California Program for Regional Enhanced Monitoring of PhycoToxins (Cal-PReEMPT)

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Summary

California coastal waters are threatened by HABs, but the state's budget for monitoring is under pressure for cutbacks. Economic realities compel managers to find efficient methods to keep up with their increased monitoring burden. Efficient and cost-effective technologies for species and toxin detection have been developed and remote sensing capabilities are available for bloom tracking, but a constraint to adoption of new methods by the California Department of Health Service (CDHS) is the lack of available funds for ground-truthing them, a necessary step before full adoption by the agency. For example, pre-screening plankton and shellfish samples in the field, using simple test kits, could reduce the number of samples submitted to the regulatory laboratory by 80 – 90%, representing a significant potential savings in analytical costs, but before CDHS can adopt these kits, they must be assured of their efficacy.

To bridge the gulf between availability of new tools and integration of those into monitoring efforts, NOAA, through its Monitoring and Event Response Program for Harmful Algal Blooms (MERHAB), is providing funding to perform necessary validation of new tools for incorporation of them into CDHS monitoring program. This presentation will provide an overview of our MERHAB-funded program and describe our expected outcomes.

Project Description

The goal of this MERHAB effort is to implement an economically sustainable harmful algal bloom monitoring plan for the California coastline that exceeds current capabilities of the California Department of Health Services (CDHS) by using new technologies for rapid toxin and species detection and bloom tracking. The innovative approach taken establishes pilot project sites where new technologies are incorporated into an intensive monitoring program, in combination with a tiered decision-making protocol that dictates specific steps to take in response to field observations. The power of this approach is that it paves the way for ultimately shifting much of the monitoring effort to the field, where a network of volunteers, with overall guidance from the CDHS, pre-screen samples using new technologies, thus ensuring early warning of impending blooms while avoiding unnecessary and expensive lab-based sample testing. Using the best available remote sensing data in conjunction with field data provided by the volunteer force will enable tracking the inception, proliferation, advection and decline of bloom events in real-time along the expansive California coast. In turn, this provides managers necessary information to make informed decisions on when and where to direct the field force to increase their efforts.

A particular strength of this program is that it was jointly conceived and developed between the state agency charged with ensuring seafood safety, the CDHS, and academic researchers actively engaged in developing and using new methods for harmful algal bloom research. This effort represents a true collaborative effort that specifically addresses the needs of the CDHS with regard to maintaining a high level of safety, while at the same time recognizing the limitations imposed by economic realities.
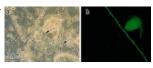
Pilot Study Areas for Intensive Monitoring

Study Sites

Integrating New Technology

Examples of technology being evaluated for possible incorporation into the CDHS' monitoring effort:

For field-based toxin detection we will evaluate Jellet Rapid Testing Ltd. MIST Alert™ test kits for use on water and tissue samples.

HOW IT WORKS FOR ASP and PSP TESTING

SHELLFISH TISSUE PREPARATION

Example of the simple results obtained when using the Jellet Rapid Testing Ltd. MIST Alert™ test kits.

Example of the type of results obtained using molecular probes to quantitatively identify *Pseudo-nitzschia australis* in a natural water sample.

Multi-Platform Remote Sensing and Feature Tracking

In Fall 2002, there was a major "flushing" event in Monterey Bay, California which resulted in the onshore transport of offshore waters, and the displacement of the resident diatom community. Following this flushing, a large red tide formed in the Bay, exceeding 35 mg/m3 chl.

The upper panel provides a series of images during Sept-Oct showing the intrusion (from offshore and south) of waters into the Bay, followed by the formation of a large algal bloom, from SeaWiFS chlorophyll. The red tide was identified as *Ceratium furca* and *C. dens.*

The lower left panel depicts chlorophyll in Monterey Bay on Oct. 7, using high-resolution (20 meter) AVIRIS data. The boxed region is dominated by the red tide; immediately adjacent (left) of it is a bloom of *Pseudo-nitzschia.*

The lower right panel shows chlorophyll contours from the AVIRIS image superimposed on RADARSAT-1 SAR data, showing that the red tide was being aggregated by an internal wave field, and possibly transported towards shore.

Project Objectives

A. Field-Based Technology

1. Pilot Study Areas – Establish pilot projects for intensive monitoring and implementing new detection technologies.
Locations for pilot projects have been selected based on their diversity of ecological conditions and HAB species, high relative frequency of occurrence for the target HAB species and toxin, and availability of historic and/or existing oceanographic programs. The selected sites are (1) the Drakes Bay region along the Marin coast (PSP); (2) Monterey Bay, including sites in Santa Cruz and Monterey (PSP/DA); and (3) San Luis Obispo (DA).

2. Tiered Approach Protocol – Develop a field protocol and decision tree for a tiered approach to using the various field tools.

3. Toxin Detection Methods – Incorporate new toxin detection methods into pilot projects.
Pilot project sites will be used to conduct rigorous field tests of the Jellet Rapid Testing Ltd. MIST Alert™ test kits for both PSP toxins and domoic acid in phytoplankton and shellfish samples. We will evaluate these with respect to ease of use, potential for operator error and false negatives or positives, and sensitivity relative to currently used methods.

B. Laboratory-Based Technology

1. New Toxin Detection Methods – Validate the receptor binding assay (RBA) for PSP and domoic acid.
Evaluate the RBA method's accuracy, precision, ease of use and cost effectiveness relative to current methodology approved for regulatory use.

2. Gene Probe Technology – Incorporate whole cell (F.I.S.H.) probing method into pilot projects.
Evaluate species specific genetic probes to assess their utility for providing HAB early warning, and for confirmation of field observations and field analytical results.

C. Remote Sensing

1. Retrospective Analysis – Evaluate remote sensing as a monitoring aid.
Examine existing CDHS qualitative phytoplankton data, which provides coverage of entire CA state coastline, to determine what species are associated with blooms detected using imagery. Real-time snapshots of coastal imagery combined with CDHS species data will provide an ecosystem-wide view of HAB inception, expansion, advection and decline as opposed to isolated observations un-linked to a bigger picture view. Work with NOAA Coast Watch on plans for integrating these snapshots into existing Coast Watch produced reports.

2. Development of Predictive Tools – Following the identification and processing of recent historic data corresponding to bloom events associated with adequate phytoplankton and biotoxin data, begin collection of remote sensing products for current HAB events. Begin analysis of these data using time-series analysis and predictive methods such as singular value decomposition based on the retrospective analyses and first 2 years of field data. Test promising methods in operational mode with the Coast Watch program.

D. Comprehensive Data Analysis

1. Evaluation of Field Technologies
Evaluate new field technologies with respect to (1) performance relative to existing accredited lab methods (accuracy, precision, frequency of false positive and false negative results); (2) their performance relative to new lab-based toxin detection methods (gene probes, receptor binding assay); (3) their utility as aids to early detection of impending HABs; (4) their use for rapid-response monitoring and decision making for developing and on-going blooms; and (5) their cost-effectiveness relative to current practices.

2. Database Management – Databases currently exist at CDHS for phytoplankton and biotoxin data that can incorporate the additional sources of data generated in this project. Copies of these data will be routinely transferred to UCSC. UCSC currently maintains a remote sensing database (http://oceandatacenter.ucsc.edu), which the CIMT program (http://cimt.ucsc.edu) is upgrading to include multiple data streams (shipboard, mooring, HF radar). We have recently acquired funds to add a web-based GIS capability (ArcIMS, ESRI) which will facilitate automated dissemination of HAB maps (already produced by the CDHS) integrated with the corresponding remote sensing products.
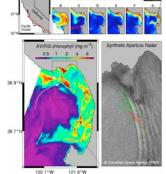
E. Community Outreach

1. Local Workshops – Following the completion of the developmental work and the field and laboratory validation, conduct a series of hands-on workshops at the local level in HAB-impacted areas along the coast of California, including demonstrations and guidance in how to access and interpret the remote sensing products. The purpose of these workshops will be to further the awareness of HABs among local public health and resource agencies, environmental groups, and educational programs. Hands-on workshops will encourage the participation of a greater number of groups in routine field monitoring for HABs, improving our ability for early detection and rapid response.

Real-Time Bloom Monitoring

In collaboration with Rick Stumpf (NOAA), we are evaluating the use of real-time satellite data in conjunction with our volunteer network to identify potential bloom hot-spots. In this example, SeaWiFS chlorophyll from the Southern California Bight on Februar 11, 2004 is shown (top), compared to the difference between January 31 and February 11 (bottom). The difference image identifies a coastal bloom which was coincident with volunteer-network reportings of elevated domoic acid and marine mammal strandings. This type of real-time imagery can help to identify bloom regions, and provide an estimate of spatial extent and areas of impact.