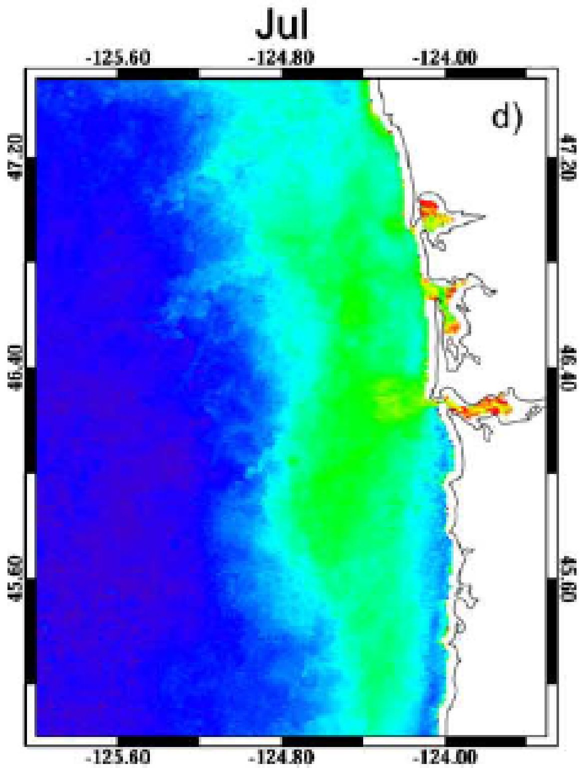
Columbia River Plume correlation with Oregon/Washington dead zones

The location of the Oregon and Washington dead zones strongly correlate with Columbia River Plum summer flow patterns.



OSU Map
From
http://images.google.com/imgres?imgurl=http://www.piscoweb.org/htmlarea-storage/images_upload/hypoxia/deadzone2_forWeb_osu.jpg&imgrefurl=http://www.piscoweb.org/research/oceanography/hypoxia&h=482&w=674&sz=104&hl=en&start=17&tbnid=d9lQlZGRizg-

Satellite-measured temporal variability of the Columbia River plume

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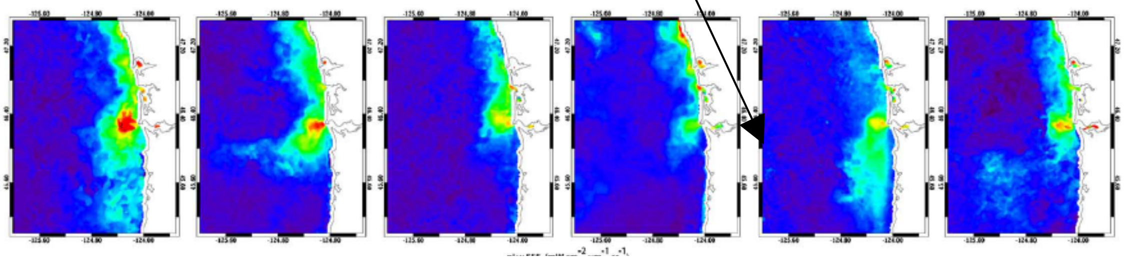
The 2002 dead zone- the most extensive to date other than in 2006 correlates with a strong southern movement of the Columbia plume in May

(1998 through 2003 satellite images of the Columbia River plume in May)

1998 1999 2000 2001 2002 2003



"In July 2002, an unprecedented low oxygen or hypoxic zone developed off the central Oregon coast. The zone was extensive in size, at least 820 km^2 and resulted in widespread die-offs of marine fish and invertebrates. Research indicates that this hypoxia can be linked to larger-scale, anomalous changes in ocean circulation over the Eastern North Pacific in 2002. (June 17,2004, Nature 429: 749-754)." PISCO at OSU http://www.piscoweb.org/files/PISCO-hypoxia-fact-sheet-2004.pdf

"Oxygen-poor water first appeared in 2002 along Oregon's coast, killing crabs and fish by the thousands (see PISCO Coastal Connections, **Volume 2).** A change in ocean circulation apparently was the primary trigger, but scientists were not sure if it was a fluke or a long-term trend." http://www.piscoweb.org/files/PISCO-CC5-hypoxia-2004.pdf

Columbia Plume can constitute a significant % of Oregon coastal waters

"With light west winds or northwest winds, the plume moves southward, and gradually mixes with the Oregon coast shelf waters. Coupled with high flow (June '99; Figure 1), this results in salinities offshore of Newport on the order of 28-30, and 60-80 percent of the study region's surface waters are plume water (based on 31 salinity cutoff)." http://www.ldeo.columbia.edu/~orton/plume_variability.html

"During periods with low riverflow (Sept '99, Sept '00, May '01; Figure 4), the plume generally covers very little of the study area (<15%), and Newport salinities are 32-33.

http://www.ldeo.columbia.edu/~orton/plume_variability.html

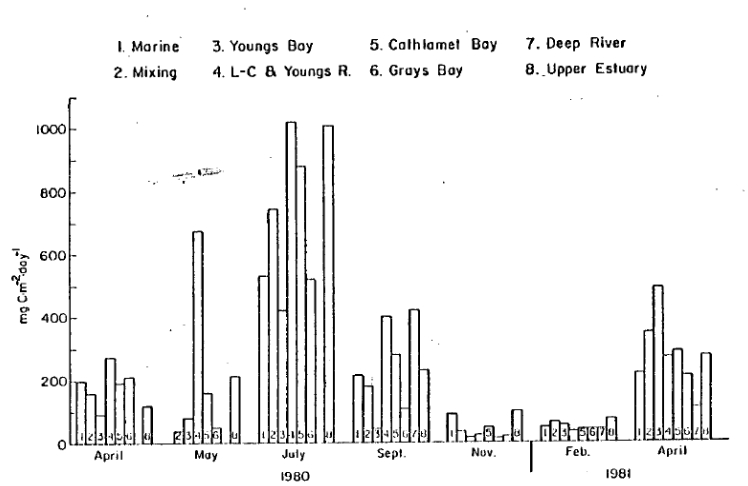
It has already been documented that the Columbia river can provide nutrients at levels that affect primary production when there is a weak or no coastal upwelling

" In May/June 2005, local upwelling was suppressed in the Pacific Northwest and nitrate was near zero to depths of 50 m across the shelf. In this situation, nitrate was being supplied directly by the river itself, a result of unusual rainfall patterns that changed the dominant river supply basin and hence the macronutrient load of river water emerging from the estuary. Chlorophyll was high only in plume-influenced water. Thus river supply of macronutrients provided the mechanism that sustained local phytoplankton growth in a period of weak or no coastal upwelling.” Complexity of a Large Freshwater Plume* Hickey, B M (bhickey@u.washington.edu) , School of Oceanography, Box 355351 University of Washington, Seattle, WA 98125-5351 United States

Nutrient levels and Primary Production in the Columbia Estuary

“This estuary (the Columbia River)apparently acts as a sink for phytoplankton biomass derived from the coastal ocean in winter and spring, but acts as a source to the ocean during the summer due to in situ growth in the estuary (Malone et al. 1980).” Water Column Primary Production in the Columbia River Estuary, Lawrence F. Small and Bruce E. Frey College of Oceanography Oregon State University Corvallis, Oregon 97331
(February 1984) at P 97

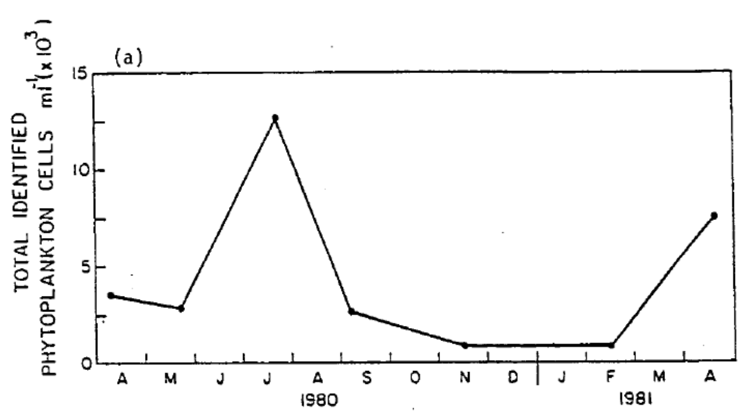
Primary production in the Columbia River Estuary peaks in July correlating with the occurrence of the dead zone.



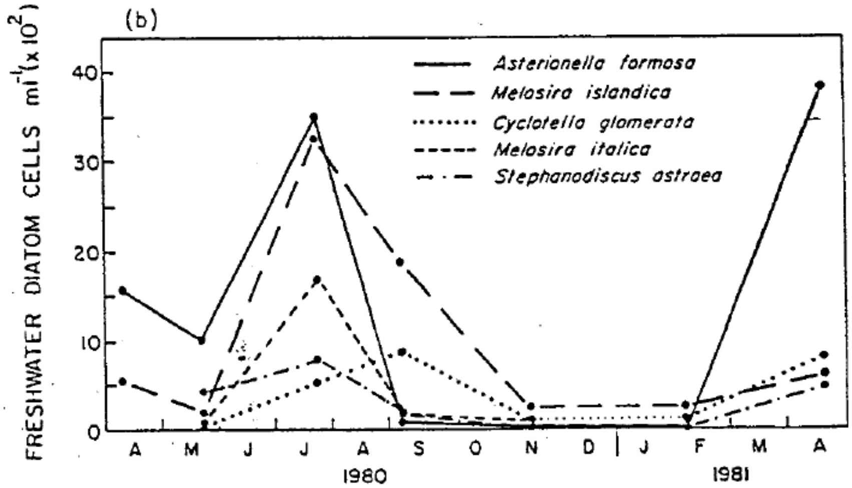
The most abundant diatoms are species associated with eutrophic waters associated suggesting high nutrient levels in the Columbia

“The most abundant freshwater diatoms during this study were Asterionella formosa, Melosira islandica, M. italica, Fragilaria crotonensis, Cylotella glomerata, and Stephanodiscus astraea. All these species are common in eutrophic lakes (Hutchinson 1967) and in other major rivers; e.g., the Mississippi River (Baker and Baker 1979) and the St. Lawrence River (Cardinal and Therriault 1976).” Water Column Primary Production in the Columbia River Estuary, Lawrence F. Small and Bruce E. Frey College of Oceanography Oregon State University Corvallis, Oregon 97331 (February 1984” at p 63

The peak of phytoplankton production in the Estuary occurs during July, the same point when dead zones have been identified off the Oregon coast. That dead zones have abated in September similarly correlates with a decrease in primary production in the Estuary

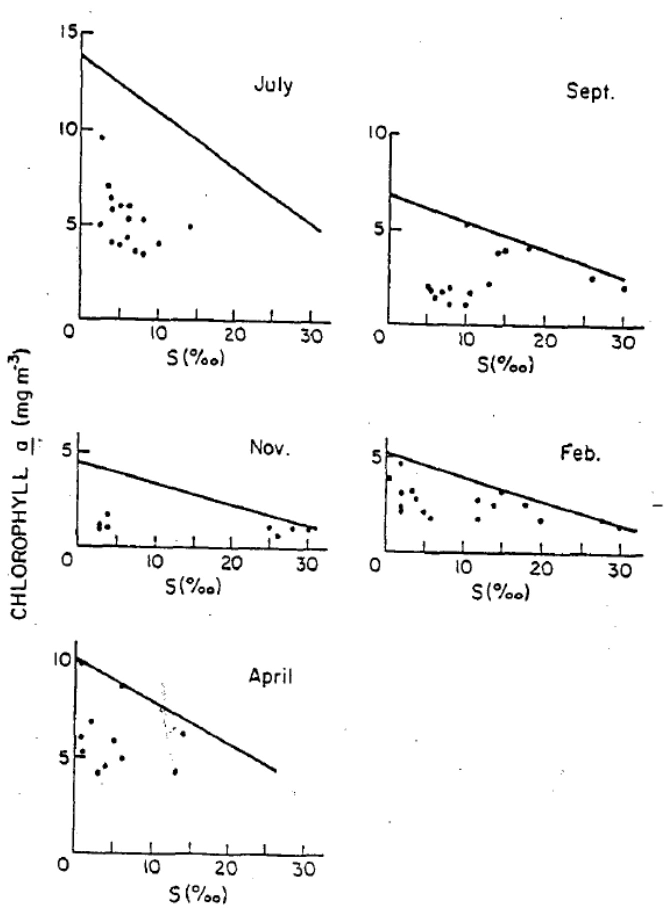


(Graph from Water Column Prim. Production Study at p)
The two most abundant diatoms are



Euphotic associated species (Asterionella formosa, Melosira islandica) are the most abundant in the Esutary and also reach peak concentrations in July.

The Water Column Primary Production in the Columbia River found that chlorophyll a levels decreased significantly as the river left the Estuary and entered saline waters. The report hypothesized that higher salinity levels were killing freshwater phytoplankton. The report also found that the highest chlorophyll a levels were in July and decreased most sharply as they reached more saline waters. This raises the question of the role that decaying phytoplankton could have in offshore eutrophic conditions. Graph below charts decrease in chlorophyll levels by month.



Why are phytoplankton levels high in the Columbia in addition to nutrients?

The reason that the Columbia River supports a relatively high phytoplankton biomass remains unclear. There is indirect evidence that the series of dams along the upper Columbia River and its tributaries may be responsible for much of the high phytoplankton biomass observed in the river. Impoundment of water behind dams changes riverine conditions to lake-like conditions, which enhances phytoplankton development (Talling and Rzoska 1967; Taylor 1971; Greene et al. 1975; Baker and Baker 1981). The main effect of impoundment is to greatly retard water flow. This in turn greatly increases residence times of water in the river, thus allowing more time for in situ growth. Also, water may stratify behind dams, allowing cells to remain in the euphotic zone. Phytoplankton blooms in reservoirs behind dams may become the source for enhanced primary biomass levels in the estuaries downstream. Our remote-sensing study indicated a significant chlorophyll a change occurring consistently within each reservoir (Bristow et al. in prep.) Col. R Water Column Study p 108.