

## Research Summary

### **Climate Change Impacts on Invertebrate Prey (mesozooplankton) for Important Higher Trophic Level Predators in the California Current**

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The California Current upwelling system off the west coast of North America is one of the most productive regions in the world's oceans. As surface water is pushed offshore by the prevailing winds, cold, nutrient-rich water from depth replaces it, creating an ideal environment for photosynthesis. Large blooms of phytoplankton are common throughout the coastal regions of the California Current and provide the base of a food web that culminates in high levels of biomass of top predators, many of which are commercially important fisheries for the state for California (Dungeness crab, salmon, Pacific hake, California halibut).

The upwelling process is dependent on the wind patterns experienced along the coast. Changes in the atmosphere due to increased levels of greenhouse gases, primarily CO<sub>2</sub>, are expected to intensify upwelling-favorable conditions, resulting in greater upwelling in coastal regions, and higher nutrient levels in surface waters. This would seem likely to increase phytoplankton productivity, thus providing greater food sources for higher levels of the food web. However, warming of surface waters promotes a more stable upper ocean and creates a greater barrier to upwelling. Increasing wind speeds also can have a negative feedback on primary productivity due to offshore transport of the production in surface waters. These factors may modulate or decrease productivity of the region in spite of the greater upwelling-favorable winds expected with climate change.

We plan to use climate models and ocean circulation models to simulate present atmospheric and coastal ocean conditions, and those conditions we can expect with twice as much CO<sub>2</sub> in the atmosphere. Linking those models to an individual-based model to simulate the abundances and life history of the krill species *Euphausia pacifica* and the copepod species *Calanus pacificus*, we can predict how climate change may impact these species. Many commercially important fishes, seabirds, and mammals feed on *E. pacifica* and *C. pacificus* and changes in their population biology are likely to have consequences for those species whose life histories have evolved to take advantage of them as food sources. A relevant and pointed example of how changes in abundance of important prey species (in this case *E. pacifica*) can impact higher trophic levels is the almost complete reproductive failure in 2005 and 2006 of the Farallon Island's population of Cassin's auklets. The reproductive failure has been attributed primarily to changing oceanographic conditions and the resulting change in *E. pacifica* abundance at a critical stage in the auklet's life history. Through modeling the future atmospheric and oceanographic conditions that we expect due to climate change, we can better predict the impact of increased CO<sub>2</sub> concentrations on important marine resources of the state of California.