

Appendix 1: State-supported HAB monitoring

[[At the November workshop, a state-by-state listing of HAB was recommended; this has not materialized.]]

1.0 The National Shellfish Sanitation Program (NSSP) mandates phytoplankton monitoring as part of the biotoxin contingency plan required for interstate shipment of shellfish. Components of the monitoring plan include

- Sample sites are selected to provide surveillance of waters near and at shellfish growing areas. They are identified by latitude and longitude. Long established sites were selected with the approval of the USFDA.
- Sampling frequency is about 10 times per year as determined by NSSP and more with event response. There are no estimates for worst case scenarios.

1.1 Alabama

Hugh MacIntyre, Senior Marine Scientist, Dauphin Island Sea Lab provided the following information.

Alabama has about 100 miles of coast line along the Gulf of Mexico and in Mobile Bay and Mississippi Sound. In past years there have been blooms of numerous HAB species (see appendix) including *Karenia brevis*, that have been responsible for fish-kills and hypoxia. There are sharp gradients from very turbid, nutrient-rich, to very clear, nutrient depleted waters. Consequently, optically based monitoring is very difficult. The high diversity within the microalgae makes chlorophyll an unreliable proxy for HAB abundance.

There are four tiers of monitoring:

1st tier: State and federal agencies, coordinated through Alabama Department of Public Health (ADPH). These monitor of Gulf beaches and oyster-growing areas in Mobile Bay, with further adaptive sampling during blooms. ADPH has regulatory authority over oyster harvesting. Routine monitoring is weekly, bi-weekly or quarterly, depending on site and season. Data include cell counts and (usually) temperature and salinity.

2nd tier: Dauphin Island Sea Lab (DISL), in collaboration with ADPH. Grant-based (i.e., finite duration) research efforts in bays and offshore. (Prior funding has come from NOAA, EPA directly or in state- or university-administered funding.) DISL is developing Alabama-centric website on HABs, eutrophication and hypoxia. Sampling is typically monthly. Data include cell counts, physical hydrography, bio-optical descriptors, HPLC pigments, nutrients etc.

3rd tier: Volunteer network (initiated by NOAA PMN with reporting to PMN database), in collaboration with DISL in inshore waters not routinely sampled by ADPH. Methodology and level of training reduce reliability as monitoring tool but excellent outreach and outreach opportunity. Sampling is biweekly. Data include relative abundance of net plankton, physical hydrography, chlorophyll a, nutrients etc.

4th tier: Instrument arrays are maintained by NDBC (one site on Dauphin Island), DISL/Mobile Bay NEP (three sites in Mobile Bay, 1 in Perdido Bay is pending), USGS/ADCNR (one site in Wolf Creek) and the Weeks Bay National Estuarine Research Reserve (four sites in Weeks Bay). Data vary by site but include hourly meteorology and hydrography (temperature, salinity, dissolved oxygen). High fouling rate in Mobile Bay and Weeks Bay limits potential application of optical sensors because of the need for daily or near-daily cleaning.

Comments:

NOAA and EPA set aside money for the state or University of Alabama.

Mooring sensors really need to be cleaned daily, but that is not realistic.

Grab samples are collected monthly.

State Sponsored HAB Monitoring

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Monitoring Agencies:

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 - Mandated monitoring Yes No
 - Authority- Required by USFDA and NSSP
 - Water Sample Type
 - Surface grab sample for cell concentrations
 - Multiple sample depths

- Frequency of Monitoring Efforts (Scheduled Sampling Events)
 - Shellfish growing area sampling sites are determined by evaluation of HAB risk. Monitoring is conducted 10- 12 times per year.
 - Event response protocol available
 - Increased sampling when *Karenia brevis* cell counts in growing areas. See protocol in Appendix
 - Arrangements are made for toxin testing when *Pyrodinium bahamense* is detected
- Monitoring Stations-Lat/Long available Yes No
- Hydrographic Data Collected with HAB sample
 - Salinity
 - Water Temperature
 - Wind Speed and Direction
 - Air Temperature
 - Tide
- Method of Phytoplankton Analysis
 - Preserved Material –Acidified Lugol’s
 - Utermohl method
 - Standard operating procedure is available
 - HAB species ID and enumeration
 - *Karenia brevis* Cells per liter >5000 requires action by Shellfish Authority
 - Other *Karenia* spp. are noted cells per liter
 - *Pyrodinium bahamense* cells per liter—requires action by shellfish authority to determine toxicity
 - *Pseudo-nitzschia* spp (identification to genus) cells per liter identified by light microscopy
 - *Prorocentrum minimum* requires no action by shellfish authority
 - *Alexandrium monilatum* requires no action. Other agencies such as Conservation and Natural Resources are notified.
 - Dinophysis spp.
 - Non HAB species ID and enumeration
 - The laboratory identifies and enumerates dinoflagellates to genus and species when possible. Diatoms are identified to genus using light microscopy when counts exceed background levels.
- Data
 - Database- MS Excel
 - Accessibility -Data sharing is determined on a case to case basis by the ADPH
- Method of HAB event notification
 - Health alert general
 - Shellfish harvest
 - When cell counts of *Karenia brevis* in shellfish growing areas are >5000 cells per liter shellfish areas are closed to harvest. The State

Health Officer issues the closure. Areas remain closed until toxin testing determines levels are <20 mouse units.

- Beach goers
 - Email (the HAB Alert list) to neighboring states and an established list of state, local, and federal regulators or data developers (NOAA)
- Voluntary collections at beach monitoring sites by Alabama Dept of Environmental Management and the Baldwin County Health Department
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 - Mandated monitoring Yes No
 - Water Sample Type
 - Surface grab sample for cell concentrations
 - Multiple depth sampling
 - Frequency of Monitoring Efforts (Scheduled Sampling Events)
 - Grab samples are collected at BEACH sites across the AL Gulf beaches from FL to Dauphin Island, AL Public Beach once or twice weekly during the swimming season May through September. Samples are collected once per month in the off season.
 - Event response- Currently under development
 - Monitoring Stations- Lat/Long available Yes No
 - Hydrographic Data Collected with HAB sample
 - Salinity
 - Water Temperature
 - Wind Speed and Direction
 - Air Temperature
 - Tide
 - Method of Phytoplankton Analysis
 - Preserved Material –Acidified Lugol’s
 - Utermohl method
 - Standard operating procedure is available
 - HAB species ID and enumeration
 - See above
 - Non HAB species ID and enumeration
 - See above
 - Data
 - Database -MS Access database
 - Accessibility- Data sharing is determined on a case to case basis by the ADPH
 - Method of HAB event notification

- Health alert general- The ADPH issues health alerts when *Karenia brevis* blooms are causing respiratory symptoms in beach goers or fish kills with irritating aerosols. Distribution to the media via press release with local contact information.
 - Shellfish harvest
 - Beach goers- Currently under development with proposed signage at various public beaches for on-site notification. Developing web based notification including HAB status reports
 - Email (the HAB Alert list) to neighboring states and an established list of state, local, and federal regulators or data developers (NOAA)
- Additional Health Information Databases for State
 - Alabama Incident Management System (AIMS and NEDS)- developing databases of human syndromic data reported by hospitals. This instrument could be modified to include biotoxin related illness surveillance if the State Health Officer makes it reportable.
 - Animal Illness database- not available specifically for Alabama.
 - Living Marine Resources database- no information available

1.2 Florida

Over 70 potential HAB species have been identified from Florida estuarine and coastal waters, which consist of over **XX** miles of coast line. By far the most common HAB in Florida waters is caused by *Karenia brevis*, which has bloomed for 49 of the past 50 years in southwest Florida, and less frequently in the Florida panhandle region and the east coast. State funding for red tide monitoring thus focuses primarily on *K. brevis*, however other HAB species (e.g. *Pryodinium bahamense* in the Indian River Lagoon) as well as other *Karenia* species (e.g. *K. mikimotoi*, *K. selliformis*, *K. papilionacea*) are also monitored.

The Florida Fish and Wildlife Conservation Commission's Fish and Wildlife Research Institute (FWRI) is the agency tasked by the state with monitoring HABs in state waters, including red tide. This is accomplished via maintenance of a HAB volunteer sampling network (consisting of FWC agency and FWRI staff, volunteers, subcontractors, other state, county and local agencies), a Florida Red Tide Offshore Volunteer sampling program (consisting of stakeholder such as charter and ferry captains, Coast Guard Auxillaries), provision of *Karenia* monitoring data and shellfish mouse bioassay data to the Florida Department of Agriculture and Consumer Services (FDACS), event response investigations of suspected HAB related impacts and a HAB research program. FWRI works closely with FDACS to provide HAB related cell concentrations and toxicity data that FDACS uses as the basis of HAB related management decisions. Commercial shellfish beds are closed by FDACS when concentrations of *K. brevis* of 5,000 or greater cells L⁻¹ are detected in the vicinity of the beds. Shellfish beds are opened when brevetoxin levels in shellfish are <20 mouse units per 100 gm of tissue and when saxitoxin levels are < 80 µg saxitoxin equivalents per 100 gm of tissue.

Red Tide monitoring is accomplished by FWRI HAB staff in cooperation with several HAB volunteer sampling networks. A variety of subcontractors and collaborators as well as state agencies (Florida Dept. of Environmental Protections, FDACS), county, local and private institutions, provide water samples or data to FWRI from coastal waters throughout the state. The Florida Red Tide Offshore Volunteer sampling program provides offshore samples from areas of interest for *K. brevis* bloom initiation. Ancillary physical, chemical and biological data is collected when possible. All samples are returned to FWRI, entered into the HAB historical database and examined and counted for >70 HAB species. Results are summarized in weekly data tables and maps. Florida HAB related products include: 1) weekly Friday bulletin of red tide locations (NW, SE, E coasts) consisting of maps and data summaries posted to the web, provided to e-mail lists and available on a toll free hotline; 2) a weekly Tuesday web update of red tide status; 3) web updates of event-response investigations; and 4) maintenance of the Florida HAB historical and fish kill databases. Additionally FWRI maintains a variety of HAB related hotlines for reporting potential HAB impacts which are followed up for investigation by scientists including: a fish kill hotline (800-636-0511) to report fish kills, diseased fish, or fish with other abnormalities, a Wildlife alert hotline (888-404-3922) for reporting wildlife in distress from HABs.

A variety of organizational efforts and new technologies are being developed and tested in Florida to assist with HAB monitoring, particularly for *K. brevis*.

Organizational efforts include:

- 1) Mote's Sarasota Operations Coastal Ocean Observing Laboratory (SO COOL), Control Center will be utilized to coordinate operations of the BreveBuster network, as well as information from other field sensors, and to interpret their results in the context of other environmental factors. Currently the brevebuster network consists of five fixed position installations with four more installations underway, and three autonomous underwater vehicles
- 2) A joint FWRI/USF Center for the Prediction of Red Tides which utilizes FWRI monitoring data in conjunction with physical and eventually coupled biophysical model results and satellite imagery to provide weekly forecasts of projected red tide movements and impacts in Florida waters.
- 3) Real-time monitoring system using lifeguards in Sarasota County was developed by Mote Marine Laboratory. Real-time data is provided using blackberry technology. A real-time respiratory irritation monitoring website was established. Brevebuster data (from AUVs and Moorings) are now available through Google/Earth by Mote Marine Laboratory.

HAB related products and infrastructure include:

- 1) a cloud free satellite SST product for SEACOSS domain developed and maintained by the University of South Florida
- 2) the Florida COOS-Caucus to plan and design an improved ocean observing network toward improving red tide tracking and prediction funded by FWC and Mote Marine Lab (2006-07)
- 3) a fleet of Bottom Station Ocean Profilers (BSOPs) continuously deployed off the WFS (http://ocgweb.marine.usf.edu/BSOP/bsop_index.shtml) developed by the University of South Florida

- 4) a particle trajectory model originating from FWC- *K.brevis* cell counts (www.ocgmod1.marine.usf.edu/WFS/Plot_HAB.html) developed by the University of South Florida in collaboration with FWRI
- 5) a fully automated nested circulation model running in a daily nowcast/forecast model (<http://ocgmod1.marine.usf.edu/WFS/>) developed by the University of South Florida
- 6) routine drifter deployment for nearshore tracking of HAB's by FWRI and USF. (www.ocgweb.marine.usf.edu/drifter/SURF_DRIFT.shtml)
- 7) FWC/USACE/NOAA funded the construction and maintenance of three MARVIN *in situ* water quality monitoring platforms allowing moveable HAB related long-term water quality monitoring using a large cadre of sensors and analyzers with testing of additional instrumentation specific to HAB's (Phytoflash, CDOM fluorometer, UV nitrate sensor, nutrient analyzers, urea sensors). FWC has funded the transmission of the MARVIN data to the USFComps and SECOORA data systems for archiving and near-realtime access via website by the public and interested managers.
- 8) integration of molecular probes with the capability of detecting 4 species of *Karenia* into the state monitoring program which have been both laboratory and field based ground truthing against microscopic counts and Brevebuster results
- 9) a laboratory based pilot study of the 'lab on a chip', which can be adapted for remote *in situ* brevetoxin detection. By FWC/UNCW/TX.
- 10) NOAA/USFComps/Various FL counties and municipalities has funded the installation of HF Radar stations off Southwest FL that can be accessed near-real-time by the public via website (www.seacoos.marine.usf.edu/HFRadar1/).
- 11) expansion of monitoring of *Karenia* species and currents coupling physical and biological monitoring in the Big Bend and Panhandle region of Florida (K tower transect) by Florida State University.

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1.3 Louisiana

The following information was provided by Anthony Roussel, Administrator, Molluscan Shellfish Program, Louisiana Department of Health and Hospitals.

The last occurrence of *Karenia brevis* in Louisiana waters was in winter 1996-1997 and shellfish beds were closed during that bloom. Due to predominant current patterns in the Gulf of Mexico, Louisiana usually receives warnings far in advance of a HAB event, owing to reports from Florida, Mississippi, and Alabama.

The Louisiana Department of Health and Hospitals (LDHH) Molluscan Shellfish Program conducts both a routine Water Quality monitoring program and a HAB monitoring program. Monthly water samples are collected from approximately 700 bacteriological sample stations and examined for fecal coliform. Other parameters recorded include salinity, temperature, and wind speed and direction. Generally at the same time, monthly water samples are collected from 24 HAB sample stations; of these 14 are located east of the Mississippi River. Samples are analyzed for cell counts of *Karenia brevis*, salinity; and other environmental conditions such as turbidity, tides, wind, etc. are collected. In the event that cell counts exceed 5000/L, additional water samples are taken and analyzed by the state laboratory and oyster meats are analyzed for toxins at either the FDA laboratory or a qualified university or private laboratory. If HAB toxins are detected, the information is shared with NOAA, the FDA Shellfish Specialist, and shellfish officials from neighboring states. If toxins are above allowable threshold, affected shellfish areas would be closed to harvest. If beds are closed to harvesting, public advisories are issued by LDHH through press releases, the news media, and the LDHH website.

LDHH maintains both water quality monitoring data and HAB monitoring data in independent databases in MS Access and Excel formats. Other agencies and the general public may access information from these databases through a written request that stipulates the intended use and distribution of the data.

State Sponsored HAB Monitoring

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Monitoring Agencies:

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- Mandated monitoring Yes No
 - Authority- Required by NSSP and US-FDA
- Water Sample Type
 - Surface grab sample for cell concentrations
 - Multiple sample depths

- Frequency of Monitoring Efforts (Scheduled Sampling Events)
 - Biotoxin sample stations are set stations collected once monthly.
 - Stations are located on the parameter of shellfish harvest areas and in specific harvest areas.
 - Event response protocol available
 - Increased sampling when *Karenia brevis* cell counts in growing areas.
- Monitoring Stations-Lat/Long available Yes No
- Hydrographic Data Collected with HAB sample
 - Salinity
 - Water Temperature
 - Wind Speed and Direction
 - Air Temperature
 - Tide
- Method of Phytoplankton Analysis
 - Preserved Material –Acidified Lugol’s
 - Utermohl method
 - Standard operating procedure is available
 - HAB species ID and enumeration
 - Action required by Shellfish Authority when *Karenia brevis* cell count is greater than 5000 cells per liter.
 - *Karenia brevis* cell counts are noted when less than 5000 cells per liter.
 - Non HAB species ID and enumeration.

- Data
 - Database- MS Excel
 - Accessibility – Data sharing is determined on a case to case basis by the Shellfish Authority
- Method of HAB event notification
 - Health alert general
 - Shellfish harvest
 - When cell counts of *Karenia brevis* in shellfish growing water areas are > 5000 cells per liter, the affected shellfish harvested area is closed to harvest.

- Areas remain closed until toxin testing determines levels are <20 mouse units.
- Beach goers
- Additional Health Information Databases for State
 - Human Illness Databases – not available for Louisiana
 - Animal Illness Databases – not available for Louisiana
 - Living Marine Resources Databases – not available for Louisiana

Academic Institutions – Active research programs in phytoplankton community composition in inshore and offshore waters, phytoplankton taxonomy, HAB species identification and toxin analyses are conducted by N. Rabalais and W. Morrison at Louisiana Universities Marine Consortium and S. Bargu at Louisiana State University.

1.4 Mississippi

Henry Folmar, Mississippi Department of Environmental Quality (MDEQ), provided the following information.

Mississippi has officially had only one documented HABs incident, a *Karenia brevis* bloom which occurred in 1996. Undoubtedly there have been other cases, and there is ample anecdotal evidence of other occurrences. However, this low incidence is largely a function of limited HABs monitoring and reporting systems.

In March 2007, the Mississippi Department of Marine Resources (MDMR) initiated a Marine Biotxin Contingency Plan for all marine and estuarine shellfish growing areas. Under this plan, discrete samples are collected and sent to the Alabama Department of Public Health for identification of potentially harmful phytoplankton species. (See Alabama state sponsored monitoring for methodology.) Additionally MDMR conducts routine monitoring of water and shellfish meats according to National Shellfish Sanitation Program Guidelines.

MDEQ, in collaboration with Dr. Cyndi Moncrief, participated in an EPA funded *Pfiesteria*/HABs monitoring project in 2003 which included phytoplankton sampling at 20 nearshore estuarine sites, MDEQ also conducts ambient water quality monitoring of its coastal waters and routine bacteria and nutrient monitoring of its swimming beaches. These programs provide useful water quality data and accomplish federal mandates, and the data can be used to supplement a HABs monitoring program.

In addition to these routine monitoring programs, a number of Mississippi researchers are involved in HABs related work.

A description of the Mississippi research efforts is provided on the GCOOS website at http://ocean.tamu.edu/GCOOS/Office/documents/HABs/MS_HAB_efforts.pdf.

1.5 Texas

Meridith Byrd, Texas Parks and Wildlife Department, provided the following information

Karenia brevis is the major concern in Texas; there are other blooms but none cause as much problem as *K. brevis*. Monitoring is done for fishery impacts, health concerns, such as the opening/closing of shellfish beds, as well as to give the public an idea of which areas of the coast are being affected and which are free of red tide. During blooms TPWD conducts daily conference calls with other agencies and universities to coordinate monitoring in order to avoid duplication of efforts, i.e. if another agency is collecting water samples in one area, TPWD will collect samples elsewhere. Texas Parks and Wildlife Department (TPWD) works closely with the Texas Department of State Health Services as well as Texas Cooperative Extension, the University of Texas and Texas A&M University. There is an interagency HAB working group that is very active and effective; their goals include facilitating research, response, early detection, and outreach.

1.6 Mexican States

Descriptions of the monitoring programs in Mexican Gulf States, as well as descriptions of monitoring programs in U.S. Gulf States, are included in Battelle (2008).