Physical Oceanography of Offshore Habitats: Scales of Variability Impacting Marine Resources

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A number of important considerations determine the role of the ocean environment in the context of pelagic MPAs:

- What are the dominant physical features and processes?
- What is the ecological importance of these features and processes?
- What are their key time and space scales?
- What are their persistence, variability, and extremes?
- Are they dynamical sources or sinks?
- Are they static (fixed) or dynamic?
- What are the links between offshore and coastal regions and features?

The west coast marine pelagic habitat, defined by the California Current System (32-48°N, coast to 200 nm offshore) is characterized by a large-scale equator-ward ocean flow, upon which is superimposed a field of strong, mesoscale (10-100 km) features. These include upwelling filaments, river plumes, eddies, and meanders at the interface between the California Current (CC) and recently upwelled water. They have strong thermal, salinity, and flow signatures. These features are generally persistent over time and fixed in space (i.e., their position and size). Their typical positions and dimensions are set by coastline morphology, with bottom bathymetry being less important in the creation and maintenance of most of these features. For example, coastal upwelling centers are associated with headlands. They are generated in response to atmospheric forcing (i.e., upwelling winds), interacting with coastal morphology and, in isolated locations, freshwater flow into the ocean. Episodic changes in forcing (e.g., relaxation of upwelling winds) occur infrequently; however, the response of ocean features to these changes is rapid. At these times, offshore features may disperse, or translate toward the coast where they interact with nearshore habitats. This may be an important mechanism for the recruitment of nearshore species, and for encounters between blue-water pelagic and nearshore species. However, these features generally return to their persistent state equally rapidly at the return of seasonal forcing conditions, making them reliable 'landmarks' for marine organisms. Dynamical ocean features can be characterized as potential biological sources (e.g. coastal upwelling centers and filaments) or sinks (e.g. upwelling fronts at the eastern edge of the CC).

Pelagic oceanic features and populations fluctuate on several time scales. The most obvious is the annual evolution of the CC's circulation and structure. Large-scale coastal upwelling begins in early spring and continues into autumn. During this upwelling season, the ocean's structure becomes more complex. This is reflected in the seasonality of primary production. In winter, near-surface waters are more isothermal and flow is pole-ward. This seasonal cycle is modulated by longer-term variability. For example, during El Niño years, the dominant source of interannual variability, upwelling may be reduced and the increasing seasonal complexity of the upwelling region retarded. These variations are also related to interannual changes in the size, distribution, health, and reproductive success of marine populations. The region is affected by planetary-scale climate change on decadal to centennial time periods as well. Because these time scales are similar to or longer than the lifespan of marine species, these climate fluctuations may have a very different effect on populations than intraseasonal to interannual variability.

Persistent environmental features and their variability are reflected in ecosystems and fisheries populations. However, the ecosystem response to these features appears to be complex. Characterizing the dominant physical oceanographic features and processes of the coastal habitats along the US west coast, and assessing their principal time and space scale of variability is the first step in developing a scientific rationale for establishing marine protected areas. Only when we can describe and understand these, can we link the region's ecosystem structure and processes to its physics, then implement scientifically based management strategies.

Pelagic Predators, Prey, and Processes:

Exploring the scientific basis for offshore marine reserves

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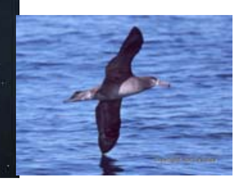

Workshop Report

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