Coastal California is typically viewed as upwelling-dominated, with strong equatorward and Ekman-dominated offshore flows, bounded to the west by the broad, meandering California Current. This implies that biological and physical processes propagate predominantly southward, that coastal run-off has negligible impacts in the near-shore oceanographic conditions and that much of biological interest is driven by seasonally intense spring upwelling. Recent observations suggest that this view is misleading, and that the occurrence of infraregular but high-impact events such as precipitation-driven coastal runoff and poleward surface flow may dominate the biological signal over large spatial and temporal scales. These events can “fertilize” the coastal ocean with anthropogenically derived nutrients, and may catalyze or exacerbate HAB conditions in the coastal ocean. With funding from the National Geographic and Atmospheric Association (NOAA), several partner institutions in the Monterey Bay, California area have established a Center for Integrated Marine Technologies (CIMT; http://cimt.ucsc.edu) with the scientific goal of describing how physical forcing (wind) eventually translates into the phenomenal biological productivity (such as whales) seen in central California, and how the presence of frequent HAB events (including both Pseudo-nitzschia and Alexandrium spp.) can occasionally result in dead whales. An overview of the CIMT program, its application to HAB monitoring, and some new emerging technologies and observations will be explored.

## HABs in Monterey Bay

Historically, central California’s spatial extentive HAB events have been dominated by the toxic dinoflagellate Pseudo-nitzschia (timeline at right). Although Monterey Bay is known as a “hot spot” for dominate red-potatoing, enhanced monitoring as part of the CIMT program has shown that multiple HAB species, as well as non-toxic red tides, are frequently present. This highlights the need for rapid, sustained monitoring of both species and toxins.

## Integrating New Technology

A primary goal of CIMT is to integrate existing and emerging technology, and apply it to coastal issues such as HABs. Here we provide three examples, starting at large spatial scales, moving to the scale of individual organisms.

### Large Scale

- **2000 - A Case Study**
  - The MBARI-sponsored MOOS Upper-Water Column Study Experiment (MUSE) provided a large-scale, multi-institute, multi-disciplinary field experiment in Monterey Bay August, 2000, facilitating during a major HAB event.
  - Although not intended to be a HAB study, the MUSE effort exemplified the power of a coordinated ocean observing network for understanding the ecophysiology of Pseudo-nitzschia, and provided a platform for evaluating several hypotheses based on a previous (1998) HAB event.

### Medium Scale

- **Nutrient-Amended Grow-Outs**
  - Chlorophyll
  - **Fu/Fm (Iron Stress)**
  - **Worsted cell nurse**

### Small Scale

- **Blanks Left**
  - During 2002/2003 Monterey Bay Bloom Experiment, the nutrient amended iron experiment was conducted following the Monterey Bay Bloom Experiment summer 2000, which showed strong enhancements of both phytoplankton biomass and chlorophyll. Nutrient amendments were conducted in iron limited reference cultures and iron amended cultures at Barley Channel, extending from Baja to Monterey, CA.

## 2000 - A Case Study

**The MUSE project involved three ships, two aircraft, two AUVs, several drones, ocean observing systems, and new technologies designed to examine a natural iron fertilization event.**

**Based on observations of possible Pseudonitzschia biomass was nitrogen (not silicon) limited. Substantial populations were associated with spatially large "thin layers."**

By creating a Center for Integrated Marine Technologies (CIMT), we are explicitly linking new technologies across disciplines of marine science to address key questions for marine resource managers - from physical forcing to fisheries and protected resources. This center provides the structure for an innovative new approach to understanding how key marine resources – fisheries, seabirds, sea turtles, and marine mammals – respond to short- and long-term changes in physical oceanographic processes such as El Niño events, decadal oscillations, and long-term climate change. Such a comprehensive, integrated, interdisciplinary approach has been identified as the best approach to an integrated ocean observing system.

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**WIND, WHALES, AND HARMFUL ALGAL BLOOMS: THE DEVELOPMENT OF A COASTAL MONITORING SYSTEM IN MONTEREY BAY**

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**Abstract**

Coastal California is typically viewed as upwelling-dominated, with strong equatorward and Ekman-dominated offshore flows, bounded to the west by the broad, meandering California Current. This implies that biological and physical processes propagate predominantly southward, that coastal run-off has negligible impacts in the near-shore oceanographic conditions and that much of biological interest is driven by seasonally intense spring upwelling. Recent observations suggest that this view is misleading, and that the occurrence of infrequent but high-impact events such as precipitation-driven coastal runoff and poleward surface flow may dominate the biological signal over large spatial and temporal scales. These events can “fertilize” the coastal ocean with anthropogenically derived nutrients, and may catalyze or exacerbate HAB conditions in the coastal ocean. With funding from the National Geographic and Atmospheric Association (NOAA), several partner institutions in the Monterey Bay, California area have established a Center for Integrated Marine Technologies (CIMT; http://cimt.ucsc.edu) with the scientific goal of describing how physical forcing (wind) eventually translates into the phenomenal biological productivity (such as whales) seen in central California, and how the presence of frequent HAB events (including both Pseudo-nitzschia and Alexandrium spp.) can occasionally result in dead whales. An overview of the CIMT program, its application to HAB monitoring, and some new emerging technologies and observations will be explored.