

## Lead Scientist's Report

---

**Summary:** This report discusses three climate indices that have been in the news of late. The indices are the El Niño (La Niña) Southern Oscillation (ENSO), the Pacific Decadal Oscillation (PDO), and the North Pacific Gyre Oscillation (NPGO). These climate indices provide some useful insights into precipitation patterns in the western U.S. and the dynamics of fish populations in San Francisco Bay and the California Delta.

---

Climate indices are now used to better predict temperature, precipitation, river runoff, and biological responses at time scales of months to up to a year in advance throughout the world. Knowledge of climate indices also helps explain responses of biological communities to changing ocean conditions for those species that use both the Delta and open ocean. Climate indices can assist ecosystem and water supply planning and management by providing some foresight into conditions up to a year in the future.

### **El Niño (La Niña) Southern Oscillation (ENSO)**

ENSO has been in the news lately because of the development of a strong La Niña condition in the tropical Pacific Ocean. La Niña conditions are characterized by cooler than normal ocean waters in the eastern tropical Pacific and warmer than normal ocean waters in the western Pacific. Sea surface temperature, sea surface elevations, tropical winds, the distribution of clouds, direction and strength of ocean currents, and vertical temperature measurements are used to determine El Niño and La Niña conditions in the tropical Pacific.

Strong La Niña conditions have now established after the El Niño of last winter. While very strong El Niño events such as those in 1982-1983 and 1997-1998 produced large flows for the rivers of California, La Niña conditions are well correlated with below-normal precipitation and reduced water from snowmelt in Southern California and the southwestern U.S. The effects of a large La Niña event on precipitation and river flows in Northern California are much less predictable since it falls in the transition zone between the wetter conditions in the Pacific Northwest and the drier conditions in the southwestern U.S.

### **Pacific Decadal Oscillation (PDO)**

The PDO was derived as an index for the strength of salmon runs in Alaska and the West Coast of the continental United States. Salmon stocks in Alaska and the West Coast of the continental U.S. fluctuate inversely with the PDO. The PDO is highly correlated with sea-surface temperature in the northeastern Pacific Ocean. The PDO generally shifts phases (warm or cool) on decadal time scales.

The PDO off California is seen in changes in ocean surface water temperature in the California current. Fluctuations in the phase of the PDO have been shown to link to the long-term strength of runs of salmon on the West Coast of the U.S. including the rivers of California.

### **North Pacific Gyre Oscillation (NPGO)**

The NPGO is the least reported of these climate indices. Recently, Jim Cloern of the U.S. Geological Survey and his colleagues published a paper showing that populations of fish, crabs, and shrimp in San Francisco Bay track large-scale climate indices in the North Pacific with the NPGO being particularly effective in tracking these biological community changes.

Regional physical manifestations of changes in California coastal ocean waters oscillations from the NPGO include changes in the strength of upwelling-favorable winds, the strength of southward transport of surface ocean water, the temperature of surface waters, and the strength of the thermocline (vertical temperature profile). The NPGO is significantly correlated with previously unexplained fluctuations of salinity, nutrients and chlorophyll-a measured in the California Current. Field observations confirm a recent intensification of wind-driven upwelling and cooling of shelf waters adjacent to San Francisco Bay with a strong upwelling index from 1999-2002 and from 2006-2008. Climate forcing affects coastal oceanography that impacts many species that use the San Francisco Bay and California Delta.

### **Contact**

Dr. Cliff Dahm  
Lead Scientist

Phone: (916) 445-0463