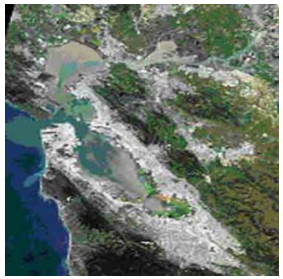
San Francisco Bay — Long-term, integrated, and multi-organizational studies conducted over 40 years in San Francisco Bay—known for the longest sustained program of research and observation in a U.S. coastal ecosystem—help resource managers and resource protection agencies understand the response of the Bay's aquatic community to the combined effects of climate variability, urbanization, changes in the hydrologic system, and the introduction of nutrients, organic contaminants, and trace elements. (http://sfbay.wr.usgs.gov/access/wqdata/index.html)

NATIONAL WATER QUALITY MONITORING COUNCIL
Working Together for Clean Water

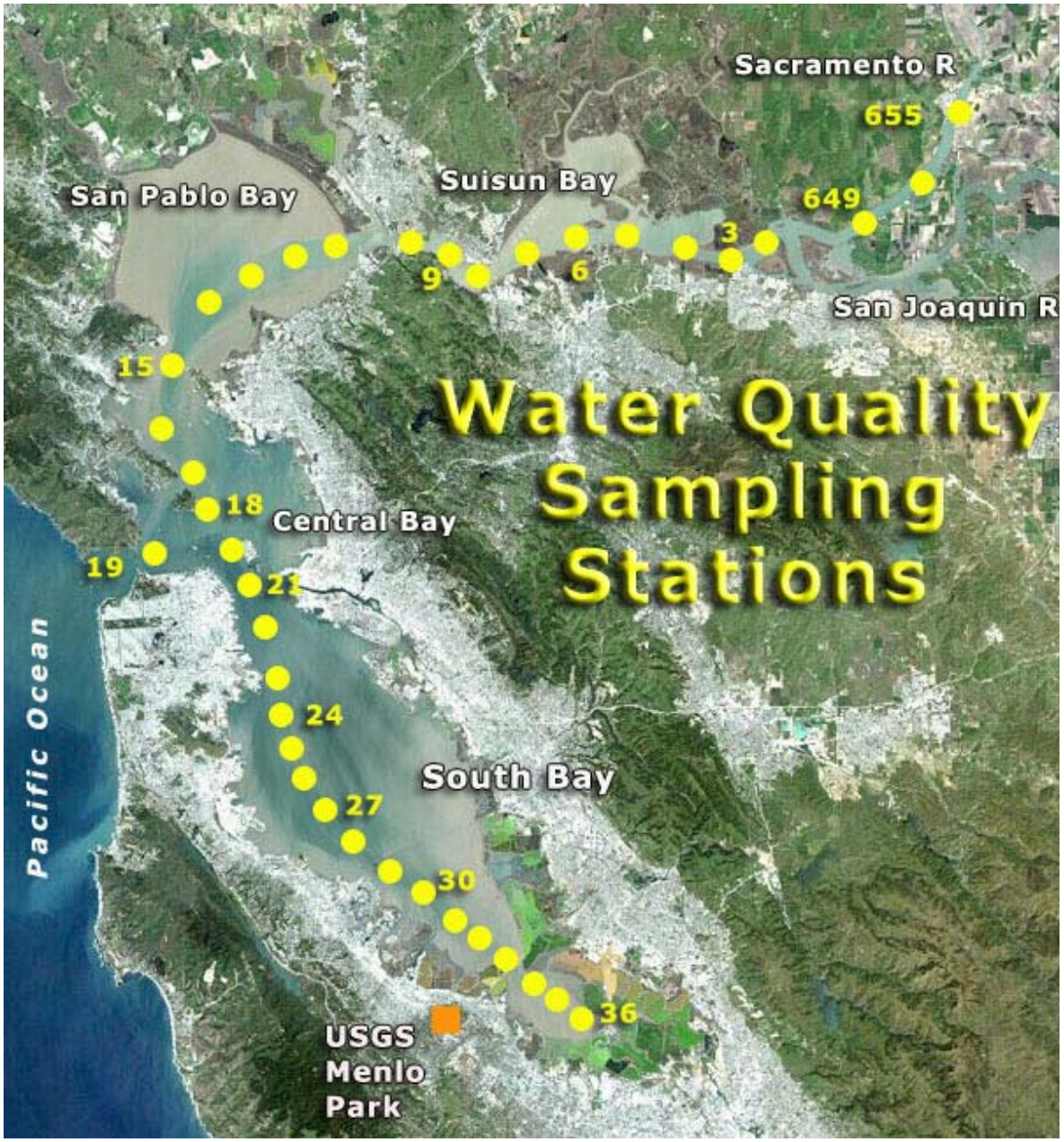


San Francisco Bay – *A demonstration area for the National Water Quality Monitoring Network for U.S. Coastal Waters and their Tributary Rivers (the "Network")*

Network monies to the San Francisco Bay project support:

- Real-time monitoring for suspended sediment and quantification of suspended-sediment flux into the Bay;
- Nutrient monitoring at selected sites, which helps to continue more than 40 years of tracking nutrient loadings to the Bay; and,
- Monitoring and assessment of the composition of the phytoplankton community (including the presence and threat of harmful algal bloom species).
- Data management and a public, web accessible database containing more than 40 years of water-quality data.
- Development of statistical tools and guides to analyze time series of water quality, extract trends and significance levels, and assess seasonal and long-term patterns of variability, which will be useful to other water-quality monitoring programs across the Nation.

Hydrologists collecting long-term data for nutrients, dissolved oxygen, chlorophyll a and other constituents in San Francisco Bay from the Polaris (right).


Sacramento R
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Water Quality
Sampling
Stations
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Central Bay
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Pacific Ocean
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South Bay
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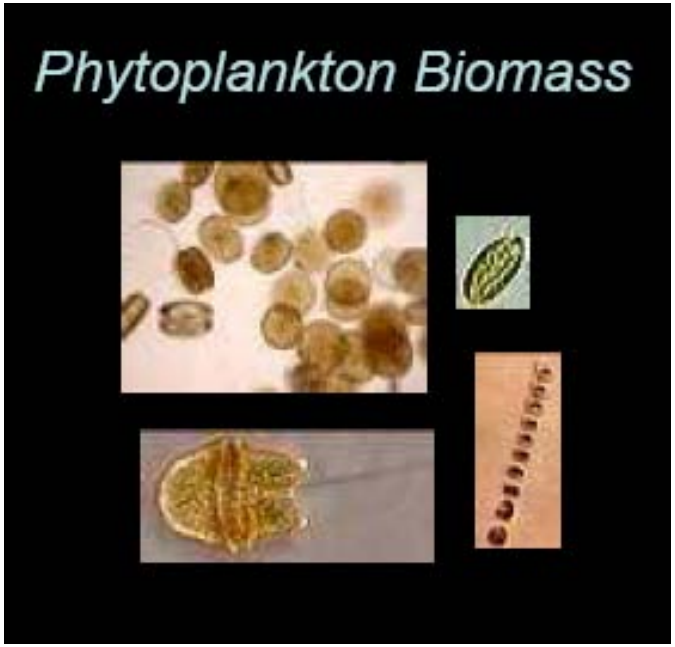
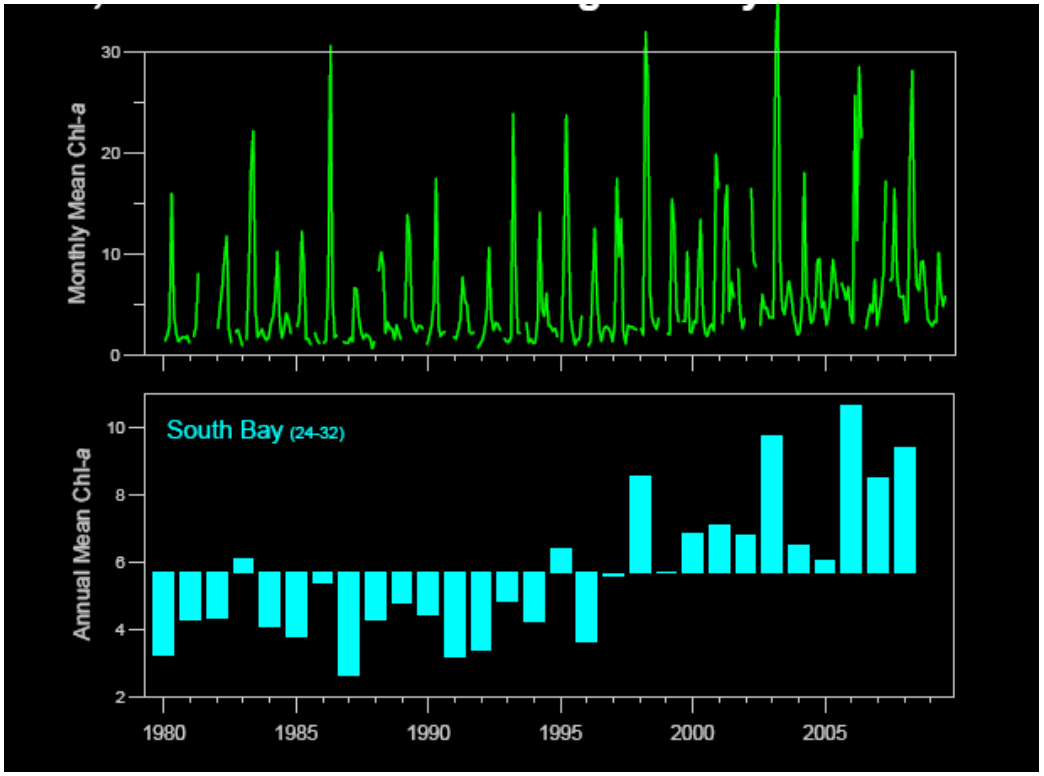
USGS
Menlo
Park

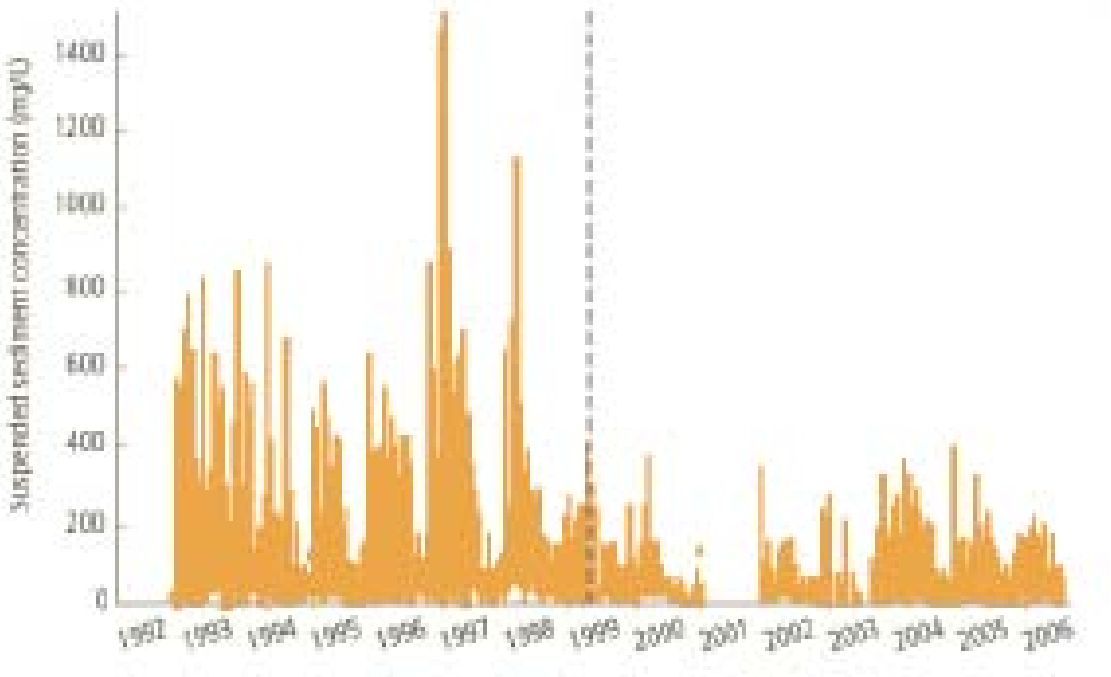
Issue: San Francisco Bay has historically been resilient to degradation from nutrient enrichment and not known for hypoxia or harmful algal blooms as known to occur in other areas, such as Chesapeake Bay. This is despite the fact that both large estuaries have elevated nutrient enrichment. One manifestation of resilience in San Francisco Bay has been relatively low concentrations of chlorophyll *a* (an indicator of phytoplankton biomass).

However, chlorophyll *a* (phytoplankton abundance) has been increasing since 1999.

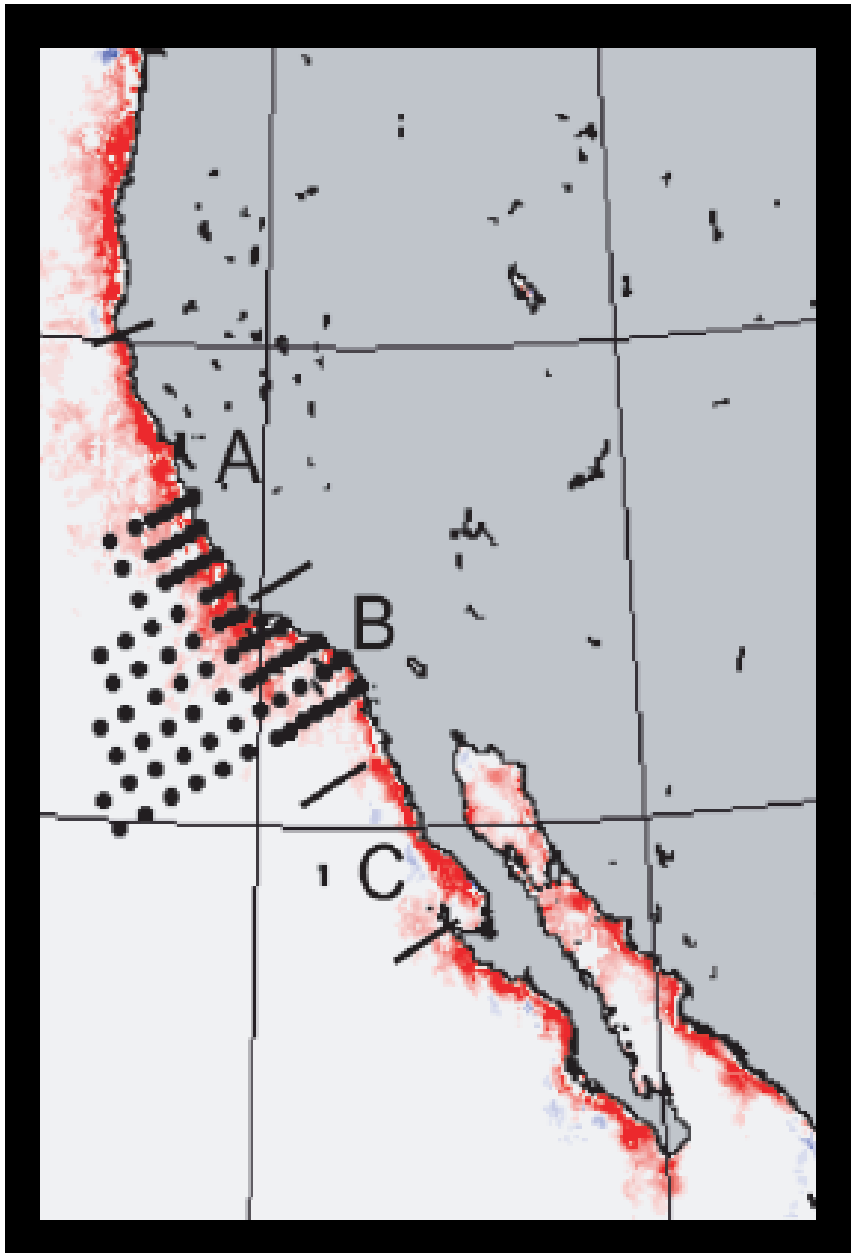




Integrated assessment findings: Three major reasons can help to explain increases in chlorophyll *a* over the last 10 years. First, water clarity is increasing because turbidity is decreasing, which allows phytoplankton growth rates to increase. Turbidity is decreasing in part because of human activities related to damming and flood control, which reduces sediment supply, as well as continued depletion of an erodible pool of sediment with origins dating back to the Gold Rush.

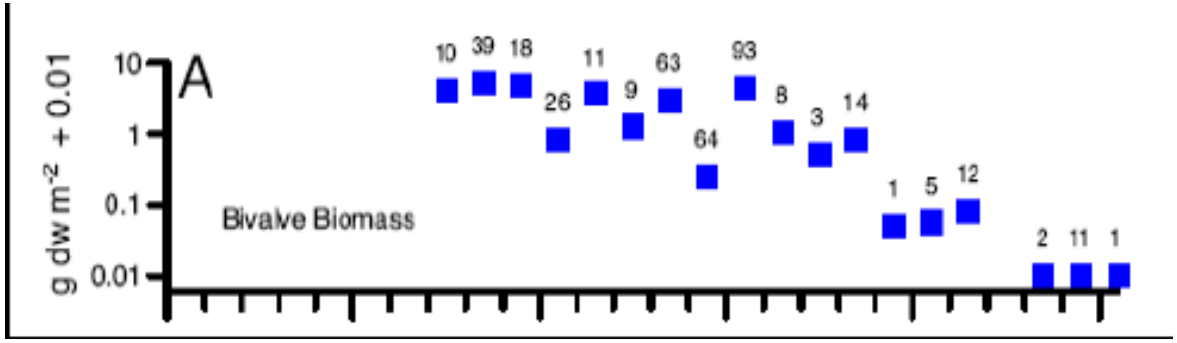


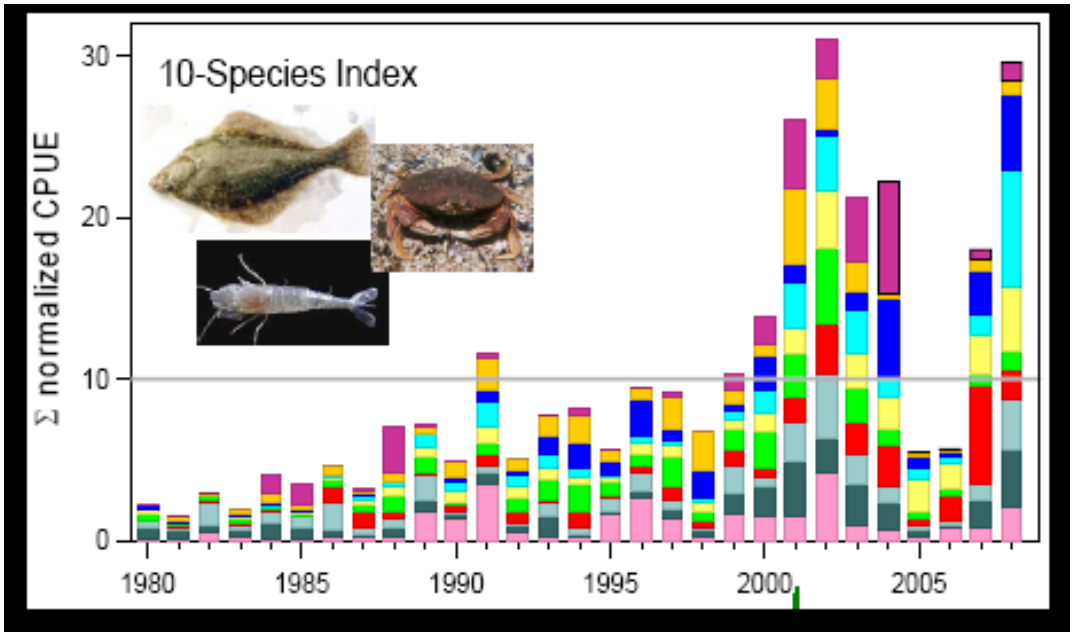
A decrease in suspended sediment since 1999 is evident in the time series of suspended sediment data from a station in Point San Pablo. Most measured sites by USGS show similar decreases. Decreasing turbidity is allowing phytoplankton growth rates to increase in the San Francisco Bay.



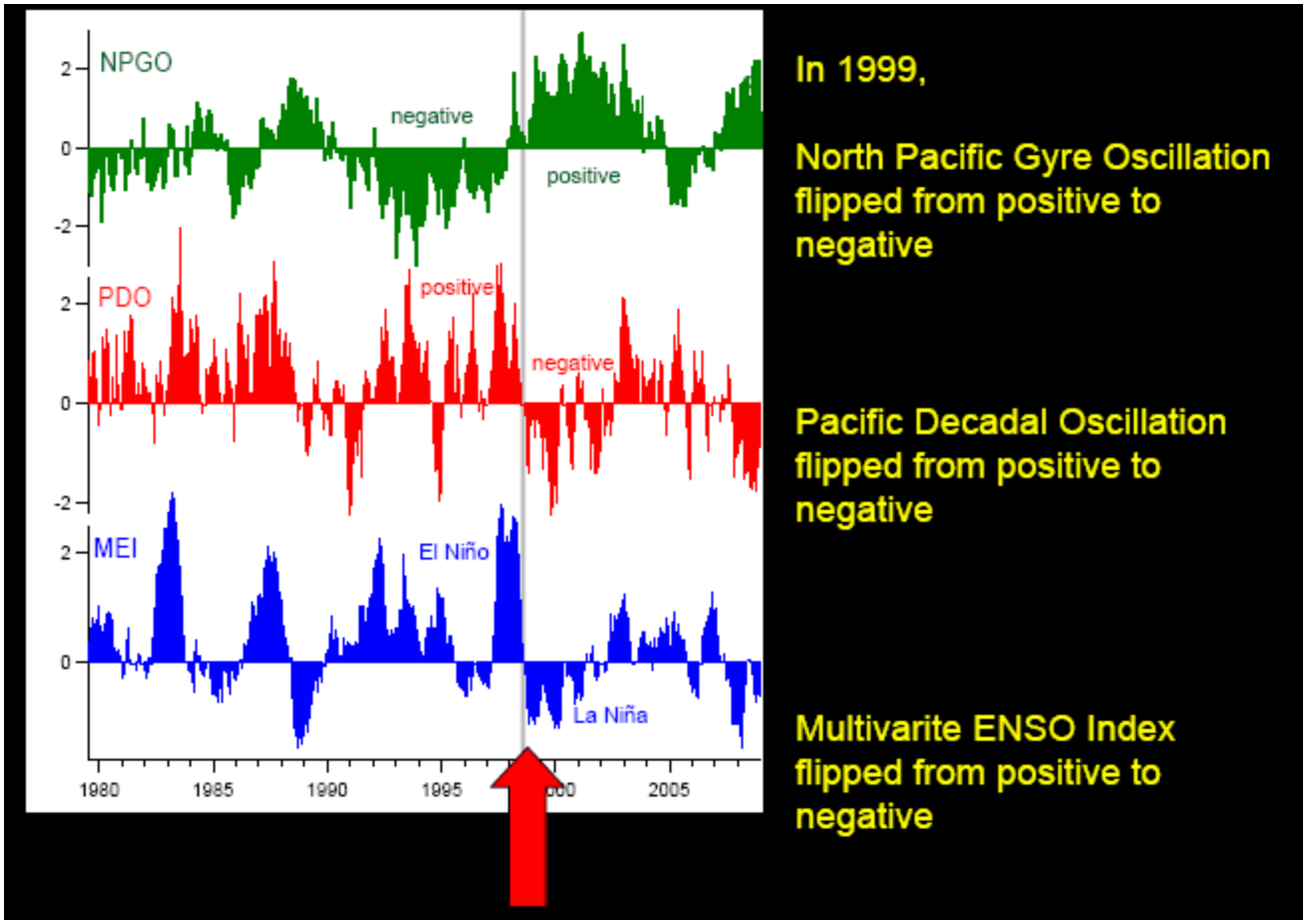
Integrated assessment findings:

The second of three major reasons that help to explain increases in chlorophyll *a* over the last 10 years is that chlorophyll *a* is increasing in the Pacific Ocean, so that the ocean is now a major source of photoplankton biomass to San Francisco Bay.





Integrated assessment findings: The third reason that helps to explain increases in chlorophyll *a* over the last 10 years is that clams (a major consumer of phytoplankton) have decreased (top graph) because of exceptionally large increases in clam predators since 1999, including the English sole, Dungeness Crab, and Bay Shrimp (bottom graph).



Large physical and biological shifts occurred in San Francisco Bay after a dramatic shift in the climatic system in 1999, including a Pacific Decadal Oscillation that flipped from positive to negative. These natural climatic oscillations, along with human activities (such as related to damming) are leading to degradation of biological communities and water quality.

Lessons learned from the integrated assessments in San Francisco Bay:

- Biological communities and water quality are influenced by both human activities (i.e. damming rivers that reduce sediment supply and turbidity) and natural climate oscillations (such as the Pacific Decadal Oscillation).

- Estuaries are influenced by their connectivity to the oceans (not just watersheds and terrestrial connections).

- Twenty to thirty year climate cycles have big impacts on estuaries, oceans, and coastal ecosystems.

Future actions:

The increase in water clarity in San Francisco Bay is likely to persist, leading to continued phytoplankton abundance and degradation due to nutrient enrichment.

Management of nutrients and development of nutrient criteria are now critical in a Bay that historically was resilient.

Continued monitoring of nutrients and sediment is needed to track water quality and sediment movement in this dynamically changing ecosystem and to help forecast future impacts of global warming on climate shifts, water quality, and biological impacts in the coastal zone.

Major partners: San Francisco Estuary Institute; Regional Monitoring Program for Water Quality in the San Francisco Estuary; Sun Microsystems; California Coastal Conservancy; South Bay Salt Pond Restoration Project; California Department of Fish and Game; California Coastal Conservancy; University of Washington; Georgia Tech; Pt. Reyes Bird Observatory; University of California campuses at Santa Barbara, Santa Cruz, Davis and Berkeley; National Science Foundation National Center for Ecological Analysis and Synthesis; U.S. Fish and Wildlife Service; U.S. Geological Survey; NOAA; Bureau of Reclamation

Web access:

http://sfbay.wr.usgs.gov/access/wqdata/index.html

http://sfbay.wr.usgs.gov/sediment/cont_monitoring/

Contacts:

Jim Cloern, jecloern@usgs.gov, (650) 329-4594

David Schoellhamer, dschoell@usgs.gov, (916) 278-3126