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Looking Ahead: Harmful Algal Blooms in Southern California Waters

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4.6 Harmful Algal Blooms in Southern California Waters

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A great variety of microalgae occur commonly and constantly in the waters off the coast of California. These species range in size from cells just larger than a typical bacterium (0.001 mm) to cells or colonies that are visible to the naked eye. Microalgae are an essential component of marine environments, and constitute a large proportion of the food consumed in the food webs of coastal and open-ocean ecosystems.

While the vast majority of these species are harmless, and even beneficial as the base of marine food webs, a few are capable of producing substances that are noxious or toxic, resulting in illness and even death of marine life and occasionally humans who consume contaminated seafood. When microalgae create these conditions, we refer to them as *harmful algal blooms* (HABs). An older term often used to describe some of these phenomena is *red tide* because of the visible discoloration (usually reddish, greenish, or brownish) that sometimes, but not always, accompanies these events.

The waters off Southern California contain a number of species of algae that can cause harmful events ranging from anoxia (loss of oxygen from the water due to over-proliferation of algae and subsequent decomposition of that biomass) to the production of powerful neurotoxins that can poison thousands of marine animals (Gulland et al. 2002, Kudela et al. 2005). Human illness resulting from these events can occur through the consumption of certain seafood, particularly filter-feeding marine bivalves (clams, mussels, and other shellfish) that strain large amounts of the algal cells from the water, giving rise to such colloquial terms as *paralytic shellfish poisoning* or *amnesic shellfish poisoning*. Two algal species responsible for these latter conditions (the dinoflagellate species *Alexandrium catenatum* and several species of the diatom genus *Pseudo-nitzschia*, respectively) occur commonly in the waters off Southern California and in Santa Monica Bay, as well as other locations throughout the world (Glibert et al. 2005).

Scientific research involving HABs is currently focusing on the environmental factors that lead to outbreaks of these harmful algae and the toxins that they produce. An essential component of that research is vigilant monitoring of coastal waters for the presence of these algae and their toxins (Seubert et al. 2013). Documenting where and when harmful algal blooms arise allows correlation of these outbreaks with local water conditions, enhancing overall understanding of their causes, as well as facilitating human response to these harmful events.

Increased HAB monitoring is the goal of a group of scientists supported by the Southern California Coastal Ocean Observing System (SCCOOS) and the Central and Northern California Coastal Ocean Observing System (CenCOOS). Scientists sample at piers located throughout Central and Southern California, including a station at the Santa Monica Pier operated by the University of

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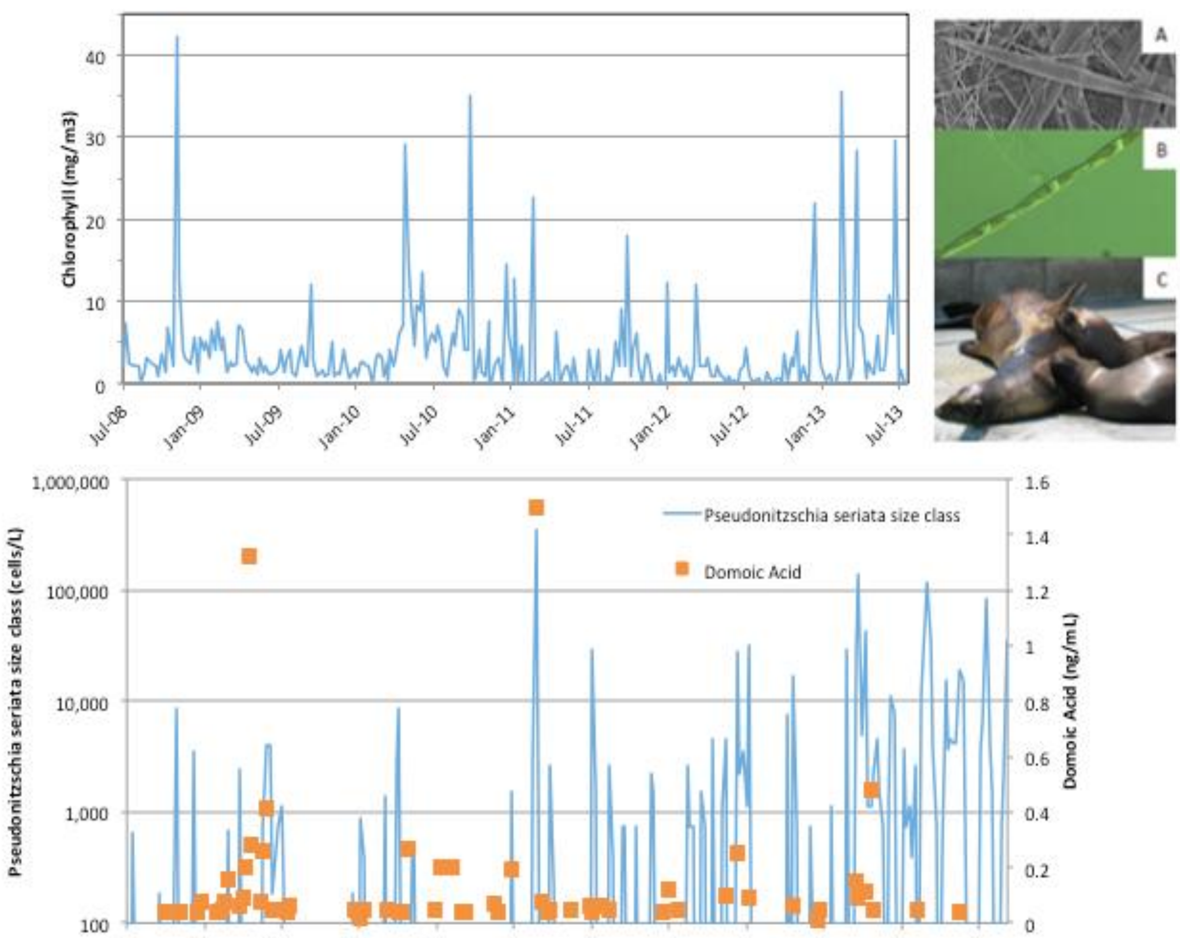
California, Los Angeles. Investigators from each group collect a standard suite of measurements weekly at each sampling location (including data on the absolute and relative abundances of harmful algal species, and nutrient and algal toxin concentrations). These simple measurements provide vital information on the presence or absence of potentially toxic algae and their toxins, and expand an ever-increasing database that is enabling an assessment of long-term changes in the occurrence of HABs in the region and their relationship to environmental conditions. Data collected weekly at each pier since mid-2008 are freely available to the public through the SCCOOS HABs website (http://www.sccoos.org/data/habs/).

Several conclusions have been drawn from the findings of this collaborative effort. Analyses of the data have identified springtime as the dominant season for the appearance of *Pseudo-nitzschia* and domoic acid, the neurotoxin it produces, in coastal waters of Southern California (Schnetzer et al. 2007, Schnetzer et al. 2013). The timing and magnitude of outbreaks of this neurotoxin in the plankton are still difficult to predict, but the trend over the last decade has been one of increasing frequency and severity in our region. Toxic blooms of these algae along the California coast have been linked to mass mortality events of marine animals in Central California since the late 1990s (Scholin et al. 2000), while blooms during 2006 and 2007 along the coast near San Pedro and Long Beach resulted in hundreds of marine mammal and bird deaths. The highest concentrations to date of toxic plankton in our region were measured during a short-lived bloom in surface waters of San Pedro Basin during the spring of 2011. Thus far, *Alexandrium catenatum*, the primary cause of paralytic shellfish poisoning in the region, has been less dominant along the coast of Southern California relative to the major environmental and human health threats it poses in the northeastern and northwestern United States. Aside from these broad generalities, the timing and magnitude of HABs in Southern California waters appears to be a consequence of a complex mixture of hydrology and local conditions rather than any single environmental factor (Figure 4.6-1). Continued study will provide greater insight into the causes, prediction, and (possibly) prevention of these unwanted events.

LOOKING AHEAD: Harmful Algal Blooms

Figure 4.6-1. Data from a weekly time series of samples collected off the Santa Monica pier beginning in 2008. The pattern of chlorophyll concentration in the plankton is shown in the top graph (a proxy for total algal biomass), while abundances of *Pseudo-nitzschia* cells of the *P. seriata* size class are shown in the bottom graph (a group of closely related species that are the most prevalent producers of domoic acid in our coastal region). Orange squares on the lower graph show the occurrence of measurable quantities of domoic acid in the plankton. Note that peaks in chlorophyll (total algal biomass) are not necessarily a good predictor of peaks in the abundances of *Pseudo-nitzschia* cells. Peaks in chlorophyll concentration appear where *Pseudo-nitzschia* cells do not, and vice-versa. Similarly, high abundances of *Pseudo-nitzschia* cells in the water are not necessarily indicative of toxin accumulation in the plankton (red dots). Only some of the peaks in the abundances of *Pseudo-nitzschia* correspond to significant occurrences of domoic acid. This reflects the fact that toxin production by the algae is not constituitive (constant and continuous), but rather is stimulated by specific environmental conditions that are only partly understood. A scanning electron micrograph (A) and photomicrograph (B) of *Pseudo-nitzschia* that caused toxic blooms on the San Pedro shelf during 2007 and 2008 are pictured. Marine mammals (C) and seabirds can suffer domoic acid poisoning by the introduction of toxic algae into their food chain. *Data Source: SCCOOS HABs website.*



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