Harmful Algal Blooms Integrated Observing System (HABIOS)
Plan 1
July 12, 2008

1.0 Vision Statement

The vision statement for the Harmful Algal Blooms Integrated Observing System for the Gulf of Mexico is:

To establish a sustained observing system as part of the U.S. IOOS (Integrated Ocean Observing System) that will facilitate and enhance efforts to monitor, manage, and reduce detrimental effects of harmful algal blooms (HABs) on human health and living marine resources (non-human animals and plants) and to mitigate impacts of HABs on coastal communities.

2.0 Terms of Reference

Numerous microalgae have the potential of producing harmful effects in the Gulf of Mexico. The most significant from the perspective of human or animal health are those microalgae that produce toxins. Some microalgae have an impact by being a poor food source or causing mechanical damage to fish gills. Others are concentrated by filter-feeding shellfish which are rendered toxic to human consumers. Still other microalgae can be detrimental to the environment through impacts on the ecosystem (shading of sea grasses, development of hypoxia). The observing system will address those algae that have a direct impact on the environment, including the human component. Of these, the best known and most important in the Gulf of Mexico is *Karenia brevis*, which is the organism responsible for frequent “Florida red tide” events. However, other species also produce toxins that adversely impact the environment; these are sometimes monitored in the Gulf and also will be considered. While the HABIOS will be designed in such a way as to generally support observing of all harmful algal species, particular emphasis will be placed on observations and impacts of *K. brevis*, given its recognized importance in various regions in the Gulf of Mexico. In the remainder of this document, aspects of HABIOS specific to *K. brevis* will be clearly identified as such to distinguish them from more general HAB monitoring capabilities.

The Gulf of Mexico contains multiple existing systems that are operated by state, federal, and local agencies and by researchers for the purpose of monitoring and forecasting harmful algal blooms and oceanographic conditions that influence their frequency, distribution and fate. These systems already provide information for decisions by public health and resource managers. However, they tend to operate independently of each other so that full advantage of all

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1 The states have monitoring and management programs for “red tide” and for shellfish safety, and some have additional information for public health and recreation. Federal capabilities include the NOAA operational Harmful Algal Bloom Forecast System (HAB-FS), which provides nowcasts and forecasts of HABs through the HAB Bulletin, and the Harmful Algal Blooms Observing System (HABSOS) which provides integration and dissemination of geographic data relevant to HABs. The Centers for Disease Control and Prevention (CDC) has the Harmful Algal Bloom-related Illness Surveillance System (HABISS). A coupled federal-state effort involves the Marine Mammal Stranding Networks. The Phytoplankton Monitoring Network has developed a volunteer monitoring network. The various ocean observing systems for the Gulf of Mexico provide a variety of oceanographic measurements including observed and modeled winds, currents, temperature, salinity, waves, and others (links to the various systems are provided at gcoos.org).
observations is not achieved. In this regard, both the user communities and managers of these systems have identified critical deficiencies that can be addressed through a more comprehensive and integrated approach that will improve our ability to detect HABs more rapidly and provide more accurate and timely predictions of potential impacts. The objective of this plan is to provide the design for such a system.

The plan must include the needed expansion, enhancement, and maintenance of current individual systems into an integrated system of systems that will provide the information needed for managing and mitigating ill effects of harmful algal blooms on living marine resources, human health, and the socioeconomic state of coastal communities. The resultant system must be 'end-to-end', meaning that it efficiently links observations (in situ and remotely-sensed), data management and communications, and modeling and analysis for the timely provision of data and information in forms and at rates required by decision makers and other users. Of critical importance to the evolution of such an approach are performance assessments by both system operators and users that are used to improve the HAB Integrated Observing System over time. Although the system does not explicitly include research needed to improve detection and prediction capabilities, performance assessment should include the identification of deficiencies that can be used to determine research priorities and a process by which advances in research and operational capabilities are used to improve its capabilities.

The system must be designed and built in a systematic and efficient manner, and we must be conservative in making decisions to alter or remove existing elements. Step one is to identify the existing capabilities (observations, data management and modeling) that will form the core of the integrated system of systems. At the same time, data providers and end users must work together to identify gaps in needed data and information that would improve the value of the integrated approach for addressing and responding to public and management concerns regarding the health of people, marine organisms, and marine ecosystems. The next step is to systematically enhance the observations, modeling, analyses, and data management and communications so as to fill the gaps in needed information and improve its delivery to users. An ongoing activity is to specify and use system performance metrics and evaluate new research and operational capabilities in order to plan system improvements.

The system design is consistent with design principles in the First IOOS Development Plan and will incorporate the ideas expressed in workshop reports and other documents. Sets of recommendations for observations appropriate and necessary for public health were made at the Workshop on Harmful Algal Blooms Observing System (November-December 2000), the Workshop on Integrating Harmful Algal Bloom Observations into the Gulf of Mexico Coastal Ocean Observing System (April 2004), the Ocean.US workshop on Public Health Risks: Coastal Observations for Decision Making (January 2006), and the Harmful Algal Bloom Observing System Plan for the Gulf of Mexico Workshop, November 2007. These documents and workshop notes identify important gaps between the ability to rapidly detect and provide timely predictions of HAB events and their potential impacts. This report sets forth a set of objectives and actions that will begin the process of filling these gaps and developing an observing system that can become operational.

3.0 Goals and Objectives

The overarching goal of the HABIOS is to provide information in forms and at rates required by decision makers and the public to manage and mitigate environmental and public health impacts
of HABs. This shall be accomplished through improvements in monitoring, data management, data integration, and modeling capabilities that address critical gaps in the existing monitoring, observing, forecasting, and information systems as they are identified. These critical gaps will be addressed by achieving several objectives.

**Objectives**

1. Identify stakeholder (user) groups and their needs and preferred delivery systems.
2. Identify areas where HABs are most likely to occur (based on both past observations and knowledge of environmental conditions associated with an increase in the probability of HAB events) and monitor them on time and space scales needed for rapid detection and response. Areas of concern include shellfish beds, beaches frequented by people, areas most frequented by protected species at risk from HABs, and selected offshore areas where HABs are known to initiate or occur frequently;
3. Integrate relevant data in consistent and understandable products and formats. Such data include the abundance and distribution of HAB species, their toxin concentrations, environmental parameters influencing abundance and distribution, human health, animal health, living marine resources, and socioeconomic impacts. (Access to human health data will be restricted, but collaborations with appropriate scientists should help ensure data access.)
4. Provide for timely archival of and easy access to available data on phytoplankton species (including HABs), associated environmental data, and morbidity and mortality events involving marine organisms, and develop methodology for obtaining access to human health data as required;
5. Track in real time and provide timely forecasts (with error estimates) of the species, location, time-space extent of the bloom, cell counts, and toxin levels and characteristics of HABs as well as HAB-associated human illnesses (via HABISS) and animal morbidity/mortality;
6. Distribute the information in ways that are timely, meaningful, relevant, and readily accessible to the various management and public communities;
7. Monitor the effectiveness of the observing system using quantifiable performance metrics that gauge system functionality (e.g., sustained, quality controlled data streams), user satisfaction (e.g., are the data provided in forms and at rates that are most useful to end users), and costs versus benefits;
8. Identify human health risks from HAB events, living marine resource risks from HAB events, and the environmental conditions epidemiologic studies should take into account as possible risk factors for exposure/development of disease; and
9. Based on stakeholder input, identify areas of research and operations that will improve the system and prioritize these areas.

To reach these objectives will require interdisciplinary and international collaboration and the development of the necessary workforce, with a particular focus on observing technology and taxonomy.

**4.0 Objective-Specific Activities**

To achieve these objectives, the observing system will be established and evolve to accomplish the activities stated below.
Objective 1

(1) Identify potential user groups, which include: the medical community and departments of health, tourism, beach goers, living marine resource managers, fishing industry, HAB researchers, coastal managers, product providers (e.g., HAB FS (Forecasting System), K-16 educators, media, and the public).

(2) For each stakeholder group identify specific needs and determine their preferred mode(s) of information delivery. Examples of information for delivery include: web sites, email, NOAA weather radio reports, text message, cell phone, kiosk, brochures, posters, and existing outreach mechanisms (e.g., GOMA (Gulf of Mexico Alliance) or GCOOS).

Objective 2

(1) Identify bloom initiation sites and areas of concern for impacts that should be monitored with higher time-space resolution than other areas and that may enhance understanding of bloom initiation and improve forecasting capabilities.

(2) Design decision processes to determine pre-planned and adaptive sampling strategies.

(3) Determine the presence, location, and extent of algal blooms before they have impacted an area of concern (with enhancement and integration of the several current monitoring programs, including state programs, phytoplankton monitoring network, and HAB-FS bulletins).

(4) Monitor with appropriate sampling rates the critical areas of concern, e.g. shellfish areas and recreational beaches, for presence and impact of HABs with appropriate sampling rates.

(5) Determine species and concentration (intensity) of detected algal blooms.

(6) Determine the toxicity levels associated with detected algal blooms. In addition to species identification and cell counts, toxin levels will influence the extent of negative human/ecosystem health and socioeconomic impacts and the need for response and mitigation.

Objective 3

(1) Expand and improve the efficiency of networks for data and information exchange among the responsible local, state, and federal agencies, and in cooperation with Mexican and Caribbean partners. This includes use of IOOS DMAC (Data Management and Communication) standards for data and metadata and enhancement of the HABSOS capability for data management.

Objective 4

(1) Provide secure provision for storage and archival of data and information. Recognize that access to some types of non-aggregated data (including human health data and detailed commercial fishing data) may be restricted (due to privacy issues) and that access may be determined on a case-by-case basis. Thus there is the need to encourage collaboration to ensure access. Storage of human health data will likely be outside the HABIOS.

(2) Ensure that all stored data and information can be discovered and retrieved from archives by machine. Build the system to acknowledge differences in data restrictions.

(3) Provide mirror (backup) storage for data and information.
Objective 5
(1) Produce predictions with uncertainties of the onset of HABs in areas of concern.
(2) Make all monitoring data for sampling locations and bloom characteristics available in a coherent form for operational nowcasts and forecasts. Improve HABSOS capability (or equivalent) to support the HABs forecasting systems such as HAB-FS system.
(3) Link observations and models more effectively through data assimilation or data simulation products, such as observing system simulation experiments (OSSEs) that can be used to improve the cost-effectiveness of monitoring.
(4) Have necessary circulation output from models available in standard formats for nowcasts and forecasts.
(5) Implement location uncertainty statistics into forecast models, with information based on both location uncertainty and the use of ensemble models for modeling uncertainty.

Objective 6
(1) Provide all pertinent information, including forecasts with error estimates, in a timely and secure manner, to appropriate local, state, and regional coastal managers, using IOOS DMAC standards and protocols.
(2) Develop educational materials for system operators, coastal managers, educators, and HABs researchers to increase understanding and value of the products of the HABIOS.
(3) Develop outreach materials for identified stakeholders and media in formats specified by the user group and to the general public to increase understanding, usefulness, and value of the HABIOS.

Objective 7
(1) Determine and use performance metrics for the efficacy of observing system functions (the efficiency of linking observations, DMAC, and modeling for sustained product delivery using information provided by data providers and modelers).
(2) Determine and implement performance metrics for how well the information provided meets the needs of user groups (user satisfaction), with information from users.
(3) Establish a users group and have periodic feedback reviews of the system.
(4) Regularly review the HABIOS using quantitative performance metrics.

Objective 8
(1) Identify human health risks from HABs.
(2) Identify human health data bases.
(3) Identify living resource data bases.
(4) Support development of human disease surveillance, e.g. HABISS, vibrio wound infections, waterborne disease outbreaks.
(5) Include environmental data as risk factors in human epidemiology studies.
(6) Assess how to incorporate other health-related data into the process (from identifying health risks to modeling), including poison information center calls, local physician networks, hospital admissions, emergency room visits, etc.
(7) Assess how to involve veterinarians in relevant companion animal disease surveillance.
(8) Use links for abstracting limited human health data to non-health databases and import relevant environmental data to health-based databases.
(9) Coordinate epidemiological studies (animal and human) with HABs observations and associated environmental conditions.

(10) Create a model to integrate human health or living marine resource health and environmental data.

**Objective 9**

1. Based on user needs and current operational capabilities identify research priorities for species identification and enumeration; measurements of toxicity; measurements of physical, chemical and biological variables made synoptically in time and space and with sufficient resolution to improve predictive capability.

2. Identify research priorities for improving data assimilation techniques and numerical model predictions.

3. Identify research priorities for improving interoperability among contributing systems and components (e.g., the establishment of standards and protocols for measurements and data integration or fusion).