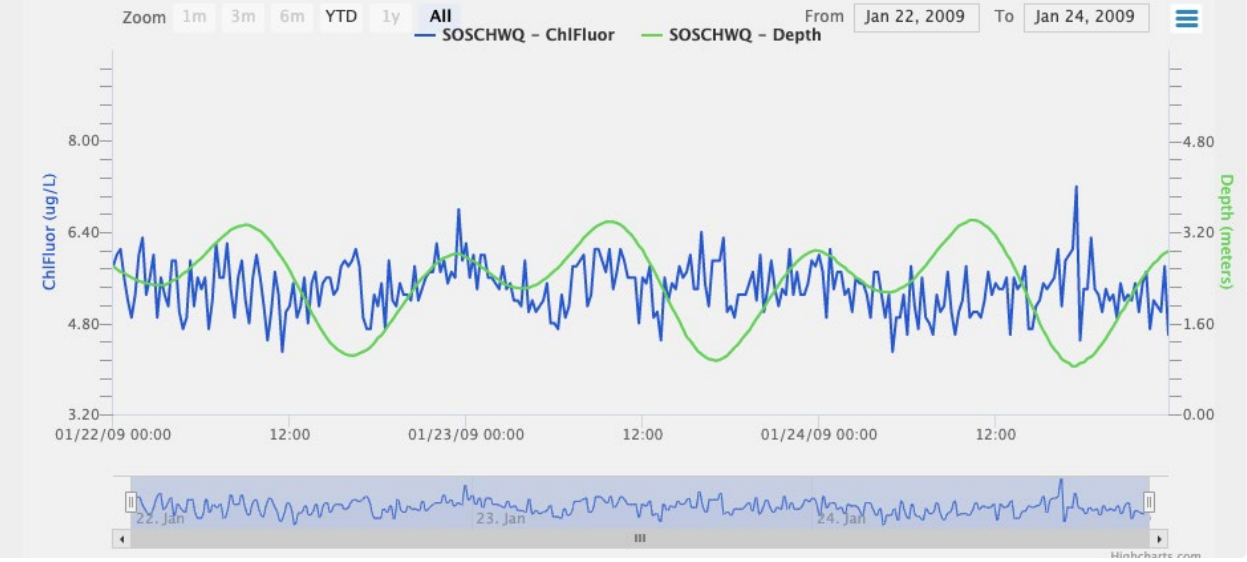
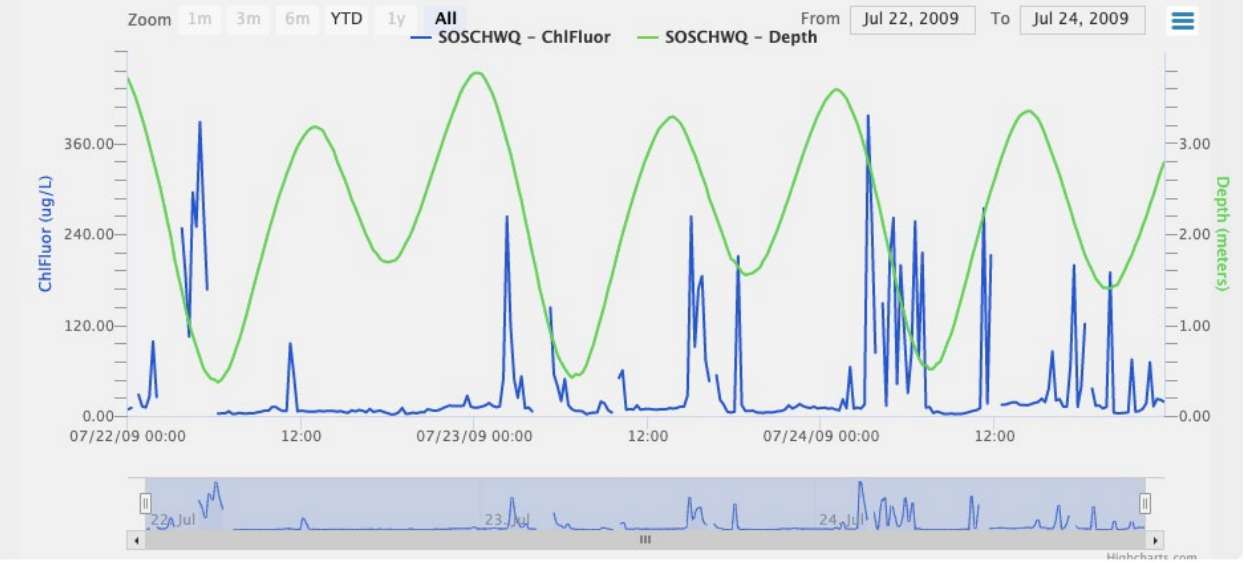


Figure 3: July 22-24, 2009 (blue line is chlorophyll a concentration; green is water depth – shows high and low tide)

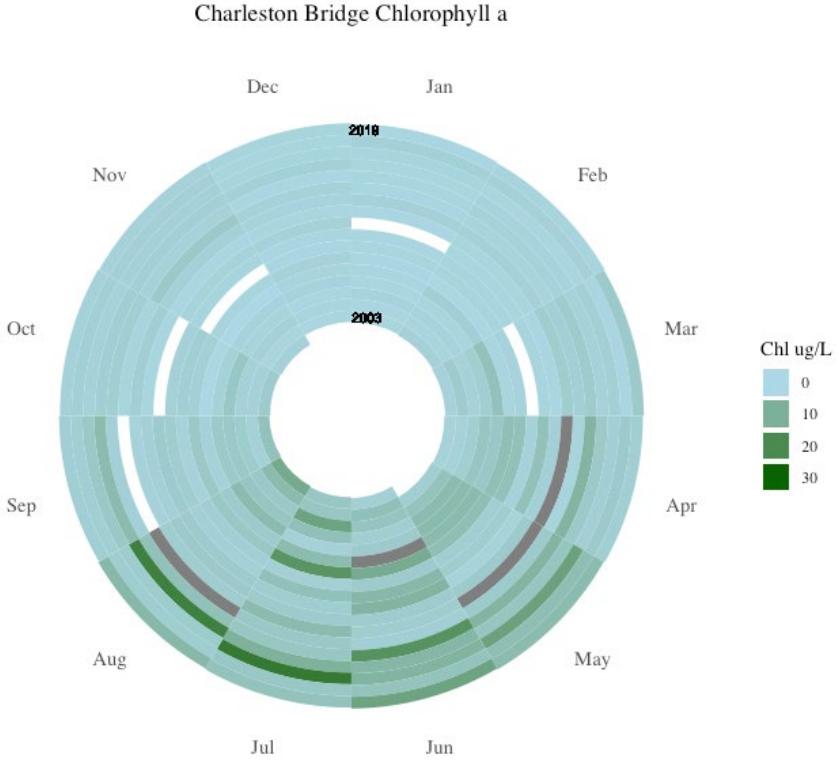


Explanation: Chlorophyll a generally reaches much higher concentrations and is more variable in the summer than in the winter. Especially in the summer, chlorophyll levels can change significantly with the tides. Phytoplankton can be swept from the ocean into the estuary with high tides, causing chlorophyll measurements at the Charleston Bridge station to spike. In the winter, there are usually fewer phytoplankton living in the ocean, so the tides don't have much influence on chlorophyll a measurements in the estuary.

Just by looking at a few days in the winter and summer, it's difficult to draw a confident conclusion about how chlorophyll changes throughout the seasons. It provides a good example, but we need more data to be more confident in our conclusion.

The figure below is a heatmap showing average monthly chlorophyll concentration (micrograms per liter, or μg/L) from June 2002 (center of the donut) to December 2019 (outermost ring), with each progressive year further from the center of the plot. Darker green blocks indicate higher chlorophyll a measurements, and light blue blocks show low chlorophyll a. The white spaces represent measurements that were excluded due to error, and gray spaces represent missing data. Looking at a larger data set this way can help us see seasonal patterns by comparing chlorophyll over the years.

Figure 4: Heat map of monthly average chlorophyll a at Charleston Bridge Station, June 2002 to December 2



What seasonal patterns do you observe in chlorophyll a? Does this make you more confident in the conclusion drawn in the first part of the exercise? Why do you think phytoplankton growth (and therefore chlorophyll a) change seasonally? Think about what you know about what increases growth in other photosynthetic organisms.

Explanation: A number of factors influence phytoplankton growth and movement, including

- Seasonal differences in amount and intensity of light;
- Upwelling* in spring and summer on the West Coast supplies more nutrients to "fertilize" phytoplankton;
  (*Upwelling = currents carry nutrient-rich water from the ocean's depths to coastal waters)
- Temperature – some phytoplankton grow more at higher temperatures; and
- Storms and mixing in fall and winter disrupt phytoplankton growing in surface waters.