# *Research Brief*

## Upwelling Links All Trophic Levels

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*What factors affect variation in upwelling?*
There are seasonal differences in upwelling. Winter upwelling and spring/summer upwelling have both been proven important when it comes to their effects on the biotic world, though winter upwelling is generally less intense than that of spring and summer. Because of this, the importance of winter upwelling is often neglected. In addition to seasonal variation, latitude also causes differences in upwelling strength. Upwelling in the California Current system is the most powerful along the central-to-northern California coast.

*What did we do?*

We examined the indirect effects of upwelling on multiple predator species in relation to seasonal changes in the Gulf of the Farallones region (from Monterey Bay to Point Arena). We developed conceptual models to demonstrate how variation in upwelling affects a variety of lower and intermediate trophic-level species which, in turn, influence the productivity of predators, including fish, seabirds, and marine mammals. In concurrence with our original hypothesis, we concluded that predator responses vary in accordance to changes in both winter and summer upwelling.

*Why is this important?*
Eastern boundary current ecosystems, such as the California Current in this study, are particularly important because they contain a huge amount of biodiversity and provide approximately 20% of the world's fisheries catch. A thorough understanding of the changing dynamics of predatory species is necessary to maintaining ecosystem sustainability while still accommodating commercial and recreational demand. This understanding can be reached through studying food availability patterns, which are directly affected by upwelling and other abiotic factors.

*Caveat*
It is challenging to directly analyze connections between upwelling and top-level species because there are intermediate trophic steps.

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Citation: Thompson, S.A., W.J. Sydeman, J.A. Santora, B.A. Black, R.M. Suryan, J. Calambokidis, W.T. Peterson, and S.J. Bograd. 2012. Linking predators to seasonality of upwelling: Using food web indicators and path analysis to infer trophic connections. Progress in Oceanography 101:106-120. doi: 10.1016/j.pocean.2012.02.001.

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