**EM-14 Assessment of Harmful Algal Blooms (HABs)**

1. Objective(s)

To minimize the human health impacts of harmful algal blooms in the Barataria-Terrebonne Estuarine System

1. To reduce the frequency and intensity of harmful algal blooms within the Barataria-Terrebonne Estuary System (BTES) by supporting best practices of watershed nutrient management.
2. Build partnerships between research scientists and agency resource managers to help prepare for and respond to some harmful algal blooms whose sources can and cannot be managed from within BTES to help reduce threats to marine organisms, human health and economic well-being.
3. Increase public awareness of harmful algal bloom threats to human health and the economic well-being of shellfish and fish industries, in the context of increasing or changing nutrient pollution, climate change, coastal land loss and restoration actions.
4. Background

*Harmful Algal Blooms in Coastal Louisiana*

Harmful algal blooms include those that are dangerous to humans, those that are toxic (poisonous) and those that are very unpleasant, this document uses the term ‘harmful algal blooms’ as the most inclusive term, recognizing that some species vary in the level of toxicity both spatially and temporally. Harmful algal blooms are commonly observed in fresh, brackish, and marine areas of the Louisiana estuaries, including the Barataria-Terrebonne Estuary System (BTES) (Dortch et al. 1999; Bargu et al. 2011; LUMCON 2016; Roy et al. 2016). Harmful algal blooms are not always toxic but may prevent fish from feeding or lead to increased organic loading that supports hypoxia development.

At the fresher end of the estuary (e.g., salinities less than 8 ppt) potentially toxic cyanaobacteria species of *Anabaena, Cylindrospermospsis*, and *Microcystis* are likely to be observed (Ren et al. 2009; Garcia et al. 2010; Riekenberg et al. 2014).

The diatom, *Pseudo-nitzschia* spp., is a concern in the more saline coastal waters (Dortch et al. 1997; Parsons et al. 2013; Bargu et al. 2016) but does occur in the BTES. They have increasingly contributed to the primary production in the surface waters of the northern Gulf of Mexico (Parsons and Dortch 2002; Bargu et al. 2016) and worldwide ([Silver et al. 2010](#_ENREF_29)). They are a concern to living resources, including humans, because they can produce the neurotoxin domoic acid (DA) which is responsible for amnesic shellfish poisoning in humans ([Bates et al. 1989](#_ENREF_2)) and death in marine organisms (Bargu et al. 2016).

A dinoflagellate, *Karenia brevis*, is also a concern as itis widely distributed in the northern Gulf of Mexico and typically associated with neurotoxic shellfish poisoning (Brown et al. 2006), although it is observed less frequently in coastal Louisiana waters, because of lower salinity across the basins. When higher salinity conditions occur due to southerly winds, low river flows, tropical storms or hurricanes, such as in Breton Sound estuary in winter of 2015, they can be abundant, resulting in oyster bed closures. Another *Karenia brevis* bloom occurred in the winter of 1996-1997 within lower salinity waters east of the Mississippi River and with oyster bed closures during a long period of the harvest season (Brown et al. 2006). Even when the numbers of *Karenia* decrease, the toxins may persist.

Other blooms of less frequency do produce toxins and persist for long periods, such as the bloom of *Heterosigna akashawi*, a raphidophyte that produces brevitoxins, in March 2011 (Rabalais unpubl. data). Satellite imagery (N. Walker, Earth Scan Lab, Louisiana State University) clearly showed the intrusion of this bloom into the lower BTES.

Several studies indicate that toxin production from Harmful Algal Blooms (HABs) is higher in lower salinities where the phytoplankton are stressed (Bourdelais et al. 2002; Brown et al. 2006; Bargu et al. 2016).

*Harmful Algal Blooms in the Barataria-Terrebonne Estuary*

In areas of BTE that are more fresh (e.g., salinities less than 8 ppt) and during the spring and summer months when nutrient and temperature water conditions are optimal for growth (Ren et al. 2009), the toxic species of cyanobacteria *Anabaena, Cylindrospermospsis*, and *Microcystis* may be observed at bloom concentrations (Garcia et al. 2010). These different species of cyanobacteria can produce hepatotoxins, neurotoxins, dermatoxins, and endotoxins, which may harm human health directly or be assimilated into the food web via foraging higher trophic levels, such as shellfish, crabs and fish. For example, in Lac des Allemands, some blue crab microcystin toxin levels have exceeded human consumption standards set by the World Health Organization (Garcia et al. 2010). Other benthic grazers that use these low salinity habitats, such as the recreational and commercially important species of blue catfish, flathead catfish, and white shrimp may also be impacted by these toxins. Best practices of watershed nutrient management would help reduce the frequency and intensity of these phytoplankton blooms and reduce vulnerability of humans and fisheries to the phytoplankton produced toxins.

At salinities greater than 15 ppt, the neurotoxin producing diatom, *Pseudo-nitzschia* spp., is of concern (Dortch et al. 1997; Parsons et al. 2013; Bargu et al. 2016). *Pseudo-nitzschia* spp. collected in Louisiana coastal waters and estuaries are commonly observed year round but most abundant in the spring (Del Rio et al. 2010; Parsons et al. 2013; Bargu et al. 2016). Detectable demoic acid concentrations have been documented in BTES, such as in the estuarine and coastal Louisiana water samples (Parsons et al. 1999; Bargu et al. 2016) and gulf menhaden ([Del Rio et al. 2010](#_ENREF_12)). Overall, few studies (e.g., N. Rabalais, unpublished data) have characterized the phytoplankton communities and related toxins along a salinity gradient in BTES.

In summary, building partnerships between research scientists and agencies to prepare and respond to these blooms is critical. An increase in public awareness and understanding of harmful algal bloom dynamics would also help address the future threats to human health and the economic well-being of shellfish and fish industries (Smith et al. 2014), especially in the face of nutrient pollution, climate change, coastal land loss and restoration actions.

1. SHORT description of how the action will be done
2. Implementation of Best Management Practices (BMPs) in Watersheds of BTES:
-promote spatial analysis of the occurrences of harmful algal blooms and local watershed sources of nutrients and implementation of BMPs
3. Promote minimization of human impacts from Harmful algal Bloom events:
Recommend including the following in the existing response system through -LDEQ incident investigation and reporting, and LDH beach monitoring program:
-develop a protocol among phytoplankton (HAB) experts and Louisiana and federal agencies for proper collection, storage and transfer of samples of suspected HABs, not just for incidents, but for routine sampling
-updated key expert contacts in Louisiana and along the Gulf coast
-location of sample analysis facilities for different algal toxins
-safe and appropriate sampling protocols for the most likely bloom species
-maintain a system for community members to lodge a notification of suspected harmful algal blooms
4. Public awareness and understanding:
-Promote an informational network of scientists and managers on harmful algal issues within coastal Louisiana
- Promote a common webpage for essential informational resources and key contacts
- Promote core information on different species that can be used at educational events, during non blooms and during blooms (safe seafood handling) to increase awareness
5. Location where the action will take place

This action applies to the entire Barataria - Terrebonne estuary watershed

1. Lead agency or entity responsible for implementing action
2. Implementation of Best Management Practices in Watersheds of BTES:
-Louisiana Department of Agriculture and Forestry
-Louisiana Department of Environmental Quality
-Natural Resources Conservation Service
-Environmental Protection Agency
-Barataria-Terrebonne National Estuary Program
3. Preparedness to minimize human impact from Toxic or Harmful algal Bloom event:
-Louisiana Department of Agriculture and Forestry
-Louisiana Department of Health
-Louisiana Department of Environmental Quality incident responders
-Louisiana Department of Wildlife and Fisheries
-US Department of Agriculture,, Food and Drug Administration
4. Public awareness and understanding:
-Barataria-Terrebonne National Estuary Program
-Louisiana Department of Agriculture and Forestry
-Louisiana Department of Health
-Louisiana Department of Environmental Quality
-Louisiana Environmental Education Commission,
-Louisiana Department of Wildlife & Fisheries
-Louisiana Universities Marine Consortium
-The Water Institute of the Gulf
-Louisiana Department of Education
-Louisiana Sea Grant College Program
-U.S. Environmental Protection Agency /National Environment Programs/Gulf of Mexico Program/Gulf of Mexico Alliance-Private aquariums along gulf coast (e.g., Audubon)
5. Timelines and/or milestones
6. Implementation of Best Management Practices in Watersheds of BTES:
-as per relevant timelines for watershed management with relevant agencies; ongoing.
7. Preparedness to minimize human impact from Toxic or Harmful algal Bloom event:
-through available opportunities and synergistic activities
-establish network of scientists and agencies in Louisiana
-collate base knowledge and develop key messages
-develop core web materials for dissemination
8. Public awareness and understanding:
-through available opportunities and synergistic activities
-establish network among citizens, agencies and environmental education resources
-collate base knowledge and develop key messages
-develop core web materials for dissemination
9. Possible Range of Costs and Sources of Funding
10. Implementation of Best Management Practices in Watersheds of BTES:
-EPA funds through LDEQ for nutrient reduction strategies/ BMPs
-CPRA nutrient reduction strategies using coastal restorations strategies
-Louisiana Department of Agriculture and Forestry
-Louisiana Department of Environmental Quality
-Louisiana Department of Health–
11. Preparedness to minimize human impact from Toxic or Harmful algal Bloom event:
-Louisiana Department of Environmental Quality
- NOAA
-Louisiana Seagrant
- Louisiana Department of Health
-GOMA – Priority issue team
12. Public awareness and understanding:
-Louisiana Department of Environmental Quality
-National Oceanic and Atmospheric Administration-Louisiana SeaGrant
-Louisiana Department of Health
-Barataria-Terrebonne National Estuary Program
-Restore Act funds
-Gulf of Mexico Alliance – Priority issue team
-Gulf of Mexico Program USEPA

H. Performance measures

a. Possible data gathered

-identify taxonomic and toxin experts
-number of experts engaged in an advisory capacity in the panel of experts
-number of web pages developed, and number of times updated
-number of fliers, brochures, informational advisory outputs developed
-number of community submissions/reports of potential harmful algal bloom events
-spatial analysis system - mapping reports of HABs
-NOAA – National Estuarine Eutrophication Assessment
-reporting of events to the national HAB reporting system (Louisiana Universities Marine Consortium)

b. Monitoring
i. Parties responsible
-central host of materials and web page

ii. Timetable for gathering data
-annual data summary (collected regularly on web page)

iii. How data are shared
-summarized on the web page and in public communications using the information collated through this mechanism

iv. Possible data gaps (This includes research needs/knowledge gaps)

-basic data on current occurrence and abundance of harmful algal bloom species within BTES.
-environmental factors controlling toxicity of harmful algal bloom species known to occur within BTES
-predictions of possible future threat from harmful algal blooms under increasing water temperature, increasing nutrient concentrations, and alterations to salinity with restoration actions.

v. If additional funding is needed

-dedicated agency funds for monitoring, assessing, and informing the public.
-there are significant knowledge gaps in the science of harmful algal blooms within coastal Louisiana as, historically, they have not resulted in large numbers of reports of human health impacts. Increasing water temperatures, increasing nutrient loading and altered sources of fresh water within BTES all have the potential to alter the risk to human health of harmful algal blooms. For these reasons, additional funding to increase knowledge of potential future human health risk is needed.
-raising public awareness through effective communication of current knowledge would benefit greatly from some additional funds to support this effort.

**Literature Cited**

Bargu, Sibel, Melissa M. Baustian, Nancy N. Rabalais, Ross Del Rio, Benjamin Von Korff, and R. Eugene Turner. 2016. “Influence of the Mississippi River on *Pseudo-Nitzschia* Spp. Abundance and Toxicity in Louisiana Coastal Waters.” *Estuaries and Coasts* 39 (5): 1345–56. doi:10.1007/s12237-016-0088-y.

Bargu, Sibel, John R. White, Chunyan Li, Jessica Czubakowski, and Robinson W. Fulweiler. 2011. “Effects of Freshwater Input on Nutrient Loading, Phytoplankton Biomass, and Cyanotoxin Production in an Oligohaline Estuarine Lake.” *Hydrobiologia* 661 (1): 377–89. doi:10.1007/s10750-010-0545-8.

Bourdelais, A.J., C. R. Tomas, J. Naar, J. Kubanek, and D.G. Baden. 2002. New fish-killing alga in coastal Delaware produces neurotoxins. *Environmental Health Perspectives* 110: 465-470.

Brown, A.F.M., Q. Dortch, F.M. Van Dolah, T.A. Leighfield, W. Morrison, A.E. Thessen, K. Steidinger, B. Richardson, C.A. Moncreiff, and J.R. Pennock. 2006. “Effect of Salinity on the Distribution, Growth, and Toxicity of Karenia Spp.” *Harmful Algae* 5: 199–212.

Del Rio, Ross, Sibel Bargu, Donald Baltz, Spencer Fire, Gary Peterson, and Zhihong Wang. 2010. “Gulf Menhaden (*Brevoortia Patronus*): A Potential Vector of Domoic Acid in Coastal Louisiana Food Webs.” *Harmful Algae* 10 (1): 19–29. doi:10.1016/j.hal.2010.05.006.

Dortch, Q., Parsons, M.L., Rabalais, N.N., and Turner, R.E. 1999. “What Is the Threat of Harmful Algal Blooms in Louisiana Coastal Waters?” In *Recent Research in Coastal Louisiana: Natural System Function and Response to Human Influences.*, edited by L.P. Rozas, J.A. Nyman, C.E. Proffitt, N.N. Rabalais, D.J. Reed, and R.E. Turner, 134–44. Baton Rouge, LA: Louisiana Sea Grant College Program.

Dortch, Q., R. Robichaux, S. Pool, D. Milsted, G. Mire, N. N. Rabalais, T. M. Soniat, G. A. Fryxell, R. E. Turner, and Michael L. Parsons. 1997. “Abundance and Vertical Flux of *Pseudo-Nitzschia* in the Northern Gulf of Mexico.” *Marine Ecology Progress Series* 146: 249–264.

Garcia, Ana C., Sibel Bargu, Padmanava Dash, Nancy N. Rabalais, Malinda Sutor, Wendy Morrison, and Nan D. Walker. 2010. “Evaluating the Potential Risk of Microcystins to Blue Crab (*Callinectes Sapidus*) Fisheries and Human Health in a Eutrophic Estuary.” *Harmful Algae* 9 (2): 134–43. doi:10.1016/j.hal.2009.08.011.

LUMCON. 2016. “Guide to Phytoplankton (Including Harmful Algae) from Louisiana Estuarine and Coastal Waters.” http://phytoplanktonguide.lumcon.edu/.

Parsons, Michael L., and Quay Dortch. 2002. “Sedimentological Evidence of an Increase in *Pseudo-Nitzschia* (Bacillariophyceae) Abundance in Response to Coastal Eutrophication.” *Limnology and Oceanography* 47 (2): 551–58. doi:10.4319/lo.2002.47.2.0551.

Parsons, Michael L., Quay Dortch, and Gregory J. Doucette. 2013. “An Assessment of *Pseudo-Nitzschia* Population Dynamics and Domoic Acid Production in Coastal Louisiana.” *Harmful Algae* 30 (December): 65–77. doi:10.1016/j.hal.2013.09.001.

Parsons, Michael L., Christopher A. Scholin, Peter E. Miller, Gregory J. Doucette, Christine L. Powell, Greta A. Fryxell, Quay Dortch, and Thomas M. Soniat. 1999. “*Pseudo-Nitzschia* Species (BacIillariophyceae) in Louisiana Coastal Waters: Molecular Field Trials, Genetic Variability, and Domoic Acid Analyses.” *Journal of Phycology* 35 (6): 1368–1378.

Ren, Ling, Nancy N. Rabalais, R. Eugene Turner, Wendy Morrison, and Warren Mendenhall. 2009. “Nutrient Limitation on Phytoplankton Growth in the Upper Barataria Basin, Louisiana: Microcosm Bioassays.” *Estuaries and Coasts* 32 (5): 958–74. doi:10.1007/s12237-009-9174-8.

Riekenberg, Jessica, Sibel Bargu, and Robert Twilley. 2014. “Phytoplankton Community Shifts and Harmful Algae Presence in a Diversion Influenced Estuary.” *Estuaries and Coasts*, December. doi:10.1007/s12237-014-9925-z.

Roy, Eric D., Emily A. Smith, Sibel Bargu, and John R. White. 2016. “Will Mississippi River Diversions Designed for Coastal Restoration Cause Harmful Algal Blooms?” *Ecological Engineering* 91 (June): 350–64. doi:10.1016/j.ecoleng.2016.02.030.

Smith, Emily A., Pamela B. Blanchard, and Sibel Bargu. 2014. “Education and Public Outreach Concerning Freshwater Harmful Algal Blooms in Southern Louisiana.” *Harmful Algae* 35 (May): 38–45. doi:10.1016/j.hal.2014.03.008.