PaCOOS Observation System for Early Warning of HAB Events

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Why the Need for a Forecasting System

"The biological samples obtained in PaCOOS will be of unprecedented geographic and taxonomic scope. They constitute a major resource for present management purposes and future research. Moreover, because of both natural and anthropogenic changes in ocean ecosystems, it is particularly important that biological samples be taken at known points in time (and space) and maintained for future investigations, and placed in a standardized context of past collections. Some of the investigations that will be undertaken with these specimens include: outbreaks of harmful algal blooms (HABs), and their consequences in food webs as well as determinations of body burdens of naturally-occuring PSPs, domoic acid, etc." (PaCOOS Science plan).

Harmful algal bloom-related mammal mortalities, widespread closures of shellfish harvest, and human illness due to HAB events can be forecast through the integration of sustained monitoring programs, development of appropriate regional bio-physical models, and remote detection and sample collection through observing systems. Our knowledge of offshore initiation sites along the U.S. west coast will allow the strategic placement of key moorings to characterize bloom development, persistence, toxicity and movement to allow forecasting of HAB arrival on beaches. The early warning of incoming bloom events will enable state monitoring and health departments to take preventative actions (e.g., focused monitoring efforts, close shellfish beds, warn affected communities) to safeguard the public health and fisheries. An effective early warning system will also decrease the extent of time/area closures of shellfish beds and thus minimize economic impacts to coastal communities.

The need is to move from reactionary monitoring of shellfish to precautionary, interdisciplinary autonomous sampling of HAB indicators.

The goal is to provide an early warning network for the detection and transport of toxic blooms using an integrated suite of sensors to include satellites, stationary sensor platforms measuring ocean water properties, currents, cells and toxins that will add real-time elements to shore-based lab testing.

How - Necessary Steps to Achieve an Integrated HAB Forecasting System

Several HAB specific research programs on the U.S. west coast that are currently funded to develop early warning systems, for example, ECOHAB PNW (Washington State), MERHAB RAPDALERT (southern California) and MERHAB Cali-PReEMPT (central California) but will have a limited lifetime unless they are made operational. The incorporation of these well-tested, autonomous HAB detection systems into the regional PaCOOS program will allow this science to take the final step toward a fully functional and operational forecasting system.

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One vision of a regional "HAB OOS" program is to use an interdisciplinary consortium of collaborators in which equipment would be shared or leased, for example, the environmental sensing platform (C. Scholin). Initially, a simple system of core detectors will be deployed at limited sites in each region. Once threshold levels of key HAB parameters (physical, biological and chemical) that can cause problems in a given area are determined, adaptive sampling strategies would be initiated. Adaptive sampling would include: 1. release of gliders, 2. increase in sampling frequency via 2-way communication with instrumentation, 3. deployment of drifters using rapid response vessels. Sampling strategies would be tailored for each location allowing deployment of optimal sensors and technologies in order to keep costs reasonable. For example, the Juan de Fuca eddy mooring off the Washington State coast will not need a profiling system because ECOHAB Pacific Northwest (PNW) cruises have shown that *Pseudo-nitzschia* cells and toxins are found in the upper 10m of the water column, in contrast to Monterey Bay where a profiling system is likely a necessary element due to the presence of these cells in thin layers. Cost savings will also be achieved by using volunteer monitoring programs for shore-based sampling, deployment of autonomous sampling systems from piers, and collaborating with other programs, e.g., invasive species, defense efforts, etc. Ultimately, each coastal region must ask the question, "How many days of early warning capability is needed for effective management of coastal resources?" A balance must be struck between cost and timeliness, effectiveness, and efficiency of the HAB OOS system.

End Users of the Forecasting System

- State government and Tribal bodies are co-managers of coastal shellfish resources. These users will be the direct beneficiaries of planned forecasting products and models. Some of these coastal management entities include the Departments of Health, Departments of Fish and Wildlife and Agriculture, Departments of Ecology, and coastal Tribes.
- General public and coastal communities will benefit from warnings issued based on results from monitoring and model forecasts. For example, razor clam digging is a popular pastime in the Pacific Northwest, producing recreational benefits for the general public and tourism revenue for coastal communities.
- Scientists from a variety of disciplines will also benefit from the increased understanding of the eastern Pacific coastal ecosystem obtained from the data gathered to develop the forecasting tools and models.

Potential Cost Savings of HAB Forecasting Capability

A HAB event in 1991 caused the closure of Washington State beaches to recreational and commercial shellfish harvesting resulting in an estimate $15-20 million revenue loss to local fishing communities. This loss would be approximately $40-50 million in 2006 dollars. A robust forecasting system that can predict the coastal area of highest impact can reduce the extent of the area closure and potentially the length of time of the closure by predicting when the event will reach the coast. Predictions of both location and time will reduce the economic impact of HABs.

Specific Forecasting Components

Hydrographic, biological and chemical sampling can be done at discreet depths, as a profiling system, or in AUV, ROV, or glider mode.

Hydrographic	Biological	Chemical	Meteorological	Models
T, S, currents	Toxins*, toxic cells*, plankton assemblage, fluorescence, optics	Macronutrients, micronutrients	PAR, wind, air temp	Transport (physical), biological, atmospheric

* - specific to HABs, all other tools have general applications

Core Technologies – all areas

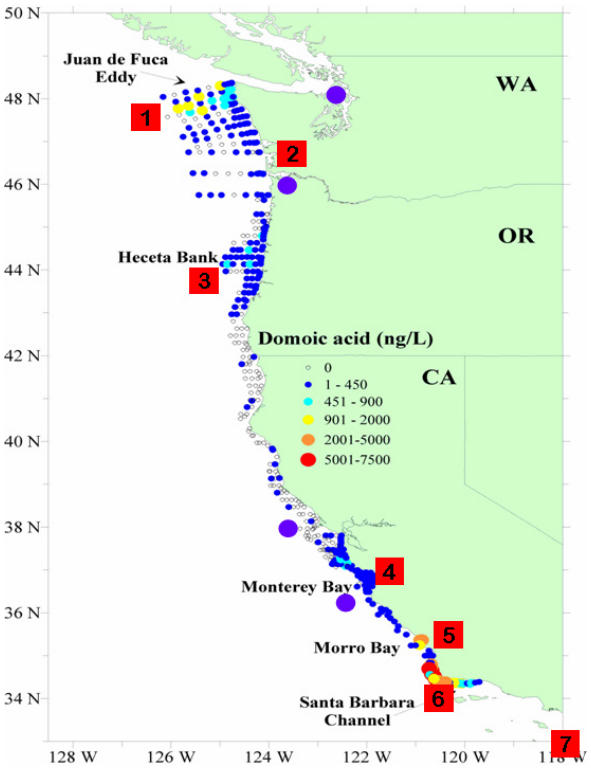
Environmental sensing platform (toxins, toxigenic cells), nutrients, current meters, T/S (SBE), fluorescence/backscatter/transmissometry, MET package (PAR, wind, air), drifters, satellite imagery.

Additional Technologies – location specific

AquaMonitor, FloCam, flow cytometer, AUV, ROV, gliders, bioluminescence detector, hyperspectral absorbance meters

Where

- Isolated topography-related retention areas may promote HABs
- Areas with strong research and monitoring programs – ECOHAB, MERHAB and others
- Areas of measurable impact



Minimum

1. Juan de Fuca eddy
2. central WA coast, Kalaloch beach
3. Heceta Bank
4. Monterey Bay
5. San Luis Obispo
6. Santa Barbara channel
7. Scripps

Additional

North Puget Sound
Columbia River
Bodega Bay
Farallone Island

Locations are hypothetical HAB initiation sites or at key locations along transport pathways. Primary focus initially is on *Pseudo-nitzschia* and domoic acid.

A figure from Trainer et al., 2000 showing cellular domoic acid concentrations during cruises in summer 1998, the year when massive sea lion mortalities occurred in Monterey and Morro Bays and a coastwide closure of the Washington State razor clam fishery occurred due to high levels of domoic acid.

When

Seasonality of offshore toxigenic *Pseudo-nitzschia* blooms is approximately May through September/ early October, but tends to appear earlier in California compared to Washington State.

Budget

Year 1: $25k
Workshop with participants from states and regional associations

Years 2-5: $4.5 million per year

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