Gulf of Mexico Alliance, Action Plan II

Water Quality Priority Issue Team

Current and future challenges and how the Gulf of Mexico Alliance can help

- As is true everywhere, water is the basis of life in the Gulf of Mexico and along its coast. The condition of that water is one of the major factors controlling the health of human and natural communities in and around the Gulf. The economies of the five Gulf States are substantially dependent on productive natural communities.
- The Water Quality Team has identified four priority areas important to Gulf States: (1) reducing the risk of exposure to disease-causing pathogens in estuarine and coastal waters; (2) minimizing effects from and control of harmful algal blooms; (3) identifying the sources and pathways by which mercury finds its way into the Gulf fish we consume; and (4) improving monitoring of Gulf water resources to provide the information by which to best manage them. These wide-spread, far-reaching problems are best addressed through regional-scale efforts such as the Gulf of Mexico Alliance.
- The risk of exposure to disease-causing pathogens in coastal waters is a problem shared among all Gulf States. Improving the ability to accurately identify where such risks exist as well as the source of the pathogens causing those risks is greatly needed. This knowledge will allow appropriate actions to prevent exposure and steps to remove the sources of contamination.
- Harmful algal blooms cause closures of beaches and fisheries and can devastate large areas of natural resources, causing economic hardship for coastal economies. The frequency, duration, and size of areas that are influenced by blooms are on the rise. Reducing or eliminating blooms and bloom effects requires better understanding of the factors causing and controlling their existence as well as the persistence of toxicity following a bloom. Achieving this understanding and minimizing effects of blooms until control can be achieved requires improved detection, tracking, and forecasting of blooms.
- Mercury is increasingly finding its way into fish, and its presence has become common in many of those of the Gulf of Mexico. This has led federal and state health agencies to announce fish-consumption advisories for many Gulf commercial fishery species. The potential sources and pathways by which mercury finds its way into Gulf fisheries do not respect political boundaries. A regional Gulf-wide research and monitoring effort is a critical first step towards understanding the main sources of the mercury we find in our seafood.

- Understanding these and other regional water resource problems calls for developing a framework for a Gulf-wide network that knits existing monitoring programs into an integrated whole. Such a network could provide accurate detection and forecasts of harmful algal blooms and pathogens, possibly revealing underlying information by which to follow mercury movements through the food chain. Such monitoring when combined with research may also provide the information necessary for understanding the causes of these and other problems. A Gulf-wide monitoring network could further provide information by which programs that reduce or eliminate the problems can be designed and implemented and their successes tracked. For example, coastal nutrient criteria are an urgent need for all five Gulf States. An integrated monitoring network could both provide the data on which to base these criteria as well as assess improvements resulting from steps taken by the Gulf States to meet those criteria.
- Existing monitoring programs across the Gulf of Mexico often use different methods. While these methods are generally suitable for the needs of the program carrying out the monitoring, the ability to compare and combine data collected by them is limited. The Gulf of Mexico Alliance is working to achieve data comparability and to create a Gulf of Mexico-wide integrated monitoring system. Data from this effort will: (1) identify areas in need of remediation; (2) feed models needed for forecasting harmful algal blooms and pathogen risk; and (3) allow assessment of water quality health and changes over time.

Long-term alliance partnership goals

- Establish near-real-time pathogen monitoring that helps identify the source of the pathogens in Gulf coastal and estuarine waters and their potential impact on human-health and the coastal economy.
- Establish a harmful algal bloom detection, tracking, and forecasting system based on the monitoring network described in the bullet below. Resulting information can then be used by coastal managers to help minimize the effects from blooms and support attempts to reduce or eliminate blooms.
- Substantially reduce the potential risk of mercury-induced health effects from consuming Gulf of Mexico seafood.
- Establish the framework for a cooperative and integrated monitoring network for estuarine, coastal, and offshore waters. The framework will identify multiple objectives for the network that include providing information on the status and trends of ecosystem health in the Gulf of Mexico.

WQ-1: Ensure healthy beaches and shellfish beds. Provide coastal managers and decision makers with better means to make decisions that benefit public health and the coastal economy by improving understanding of the sources and survival in coastal waters of the organisms causing disease in humans.

An improved understanding of the sources and survivability of human pathogens and their indicators in the environment is necessary in order to create improved detection and tracking methods and to provide coastal managers with information that can be used to make management decisions most beneficial to the public and the coastal economy.

Economics:

- Reduced health costs
- Increased 'beach days'
- Reduce loss of closure-induced seafood revenues

Headlines:

- Public health better protected by new waterborne disease-detection methods.
- Technology advancements improve swimmer safety.
- Shellfish harvest areas expanding as water quality improves.

Results at the end of five years:

- Workshops were carried out on pathogen detection and indicators to provide guidance for research.
- New methods are available to assess the source of pathogens or their indicators (human vs. animal) and to allow human-health risk to be better determined.
- Survivability of pathogens and current indicator organisms in ambient waters has been assessed.
- One pollution source-tracking pilot study has been carried out in each state at a beach with bacterial-contamination problems.
- Models that incorporate seasonal and geographic distributions are available to predict when pathogen concentrations generally exceed regulatory criteria.
- A data portal is available that contains current water-quality data from all Gulf States' beach-monitoring programs.
- Areas of high-risk are identified for exceeding microbial pollution standards and areas of documented (303(d) listed) impairment are mapped.

- Information on the distribution of *Vibrio* species is available to better assess risk to human health.

Who will lead and support this action: see Activities Matrix

Why do this?

- To identify the most effective health protection methods against pathogen contamination and make them available to the Gulf States' programs.
- To allow for robust risk-assessment approaches to identifying human health risk that would provide proactive rather than reactive health-management decisions.
- Appropriate information must be available to allow coastal managers to employ 'best management practices' for protecting public health at beaches and ensuring a robust economy.
- To reduce the number of *Vibrio*-related deaths and illnesses through a better understanding of the incidence of *Vibrio*-caused disease and the factors affecting the distribution of *Vibrio* species in the Gulf of Mexico.

Action Steps:

WQ-1.1: Recognizing that the Gulf of Mexico has region specific conditions, develop new and improved methods to identify the coastal waters and beaches that are impaired by pathogens and to track the sources of these disease-causing organisms.

Gulf coastal waters and beaches are experiencing closures and warnings as a result of the presence of disease-causing organisms or their indicators. Better tools to determine the areas where human-health risks exist and to track the sources of the contamination are needed.

Action Items:

WQ-1.1.1 Communicate to EPA need for increased consideration of factors specific to Gulf of Mexico in the development of revised recreational criteria guidance: a) sub-tropical bacterial ecology, b) environmental parameters (such as high organic loading, turbidity, temperature and salinity range, year-round use, rainfall, large areas of low human disturbance), and c) land use.

Task 1 Conduct a pertinent literature collection to support creating a position paper.

Task 2 Review how EPA is assessing their peer-reviewed research results to see how it addresses Gulf of Mexico specific concerns.

Task 3 Create position paper expressing the concern that methods and their associations to health outcomes be applicable in Gulf of Mexico's temperate and sub-tropical waters.

WQ-1.1.2 Compile and compare existing Gulf States' programs in estuarine and marine water that use pathogens and indicators and provide information to States. Include shellfish program data if possible.

Task 1a Update state program info compiled by EPA GMPO after 2006 GOMA workshop.

Task 1b Encourage holding a unified conference call of Gulf of Mexico BEACH coordinators (both Region IV and VI) as means to update info in existing document. Build on information in Monitoring Programs Catalog.

Task 2 Use GOMA Monitoring Forum breakout groups for annual updates.

Task 3 GOMA workgroup drafts comparison document, developing points of comparison between state microbial water quality programs.

Task 4 Investigate how best to collect useful information from states about shellfish programs.

WQ-1.1.3 Identify any novel and recent research methods suitable for laboratory and field trials.

Task 1 Conduct targeted workshops to identify novel and recent research methods on pathogen detection and indicators.

Task 2 First one conducted February 2009 and combined with GOMP-grant researcher workshop.

WQ-1.1.4 Develop good candidates from 1.1.3 into standard tools and for validation by relevant agencies.

Task 1 Create framework by which to devise assessment criteria for when to recommend converting research methods to standard tools.

Task 2 Devise assessment criteria for when to recommend converting research methods that are potentially suitable for microbial source tracking into standard tools.

Task 3 Devise assessment criteria for when to recommend converting research methods that are potentially suitable for rapidly determining when to open shellfish beds into standard tools.

Task 4 Devise assessment criteria for when to recommend converting research methods that are potentially suitable for establishing beach advisories into standard tools.

Task 5 Devise assessment criteria for when to recommend converting research methods that are potentially suitable for determination of Impaired Waters into standard tools.

Task 6 Devise assessment criteria for when to recommend converting research methods that are potentially suitable for use in NPDES point source evaluation into standard tools.

Task 7 Evaluate methods identified in 1.1.3 using assessment criteria developed above and recommend good candidates for use as standard water quality tools.

Task 8 Conduct field trial of recommended methods to confirm suitability for technology transfer.

Task 9 Identify mechanisms of technology transfer so that methods identified above can be implemented.

WQ-1.1.5 Evaluate studies on real-time and rapid detection methods (e.g., EPA National Epidemiological & Environmental Assessment of Recreation Water studies, etc.) for potential utility and approval by EPA.

Task 1 Hold workshop on state of science of rapid-detection methods. Use assessment criteria in 1.1.4 to evaluate existing methods.

WQ-1.2: Improve the understanding of which pathogens constitute risks to human health in Gulf coastal waters.

The common indicators presently used to determine whether coastal waters and beaches constitute a risk to human health have proven more effective in northern fresh waters than in southern salt waters. States and communities need coastal tools to distinguish those

organisms and indicators showing a risk to human health from those that do not. Better understanding of disease-causing organisms will help with accurate determinations on whether or not to close coastal swimming areas or shellfish harvesting areas.

Action Items:

WQ-1.2.1 Assess the survivability of non-*Vibrio* pathogens and current indicator organisms in the environment by carrying out regrowth and persistence studies.

Task 1 Conduct a literature review and evaluate results concerning the viability of waterborne pathogens and fecal indicators in both the water column and sediments. (Can sediments harbor viable pathogens and fecal indicator populations for extended periods that result in exceedances in the watercolumn?).

Task 2 Perform gap analysis for missing survivability data.

Task 3 Conduct research to fill information gaps.

Task 4 Present research results at applicable conferences.

Task 5 Draft GOMA paper on persistence of pathogens and indicators in Gulf of Mexico conditions.

WQ-1.2.2 Evaluate persistence of molecular targets and their relationship to infectivity.

Task 1 Conduct a literature review on persistence of molecular targets and their relationship to infectivity.

Task 2 Perform gap analysis for missing persistence and infectivity data.

Task 3 Conduct research to fill information gaps.

Task 4 Present research results at applicable conferences.

Task 5 Draft GOMA paper on persistence of molecular targets and their relationship to infectivity in Gulf of Mexico conditions.

WQ-1.2.3 Build on workshop described in WQ-1.1.3 by holding at least one microbial source tracking pilot project in each state. At least one in each state should be at a beach that has been determined to be impaired for water quality.

Task 1 Select methods building on field trials of EPA GMPO grant-funded MST research.

Task 2 Identify candidate sites in each state.

Task 3 Conduct pilot studies.

Task 4 Prepare report comparing results across five states.

WQ-1.2.4 Recommend epidemiological studies that address GOM regional conditions to determine risk to human-health by exposure to human/animal pollution sources.

Task 1 Identify gaps in existing and planned epi studies.

Task 2 Draft GOMA position paper recommending additional epi studies to target gaps.

WQ-1.3: Provide coastal managers with information to make better informed health and resource management decisions.

Decisions that both protect human health and improve resource-management can be improved by rapid delivery of accurate information as to the microbial conditions of Gulf coastal and estuarine waters.

Action Items:

WQ-1.3.1 Compare implementation of microbiological standards for surface water quality (including beach and shellfish growing waters) in Gulf states to help compare and contrast approaches.

Task 1 Compile list of implementation strategies from each state. Include county and local government aspects.

WQ-1.3.2 Develop tools that address seasonal, climatological, and geographic distributions in the Gulf of Mexico to improve prediction of pathogen indicator exceedances in support of better management decisions.

Task 1 Develop assessment criteria for applicability of modeling tools identified in Task 2.

Task 2 Hold workshop: assemble modelers of appropriate types to create approach for GOMA to pursue for improving predictions [e.g.; risk assessment modelers, beach modelers, QMRA; include both present pathogen modelers and those who are involved in similar modeling, e.g., eco risk assessment, human health risk assessment, toxicity risk assessment].

Task 3 Identify mechanisms to implement modeling tools relating to Task 2 above.

Task 4 *Draft improved language:* "Implement modeling tools using means identified in Task 3 above for tools identified in Task 2 and selected using assessment criteria from Task 1."

WQ-1.3.3 Ease access to state's BEACH water-quality data.

Task 1 Add a link on the GOMA public site for accessing each state's data.

WQ-1.3.4. Map areas in coastal waters that have been identified as impaired (i.e., impaired per Section 303(d) of the Clean Water Act) for microbial pollution for use in reporting on Gulf-wide trends and for selection of study sites and pilot projects.

Task 1 Compile the list from each state and create map.

Task 2 Make available on the GOMA website.

WQ-1.4: Work with universities and Gulf health agencies to better understand *Vibrio* bacteria ecology, health risks, and research needs.

Vibrio bacteria species are found in the waters of different areas along the Gulf. Each year there are multiple deaths and injuries resulting from *Vibrio* infections acquired from wounds or eating shellfish.

Action Items:

WQ-1.4.1 Conduct a literature review including Center for Disease Control data to determine recent trends in incidence of vibriosis.

Task 1 Write literature review/summary.

Task 2 Make a summary available on the public website.

Task 3 Make a press release that includes inviting *Vibrio* interests to make a link.

WQ-1.4.2 Assess the status of *Vibrio* research applicable to the Gulf of Mexico.

Task 1 Hold workshop to identify state of the science, identify gaps, and establish potential collaborations.

WQ-1.4.3 Determine causes of differences in virulence among different strains of *Vibrio vulnificus*.

Task 1 Characterize clinical isolates for virulence factors and compare with environmental isolates from Gulf recreation and shellfish harvesting waters and seafood.

WQ-1.4.4 Obtain data and provide an analysis of temperature, salinity, and related environmental factors that could help predict seafood and recreational health risks from *Vibrio* species.

Task 1 Obtain preliminary data related to environmental factors that could help predict public health risk from ingesting seafood contaminated by *Vibrio vulnificus* and identify data gaps.

Task 2 Conduct studies to provide missing data.

Task 3 Analyze available data to identify the environmental factors that help predict risk.

Task 4 Obtain preliminary information related to environmental factors that could help predict public health risk from wound infections resulting from exposure to coastal waters containing *Vibrio vulnificus* and identify data gaps.

Task 5 Conduct studies to provide missing data.

Task 6 Analyze available data to identify the environmental factors that help predict risk.

Task 7 Obtain preliminary information related to environmental factors that could help predict public health risk from ingesting seafood contaminated by ***Vibrio parahaemolyticus*** and identify data gaps.

Task 8 Conduct studies to provide missing data.

Task 9 Analyze available data to identify the environmental factors that help predict risk.

Task 10 Publish all the data in one place in peer reviewed paper or journal chapter or report.

WQ-1.4.5 Obtain data and provide seasonal and geographic distributions for different *Vibrio* species and assess potential reasons for any differences.

Task 1 Obtain preliminary information related to seasonal and geographic distributions in water and seafood for *Vibrio vulnificus* and assess potential reasons for any differences.

Task 2 Obtain preliminary information related to seasonal and geographic distributions in water and seafood for ***Vibrio parahaemolyticus*** and assess potential reasons for any differences.

Task 3 Publish all the data in one place in peer reviewed paper or journal chapter or report.

WQ-1.4.6 Use knowledge gained to enable *Vibrio* forecasting.

Task 1 Hold workshop to assess results from *Vibrio* work in APII and prepare plan for developing models and forecasting in Action Plan III.

WQ-2: Reduce impacts of Harmful Algal Blooms (HABs). Reduce effects on human health and coastal economies by improving the ability to predict, detect, track, and forecast the movement and effects of harmful algal blooms in waters along the Gulf coast.

Developing forecasting capabilities and better understanding of what environmental and human-induced factors cause harmful algal species to bloom and dissipate can help to reduce the effects of harmful algal blooms on human and natural resources health and minimize impacts to the coastal economy.

Economic factors:

- Tourism
- Fisheries
  - Public health
- Headlines:
- Improved treatment of red-tide induced asthma attacks results in dramatic healthcare cost savings.
- Harmful algal frequency declines drastically over last three years.
- GOMA website saves Labor Day. Labor Day beach-crowds boom as Gulf Beaches website provides confidence that red tide bloom has left area.
- Improved accuracy of harmful algal bloom forecast helps coastal managers reduce effects of blooms.
- Harmful algal bloom warning system saves millions $ in fishery and tourism losses.
- Early warning system protects swimmers and seafood lovers.

Results at the end of five years:

- Human health impacts from harmful algal blooms are better understood.
- Methods and technologies being used for harmful algal bloom species and toxin detection have been evaluated and standardized.
- Researchers and managers have access to standardized protocols and an understanding of how to use new technologies to detect, characterize, and forecast harmful algal blooms. A framework for a harmful algal bloom monitoring network has been developed. Active collaboration is taking place with Mexican states in regards to harmful algal bloom prediction, detection, and tracking.
- An operational web-based discussion board is in place for public communications and for managerial communications.

- Training is provided to help coastal managers use their resources efficiently to minimize bloom effects.
- Tools are available for state epidemiology units to assess harmful algal bloom effects.
- Methods are available that help prevent, control, or mitigate harmful algal blooms.
- The significance of ballast-water introductions of new harmful algal bloom species into the Gulf of Mexico and transfers of existing bloom species within the Gulf is better understood.

Who will lead and support this action: see Activities Matrix

Why do this?

- To better understand the ecology of harmful algal bloom species so that management strategies can be developed and implemented to reduce the human and environmental impacts of blooms.
- To minimize harmful algal bloom impacts (e.g., beach and shellfish bed closures, fish kills) to coastal recreation and ecosystems.
- Present technologies are expensive and are generally not suitable for long-term deployment to provide real-time data for an early-warning and forecasting system.
- Existing monitoring networks need greater coverage to provide information necessary to adequately detect, track, and forecast blooms for the entire Gulf coast.
- To improve responses to bloom events by sharing knowledge and understanding and providing necessary information to appropriate decision makers.
- Reducing bloom frequency and extent would minimize harmful algal bloom effects on human and natural resource health and the environment.

Action Steps:

WQ-2.1: Provide decision-making information regarding HAB ecology and toxicity to coastal managers.

Many different harmful algal bloom species occur in the Gulf of Mexico and each species differs greatly in their ecology, their toxins, and potential human and environmental impacts. This action item examines environmental and other factors influencing ecology and toxins of each of the major HAB species in the Gulf to provide managers with the data needed to better monitor blooms and their impacts.

Action Items:

WQ-2.1.1 Examine the relationship between harmful algal blooms (*Karenia brevis, Karenia mikimotoi, Ciguatera* spp., *Dinophysis, Pseudo-nitzschia, Pyrodinium, Karlodinium*) and the regional or local environmental conditions that contribute to bloom occurrence.

Task 1 Inventory HAB monitoring data in each state.

Task 2 Identify suitable host and platform for data storage.

Task 3 Compile relevant data for analysis.

Task 4 Analyze data for environmental correlates of bloom dynamics.

Task 5 Hold workshop to identify key questions for hypothesis testing of environmental linkages identified by Task 4, including the relationship between human activities, land use, and HABs.

WQ-2.1.2 Collect information to help determine the environmental controls and influences on harmful algal bloom toxin production, routes of toxin transfer, and persistence in coastal environments.

Task 1 Standardize single method for toxin sampling applicable to at least 3 of the main genera listed in 2.1.1.

Task 2 Identify phytoplankton sample programs for toxin sampling**.**

Task 3 Identify population thresholds that trigger analysis of toxins.

Task 4 Identify existing standardized matrix-specific (e.g., water, sediments, tissues) and toxin-specific (e.g., metabolites, biomarkers) methods for the main genera listed in 2.1.1.

Task 5 Establish list of methods (regulatory-approved and other standard methods) for use in GOMA toxin sampling and analysis efforts.

Task 6 Create standardized matrix-specific and toxin-specific methods where none exist.

Task 7 Identify cost of adding toxin sampling and of analyzing samples.

Task 8 Determine sampling design and collect toxin samples in conjunction with routine sampling programs and analyze when populations reach threshold.

Task 9 Standardize approach for assessing transfer vectors.

Task 10 During and after harmful algal blooms, measure toxin concentrations in potential vectors.

Task 11 Determine toxin persistence in commercial shellfish species.

Task 12 Assess toxin persistence in water and sediments.

WQ-2.1.3 Standardize data and improve data comparability.

Task 1 Standardize data formats for reporting information on at least the five main HABs (not including the *Karenia* species).

Task 2 Standardize the timely compilation and communication of observational data.

Task 3 Standardize formats for transmitting data (e.g., harmful algal bloom presence, distribution, intensity and toxicity) between forecasting entities.

Task 4 Conduct laboratory proficiency testing for toxin analysis.

WQ-2.1.4 Initiate development of forecasting tools for harmful algal blooms and their effects.

Task 1 Identify forecast needs of the end-users.

Task 2 Identify pertinent information and data needed to develop forecasting tools that address end-user needs.

Task 3 Initiate development of forecast capabilities for HABs.

Task 4 Identify effective means for communicating these products to environmental and health managers.

WQ-2.1.5 Determine how to better identify and document the economic effects of harmful algal blooms.

Task 1 Perform literature search for existing methods.

Task 2 Identify the data required to document economic effects of HABs. Include at least fisheries, recreation and tourism, public health, monitoring, and management.

Task 3 Draft recommendations for documenting economic effects of HABs.

WQ-2.1.6 Identify and/or create effective means to improve communication on harmful algal blooms.

Task 1 Hold workshop to identify and/or create means for effective communication with non-technical audiences.

Task 2 Hold workshop to identify and/or create means for effective communication with managerial and other technical audiences.

WQ-2.1.7 Provide periodic harmful algal bloom education to coastal managers to maintain state-of-the science knowledge.

Task 1 Identify venues for educating the range of managers.

Task 2 HABs workgroup semi-annually identifies need for communicating new information to appropriate target manager audience.

Task 3 Disseminate new information to appropriate target managers through venues identified in Task 1.

WQ-2.1.8 Enhance the value of data from Harmful Algal Bloom-related Illness Surveillance System (HABISS) and Harmful Algal Bloom Integrated Ocean Observing System (HABIOS) for public health decision making.

Task 1 Create data packages from HABISS and HABIOS data that can be used to support public health decision-making.

Task 2 Use data from HABIOS and HABISS for a pilot study in Florida to create manager-response models to train managers.

Task 3 Use the outcome of training models to modify the data packages derived from HABISS and HABIOS.

WQ-2.2: Improve the capabilities of Gulf-wide HAB monitoring networks to support HAB detection and tracking.

Improvements and innovations in harmful algal bloom cell and toxin detection technologies are occurring rapidly. Effective transitioning of these improvements to management and public use requires Gulf-wide standardization and integration of methods into existing and developing Gulf-wide monitoring networks and observing systems.

Action Items:

WQ-2.2.1 Improve spatial and temporal resolution and the sensitivity, accuracy, and precision of methods and technologies for detection of harmful algal bloom species and/or their toxins.

Task 1 Identify methodologies suitable for developing operational *in situ* harmful algal bloom and harmful algal bloom toxin sensors.

Task 2 Improve detection resolution for harmful algal bloom technologies where needed to meet the needs of end users.

Task 3 Promote the testing and production of harmful algal bloom detection technologies capable of detecting multiple species and toxins.

Task 4 Identify the harmful algal bloom related methodologies and monitoring protocols for the priority species identified in 2.1.1 that need to be standardized in the Gulf.

Task 5 Standardize across the Gulf the harmful algal bloom related methodologies and monitoring protocols for the priority species identified in 2.1.1.

Task 6 Conduct harmful algal bloom training with curricula including standardized monitoring protocols, methodology for *in situ* sensors, field collection, laboratory analyses, and taxonomy training (including microscopic identification of harmful algal bloom species, the 'gold-standard' for cell detection technologies).

WQ-2.2.2 Facilitate completion of the HABIOS monitoring network design and its implementation.

Task 1 Integrate HABIOS network with the coastal monitoring networks, Integrated Ocean Observing System (IOOS), Harmful Algal Blooms Observing System (HABSOS), and Gulf of Mexico Coastal Ocean Observing System (GCOOS).

Task 2 Provide information to HABIOS system designers so that the system will provide forecasts that are useful to coastal managers at appropriate spatial and temporal scales.

WQ-2.2.3 Increase collaboration with Mexican states to improve harmful algal bloom forecasting capabilities in the Gulf of Mexico.

Task 1 Encourage harmful algal bloom monitoring infrastructure in Mexican coastal waters.

Task 2 Exchange methods for development of a volunteer network for harmful algal bloom monitoring purposes with the Mexican Gulf states.

Task 3 Support training workshops on harmful algal bloom taxonomy and detection technologies.

Task 4 Develop methods to improve Mexican-U.S. harmful algal bloom communications.

WQ-2.3: Determine the significance of ballast water introduction and transfer of native and invasive HAB species in the Gulf of Mexico.

Many harmful algal bloom species are experiencing an increase in their global distribution. Gulf of Mexico estuarine and coastal environments are potentially susceptible to the introduction of non-native and invasive HAB species via introduction from ballast waters and the significance of this potential introduction route is unknown. This action item aims to improve understanding of HAB transport pathways and implement measures to prevent HAB expansion in the Gulf.

Action Items:

WQ-2.3.1 Develop and standardize protocols for sampling ballast waters and detecting potentially invasive harmful algal bloom species in the Gulf region.

Task 1 Compile information on ballast sampling methods.

Task 2 Hold workshop to establish state-of-the-art in ballast sampling and agree on standard sampling methods and necessary training.

WQ-2.3.2 Identify potential high-risk introduction and transfer mechanisms.

Task 1 Compile information on identifying high risk HAB introduction and transfer mechanisms and identify areas already known to be high risk or hotspots.

Task 2 Hold workshop in conjunction with 2.3.1.

WQ-2.3.3 Establish targeted surveillance for new ballast water introductions of harmful algal bloom species of concern.

Task 1 Use Information from workshop in 2.3.2 Task 2 that identifies high-risk areas to select surveillance locations.

Task 2 Design surveillance appropriate to each location and coordinated with existing monitoring where possible.

Task 3 Implement surveillance.

WQ-2.3.4 Establish system to alert coastal managers to new HAB 'sightings' or expansion of existing HAB ranges.

Task 1 Communicate list of known Gulf HABs and potential 'threat' HABs to phytoplankton and HAB monitoring programs.

Task 2 Distribute information to appropriate parties using means identified in 2.5.3.

WQ-2.4: Determine the connection between HABs and human/wildlife health effects.

Harmful algal blooms potentially impact both human and animal health. Effective monitoring of both requires efficient surveillance and communication systems which facilitate collaboration and communication between environmental and public health managers. Early HAB warning, rapid response, and timely public notification are necessary for effective protection of living resources and human health, and these are the ultimate goals of this action item.

Action Items:

WQ-2.4.1 Help states to contribute data on human and animal illness to the Harmful Algal Bloom-related Illness Surveillance System (HABISS) developed at the Centers for Disease Control and Prevention.

Task 1 Hold HABISS training workshop(s).

Task 2 Encourage and facilitate inclusion of HABs-related illness as part of state-reportable-disease requirements.

WQ-2.4.2 Assess adverse human/animal health impacts from harmful algal blooms by conducting exposure assessments and epidemiologic studies.

Task 1 Create plan of action/template for opportunistic response to HAB bloom.

Task 2 Conduct at least one human exposure assessment or epidemiologic study addressing each of the five major HAB species of concern.

Task 3 Conduct at least one animal exposure assessment or epidemiologic study addressing each of the five major HAB species of concern.

WQ-2.4.3 Develop enhancements in HABISS and HABIOS to assist state epidemiology units with HAB surveillance.

Task 1 Adapt an existing syndromic surveillance paradigm for use with HABISS.

Task 2 Create links to other relevant data such as weather or climate data.

WQ-2.4.4 Enhance communications and agency response to fish and wildlife mortality HAB events.

Task 1 Assess needs of local/state/federal agencies for HAB information.

Task 2 Hold workshop to identify best method for building and implementing system.

WQ-2.5: Develop and evaluate methods and technologies for the prevention, control, and mitigation of HABs and their impacts.

A variety of potential prevention, control and mitigation strategies exist to reduce the spread of harmful algal blooms and their ecological and socioeconomic impacts. Effective implementation of these strategies can yield many benefits for public health and resource managers, and other stakeholders in at-risk and affected communities. These benefits include healthy fisheries, reductions in unsightly and/or toxic blooms that affect tourism and property value, reduced spread of harmful invasive species, lowered risks to human health, and a well-informed public.

Action Items:

WQ-2.5.1 Develop and evaluate methods to minimize the size, intensity, or duration of harmful algal blooms.

Task 1 Develop and implement communication strategy to inform public sector on processes that promote blooms and activities that can lead to bloom control.

Task 2 Compile information about previously-tested prevention and control methods. Assess promising avenues that consider species-specific, impact-specific, or location-specific prevention and control strategies.

Task 3 Develop criteria for assessing suitability of potential prevention and control methods for field trial.

Task 4 Conduct at least three projects that test methods or protocols that prevent or control HABs and their impacts. Examples of prevention include ways to minimize reproduction of invasives. Examples of control include clay and algacides.

WQ-2.5.2 Develop and evaluate methods to reduce the environmental, economic, social, or public health impacts of harmful algal blooms.

Task 1 Compile information about previously-tested mitigation methods. Assess promising avenues that consider species-specific, impact-specific, or location-specific methods.

Task 2 Develop criteria for assessing suitability of potential mitigation methods for trial.

Task 3 Conduct at least three projects that test methods or protocols that mitigate (e.g., early warning/response, shellfish closures, fishing bans) HABs and their impacts.

WQ-2.5.3 Develop real-time public warning and alert capabilities through the web.

Task 1 Identify appropriate contacts in each state through which alert/warning info should be disseminated.

Task 2 Create template by which states could effectively distribute HABs public warning.

Task 3 Use information from 2.4.3 and 2.4.4 to trigger distribution of warning/alert.

WQ-3: Set the stage for control of mercury in Gulf fish. Quantify the inputs and other factors controlling the accumulation of mercury in the Gulf of Mexico ecosystem.

Mercury has been found in sometimes high concentrations in some species of Gulf fish and has been identified as a human-health risk. It is necessary to understand the cycle of mercury through the Gulf of Mexico food web and to identify the sources of mercury in the Gulf of Mexico to devise means to reduce the risk of mercury exposure.

Economics:

- Fisheries (recreational and commercial). If tourists avoid high mercury impact areas (i.e., areas with fish consumption advisories?), there are broader tourism impacts. Human and ecosystem health effects.

Headlines:

- New seafood survey confirms Gulf seafood safe to eat.
- Guide to Gulf seafood safety released.
- Study identifies primary sources of mercury to the Gulf of Mexico.
- Gulf of Mexico Alliance launches website to promote public awareness of mercury related issues in seafood.
- Risk to endangered marine species from mercury understood.

Results at the end of five years:

- The mechanism by which mercury enters the food chain and accumulates in Gulf of Mexico fish is described.
- The primary inputs of mercury that are responsible for its accumulation in Gulf of Mexico fish are being identified.

Who will lead and support this action: see Activities Matrix

Why do this?

- To understand the scope of effects from mercury in seafood on human health and the economy.
- To identify how best to remove sources of mercury in seafood.

Action Steps:

WQ-3.1: Regularly post research information on mercury cycling in the Gulf to a public Web site.

Action Items:

WQ-3.1.1 Generate a contact list of researchers working on mercury in the Gulf of Mexico and identify their area of expertise. Post on the GOMA web site and update the information at least annually.

Task 1 Develop list with input from workgroup.

Task 2 Post on website.

WQ-3.1.2 Compile and summarize past and present efforts to define the spatial distribution and magnitude of mercury in fish and shellfish, mercury sources, mercury methylation and demethylation kinetics, mercury cycling, and mercury bioaccumulation in the food webs of the Gulf of Mexico. Post on the GOMA web site and update the information at least annually.

Task 1 Create a searchable database to house the information on the spatial distribution and magnitude of mercury in fish and shellfish, mercury sources, mercury methylation and demethylation kinetics, mercury cycling, and mercury bioaccumulation in the food webs of the Gulf of Mexico.

Task 2 Compile information on mercury in fish and shellfish.

Task 3 Compile information on mercury sources.

Task 4 Compile information on mercury methylation and demethylation kinetics.

Task 5 Compile information on mercury cycling.

Task 6 Compile information on mercury bioaccumulation in food webs.

WQ-3.1.3 Host a regular mercury forum for researchers to exchange information, synthesize the results for previous and ongoing research on mercury cycling in the Gulf of Mexico, and to develop research priorities. Post on the GOMA web site and update the information after each forum.

Task 1 Assess need for forum every 6 months.

Task 2 Determine agenda and invitees.

Task 3 Hold Mercury Forum.

Task 4 Post meeting reports.

WQ-3.1.4 Post tables of information on the GOMA web site that display and explain the various mercury fish tissue criteria for the Gulf states, including fish consumption limits and guidelines established by appropriate agencies.

Task 1 Compile information.

Task 2 Design website to be public-friendly.

Task 3 Implement website.

WQ-3.2: Quantify and model the major sources (for instance atmospheric or river input), fate, and transport of mercury to the Gulf.

Action Items:

WQ-3.2.1 Determine how and where methylmercury enters into the food webs and bioaccumulates in fish (in collaboration with Nutrients PIT).

WQ-3.2.1.1 Use the information collected in WQ-3.1.2 to compile and assess available information on where methylmercury enters into food webs and bioaccumulates in fish. Focus on differences between estuarine food webs, nearshore food webs, and offshore food webs.

Task 1 Synthesize existing data or re-prioritize the data including mercury concentrations in fish, other biota, water, and sediments.

Task 2 Create/develop a spatially explicit database of mercury concentrations in the above media.

Task 3 Assess data gaps in spatial and species coverage and prioritize collection of new data.

Task 4 Conduct literature review (published and unpublished) of other experimental or tracer studies that address the entry into the food web.

WQ-3.2.1.2 Conduct trophic transfer studies of important fishery species (e.g., king mackerel, red and gray snapper, and gag grouper) identified as critical to ecological health and for critical processes or leading to bioaccumulation. (Goal: Get to a model you actually parameterize)

Task 1 Develop criteria to select species of interest. Include wildlife and critical processes.

Task 2 Develop a conceptual trophic bioaccumulation model(s) leading to the selected species of interest. Should involve: identification of trophic relationships, development of a literature-based bioenergetics model, and development of a mercury mass-balance model.

Task 3 Develop quantitative models using the existing information that simulates mercury concentrations in the food web and makes predictions subject to model validation.

Task 4 Update the models using newly collected data.

Task 5 Initiate a quality assurance program to assure useful data for the models by employing inter-laboratory calibrations and round robins.

WQ-3.2.1.3 Assess methylmercury entry into the lower food web (phytoplankton, zooplankton, and benthos).

Task 1 Develop an approach to field sampling that integrates with the GOMA coastal nutrient criteria framework studies.

Task 2 Based on Task 1, design and conduct appropriate observational studies such as natural isotope tracers that help identify the point of entry into the mercury food web.

Task 3 Conduct experimental studies to determine where methylmercury enters the food web.

WQ-3.2.1.4 Communicate and consider trophic information into the coupled hydrodynamic/mercury water quality model to help identify data gaps and any additional information or research needs.

Task 1 Integrate research results of the trophic studies into the model framework and communicate what biological or ecological information is important to be included in the model (including behavioral) through regular meetings with the modeling team.

WQ-3.2.1.5 Assess biological transport of Hg through space, e.g. from sediments, via vertical transport of zooplankton, from an estuary to the nearshore to offshore.

Task 1 Estimate movement of fish biomass between estuaries and offshore.

Task 2 Estimate Hg mass transported in fish.

Task 3 Determine significance of microbial loop as entry point to food web and vertical biotransport of MeHg via zooplankton undergoing diel vertical migration (DVM).

WQ-3.2.2 Determine where mercury methylation occurs and what processes govern its occurrence.

WQ-3.2.2.1 Use the information collected in WQ-3.1.2 to identify what we know about methylation distribution and net methylmercury production in estuarine, coastal, and pelagic systems.

Task 1 Synthesize information from 3.1.2 on mercury methylation and determine what research is still needed.

WQ-3.2.2.2 Develop a strategy to understand sources of mercury that lead to methylmercury production/accumulation.

Task 1 Create a conceptual diagram of mass balance understanding of mercury and methylmercury in the Gulf of Mexico ecosystem.

Task 2 Identify key sources and sinks of methylmercury in the Gulf of Mexico ecosystem.

Task 3 Based on Task 1, identify critical regions which would resolve the magnitudes and uncertainties.

Task 4 Examine utility of Hg isotope fractionation techniques to assess Hg sources/age for methylation and methylmercury sources.

Task 5 Depending on whether or not Task 4 finds technique applicable, apply isotope modeling approach to assess age and source of methylmercury.

Task 6 Based on results from Tasks 3 and 5, identify representative intensive study sites from which you can extrapolate results to the broader system. Net methylmercury production and flux to be determined in these systems: Deep Gulf – detailed water column profiles, Mississippi River delta system, Continental shelf, Coastal marshes, Coastal watersheds, Hypoxic zone, and Oil/gas platforms.

WQ-3.2.2.3 Implement mercury methylation-demethylation studies based on strategy created in WQ-3.2.2.2. Conduct estuarine, nearshore, and pelagic mercury methylation-demethylation rate studies in appropriate environments. Conduct laboratory and *in situ* experiments to quantify mercury methylation and demethylation rates. Measure pore-water total mercury and methylmercury concentration gradients to estimate benthic fluxes.

Task 1 Conduct estuarine, and nearshore, and pelagic mercury methylation-demethylation rate studies in appropriate environments. Conduct laboratory and *in situ* experiments to quantify mercury methylation and demethylation rates. Measure pore-water total mercury and methylmercury concentration gradients to estimate benthic fluxes.

WQ-3.2.2.4 Integrate methylation information into the coupled hydrodynamic/mercury water quality model to help identify data gaps and any additional information or research needs.

Task 1 Interact with methylation research team, integrate their research into the model framework, and obtain feedback on model framework from team.

WQ-3.2.3 Develop a coupled hydrodynamic/mercury water quality modeling framework to quantify how present and future mercury loadings will affect fish mercury concentrations in the Gulf of Mexico region, including both temporal and spatial variability.

WQ-3.2.3.1 Define questions to be answered with model.

Task 1 Form a modeling technical advisory committee.

Task 2 Present and confirm the following list of questions to be answered by the model with relevant agencies: (1) Factors controlling fish Hg in Gulf of Mexico; (2) Effects of current Hg loading, biogeochemical processing, and bioavailability on fish Hg concentrations in the Gulf of Mexico; (3) Predict response to future changes in Hg loading in the Gulf of

Mexico and estimate inherent uncertainty; (4) Effects of environmental change on fish Hg (climate, see list from other groups); (5) Timing and magnitude; and (6) Spatial variability.

WQ-3.2.3.2 Define domain to be modeled.

Task 1 Identify the key fish species that are tractable to model and what are their migration patterns? Include spatial heterogeneity in mercury concentrations in fish and the water and sediment to which they are exposed.

Task 2 Identify sources including biogeochemical processes and bioavailability.

Task 3 Define temporal and spatial scale of the model.

WQ-3.2.3.3 Identify the data needs and constraints on model framework development.

Task 1 Identify the types of Hg data that are needed to calibrate a mercury cycling model for the Gulf of Mexico that includes loading, cycling, and bioaccumulation.

Task 2 Identify ancillary data that are needed (e.g., hydrology, water quality, sediment quality, meteorology, trophic structure, fish migration).

Task 3 Determine data items that are identified by the above two activities are not achievable in the next five years?

Task 4 Identify available data from database in WQ-3.1.2.

WQ-3.2.3.4 Design model structure (phase 1 screening; phase 2 final).

Task 1 Conceptualize the key physical and biogeochemical processes necessary to simulate Hg cycling appropriate to the scale of the model.

Task 2 Determine spatial and temporal scale.

WQ-3.2.3.5 Assemble coupled modeling framework.

Task 1 Link the modeling components to create a coupled modeling framework (Hg, flow, water quality, trophic structure), (screening, then final model).

WQ-3.2.3.6 Test and calibrate modeling framework.

Task 1 Assemble data.

Task 2 Run model components.

Task 3 Evaluate results.

WQ-3.2.3.7 Apply model to answer policy questions identified in item WQ-3.2.3.1.

Task 1 Hg loading.

Task 2 Productivity and trophic factors.

Task 3 Climate related questions.

Task 4 Water quality.

WQ-3.2.4 Quantify major input pathways.

WQ-3.2.4.1 Determine atmospheric inputs of mercury.

WQ-3.2.4.1.1 Compile measurements of wet deposition of mercury and methylmercury from existing studies. Update annually.

Task 1 Form an Atmospheric Mercury Committee. This committee will coordinate atmospheric measurement and modeling activities related to mercury.

Task 2 Access Mercury Deposition Network (MDN) data for sites in Gulf of Mexico states.

Task 3 Seek additional data from other studies.

Task 4 Data placed in a limited-access database to "protect" data from other projects.

WQ-3.2.4.1.2 Add at least three more Mercury Deposition Network sites along the gulf coast to improve our knowledge on wet deposition of mercury and methylmercury.

Task 1 Establish at least three additional National Acid Deposition program (NADP) and Mercury Deposition Network (MDN) sites to improve spatial coverage and to provide needed data for model evaluation.

Task 2 Add MeHg to existing mercury rainfall monitoring efforts. Start at a small scale (a few sites around GOM, one full year); expand duration and spatial scale as necessary depending on the spatial variability and relative importance.

Task 3 Expand monitoring to add major ions, nitrogen species, and other trace elements as potential source tracers. This may require developing and distributing a protocol for collecting rainfall that allows this.

Task 4 Switch at least two coastal MDN sites to event based sampling, perhaps for a 12-month period.

Task 5 To assist modelers, compile data from rainfall Hg monitoring sites into a limited access database.

WQ-3.2.4.1.3 Estimate nearshore dry deposition fluxes by quantifying dry deposition of reactive gaseous mercury (RGM), gaseous elemental mercury (GEM), and aerosol mercury (Hg-part.) using existing and additional measurements.

Task 1 Compile list of all atmospheric Hg speciation sites along GOM .

Task 2 Continue atmospheric Hg speciation monitoring at existing sites (Grand Bay NERR, Pensacola, Tampa, Jacksonville, and Broward County (FL)).

Task 3 Coordinate/participate in NADP/Atmospheric Mercury Initiative (for speciated atmospheric Hg measurements using "Tekrans") at existing sites.

Task 4 Include supplemental air monitoring equipment (NO_x, SO_2, O_3, PM2.5, etc.) to aid in the interpretation of the atmospheric Hg data. Requires appropriate ancillary data: full met data set, insolation, etc.

Task 5 Using existing modeling methods, convert GEM, RGM, and Hg-part. concentrations into "dry deposition fluxes."

Task 6 Add one or two more atmospheric Hg speciation sites.

WQ-3.2.4.1.4 Deploy samplers on offshore platforms to measure wet and dry deposition fluxes of mercury over the Gulf of Mexico. Include supplemental air monitoring equipment (NO_x, SO_2, O_3, CO, PM2.5, etc.) to aid in the interpretation of the GEM, RGM, and Hg-part. data.

Task 1 Develop sampling plan for offshore measurements at 1-2 sites including all of the above considerations regarding sampling frequency, instrumentation, analyses. In this planning process, consider logistics for far off-shore vs. closer in. Also, extensive coordination with platform operators must be carried out to identify appropriate

sites, get permission, assistance with transportation and site operators (may have to send research people; undergrads).

Task 2 Implement sampling plan devised in Task 1, to establish 1-2 sampling sites, and begin measurements.

Task 3 Measure other trace elements in aerosol samples, as source tracers.

WQ-3.2.4.1.5 Concurrently with expanded monitoring for wet and dry deposition of mercury, model the fate and transport of atmospheric mercury to estimate wet and dry deposition to Gulf of Mexico ecosystems and to produce source-attribution estimates.

Task 1 Coordinate calculation of deposition estimates that have the appropriate spatial resolution to be used as inputs into the aquatic cycling model. Atmospheric modeling teams must coordinate with aquatic mercury cycling modeling teams to produce deposition estimates that have the same (or better) resolution than the surface "boxes" used for aquatic cycling modeling.

Task 2 Assemble regional emissions inventory for 2007 to serve all model efforts. Inventory should be spatially and temporally resolved (point and area sources, better than just an annual value), and include speciated emissions (GEM, RGM, Hg-part.), along with information on how each emission value was derived.

Task 3 Revise/improve emissions inventories for natural and anthropogenic sources and outside the immediate Northern Gulf of Mexico region (including Mexico, the Caribbean, and global sources); update periodically to make available for states and modelers.

Task 4 Improve estimates of natural emissions and re-emissions of previously deposited anthropogenic mercury.

Task 5 Consider making more measurements on point sources (stack measurements) to improve emission estimates.

Task 6 Create high-resolution (12 km?) met data re-analysis product for all modelers to share; consistent with year of emissions inventory.

Task 7 Conduct atmospheric mercury model runs; arrange for model intercomparisons.

Task 8 Conduct source-attribution modeling.

Task 9 Compare model results with monitoring data and with other models. Resolve discrepancies (errors in emissions inventories, met data, atmospheric chemistry algorithms, etc.).

Task 10 Model atmospheric deposition to watersheds (wet plus dry) and the impacts it has on mercury concentrations in rivers and streams fluxes and urban runoff.

Task 11 Hold planning meetings/conference calls to ensure necessary coordination.

WQ-3.2.4.2 Determine riverine inputs of mercury to Gulf of Mexico estuaries.

WQ-3.2.4.2.1 Form a Subcommittee to develop the overall framework and goals required for monitoring mercury concentrations and develop load estimates in rivers using the river drainage areas and flow data. Coordinate with the nutrient criteria and the Action Sub-Sub Item 3.2.4.3 groups.

Task 1 Establish primary goals necessary to determine riverine inputs, cycling within estuaries, and transport offshore. Establishing primary goals will include eliciting

input from stakeholders to help define the problem and objectives the stakeholders need to satisify.

Task 2 Identify criteria (including flow, potential sources, environmental conditions [e.g., hypoxic, total organic carbon, pH]), to select subset of rivers.

Task 3 Compile and assess existing mercury data (methylmercury, dissolved and particulate mercury) in the rivers identified in Task 2.

Task 4 Identify subset of rivers for monitoring.

WQ-3.2.4.2.2 Develop a monitoring plan for the selected rivers and their associated estuaries identified from Action Item 3.2.4.2.1. that will meet (1) primary goals set by Task 1; (2) satisfy criteria conditions set by Task 2; and (3) effectively utilizes and complements data compiled under Task 3 of that sub-item.

Task 1 Hold workshop to develop the specifics of the actual field sampling program for rivers, their associated estuaries, and the offshore component.

WQ-3.2.4.2.3 Implement the monitoring plan developed as a deliverable for Action Sub-Sub Item 3.2.4.2.2.

Task 1 Implement monitoring plan.

WQ-3.2.4.3 Establish the net fluxes of dissolved and particulate mercury and methylmercury to the coastal waters of the Gulf of Mexico.

WQ-3.2.4.3.1 Determine the net flux of mercury and methylmercury from rivers and estuaries to coastal waters (other than the Mississippi River).

Task 1 Form Estuarine Dynamics Subcommittee to develop the overall framework and goals required to establish net fluxes of mercury species from estuaries to the coastal waters of the Gulf of Mexico.

Task 2 Conduct workshop to select estuaries for study and develop experimental design for field sampling program. Estuaries selected will be a subset of at least four systems that also will be selected for analyzing riverine discharges to upper estuaries (Task 3.2.4.2). Coordinate design of sampling network with modeling of estuarine circulation dynamics to optimize station selection for flux calculations.

Task 3 Implement experimental design developed through Task 2 to (1) determine the net flux of mercury and methylmercury from rivers and estuaries to coastal waters (other than the Mississippi River) and (2) elucidate mercury transport and cycling through selected estuaries. Choose estuaries that are associated with the above river monitoring program and integrate studies with the GOMA coastal nutrient criteria framework studies. Conduct studies for at least 2 years with emphasis on quantifying the estuarine flushing effects from major storm events.

WQ-3.2.4.3.2 Determine the flux of mercury and methylmercury from the Mississippi River to the GOM.

Task 1 Conduct sampling of the Mississippi River estuary gradient and calculate speciated mercury fluxes into and out of the estuary.

WQ-3.2.4.4 Characterize temporal and spatial ambient mercury and methylmercury concentrations along typical coastal areas to emphasize areas of groundwater input and coastal wetlands.

WQ-3.2.4.4.1 Collect vertical profiles of total mercury and methylmercury in a series of transects from the coastline to offshore to measure mercury-concentration gradients. Overlap coastal transects with the river and estuarine study sites above and integrate with the GOMA coastal nutrient criteria framework studies.

Task 1 Use same workgroup that designed riverine flux studies to decide on study design.

Task 2 Carry sampling of coastal transects.

WQ-3.2.4.5 Quantify the net flux of total and methylmercury from the inflow and outflow of water between the Caribbean Sea and the Gulf of Mexico.

WQ-3.2.4.5.1 Measure ambient concentrations of total and dissolved methylmercury and total and dissolved mercury in the Loop Current flowing into and out of the Gulf and calculate associated fluxes.

Task 1 Conduct scoping study to determine if Loop Current is a significant source or sink.

Task 2 Determine through uncertainty and sensitivity analyses if more refined measurements of mercury import and export via the Loop Current are necessary and, if so, feasible.

Task 3 Conduct additional measurements to refine flux estimates from scoping study if necessary.

WQ-3.2.4.6 Quantify the impact of submarine groundwater discharge on mercury fluxes in the Gulf of Mexico.

WQ-3.3.4.6.1 Assess the potential importance of submarine groundwater discharges to the Gulf of Mexico.

Task 1 Identify researchers in this field and determine significance of submarine groundwater discharge (SGD) to Gulf.

Task 2 Examine USGS groundwater flow data.

Task 3 Sample high groundwater flow areas for Hg.

WQ-3.2.4.7 Quantify the sediment water exchange flux of mercury and methylmercury in coastal and marine sediments.

Task 1 Carry out benthic chamber studies and sediment core studies of porewater profiles as appropriate to quantify flux from multiple sources.

Task 2 Calculate preliminary estimates of sediment flux based on estimates from Task 1 and knowledge of spatial distribution of bottom sediment types.

WQ-3.2.4.8 Determine the flux of methylmercury from deep GOM waters as a source to pelagic surface waters.

Task 1 Detailed water column profiling in the open Gulf. (Should be combined with Straits work for cost efficiency.) (Two profiles, 10 depths to 2000m)

Task 2 Use the information gained in Task 1 to develop a detailed estimate of the exchange of methylmercury, between the surface and deep ocean waters. Incorporate fluxes into model.

WQ-3.2.5 Better our understanding of mercury effects on key non-fishery species (e.g., whales and dolphins, seabirds).

WQ-3.2.5.1 Use information from WQ-1.1.2 to summarize what we know about mercury concentrations and effects in non-fishery species.

Task 1 Compile the metadata of mercury concentrations in other biota within the Gulf, including but not limited to: whales, dolphins, sharks, and seabirds, but also coastal populations wading birds, rails, marsh sparrows, terrapins.

Task 2 Create/develop a spatially explicit database of biomarkers of exposure, i.e., tissue mercury concentrations, etc.

Task 3 Produce a report that reviews (published and unpublished) potential biomarkers of effect in key species both within and outside of the Gulf to identify assessment tools and vulnerable species.

Task 4 Based on the results of Task 3 and what is known about food habits and Hg levels within prey species (from 3.2.1.1 Task 2), develop criteria and select key species that may be vulnerable.

Task 5 Assess data gaps in spatial and species coverage and make recommendations on prioritizing new data collection (biomarkers of exposure and effects).

WQ-3.2.5.2 Using data compiled under 3.2.5.1, assess mercury risk for several key non-fishery species.

Task 1 Conduct a risk assessment.

Task 2 Identify the species at risk from the data compiled.

Task 3 Communicate species at risk from risk assessment to the appropriate resource management agencies.

WQ-3.2.5.3 Combine information with exposure models in 3.2.5.2 (e.g., food-web information and trophic bioaccumulation models) to understand ultimate linkages to mercury sources throughout the Gulf.

Task 1 Produce a report that extrapolates mercury exposure to non-fishery species back to ultimate source of MeHg.

Task 2 Compare and contrast ultimate source and route of exposure between non-fishery species (from 3.2.5.3 Task 1) and humans (3.3), i.e., is it the same pathway.

WQ-3.3: Work with Gulf health agencies to develop a strategy to inform decision makers and public health advisory groups regarding the relative importance of different sources and pathways for mercury accumulation in fish.

Action Items:

WQ-3.3.1 Compile existing data on mercury exposure rates to humans along the Gulf coast.

Task 1 Compile existing data.

WQ-3.3.2 Identify the high-risk human groups based on the information gathered from the above compilation of data and expert opinion.

Task 1 Analyze data for species being eaten, amounts of each species being eaten, catch of each species being eaten, and mercury concentrations of those species (assess quality of data including spatial

variability and when data were collected). Identify high-risk human groups and gaps in information and geographic coverage.

WQ-3.3.3 Develop and implement a strategy to inform coastal managers of the information gathered on at-risk, mercury-consuming populations.

Task 1 Develop committee comprised partially of key stakeholders.

Task 2 Identify objectives identifying key evaluative metrics.

Task 3 Implement studies to satisfy the objectives and develop a report.

WQ-3.3.4 Use survey methodologies to determine species specific consumption patterns of the identified high-risk human groups.

Task 1 Design the survey.

Task 2 Carry out the survey.

Task 3 Analyze and report survey results.

WQ-3.3.5 Validate model by performing human hair mercury analyses on subset of those responding to survey.

Task 1 Design validation study.

Task 2 Perform sampling and hair analysis.

Task 3 Analyze data and report results.

Task 4 Perform model validation.

WQ-3.3.6 Develop criteria to select fishery species of interest.

Task 1 Create criteria that include human health.

Action WQ-4: Obtain and provide vital information about the conditions of Gulf of Mexico waters. Support good management decisions about coastal fisheries, recreation, tourism, public health, and infrastructure planning by providing information on the condition of Gulf of Mexico waters and the plants and animals living in them.

Healthy Gulf coast habitats and the plants and animals living in them depend on good water quality. The coastal economies of the Gulf States are generally based on these ecosystems. Good management decisions about coastal fisheries, recreation, tourism, public health, and sustainable development depend on the availability of information about the quality of the water and the condition and health of the ecosystems depending on that water. Good management is built on good information that is based on good data from water resource monitoring.

Economics:

- Well designed monitoring systems provide maximum cost-effective information for good decision making.
- Good monitoring information helps ensure that taxpayer dollars go for restoring water bodies that have been scientifically documented as impaired and subsequently subjected to TMDL regulatory requirements.
- Good monitoring allows proactive management rather than future restoration. Prevention is less expensive than restoration.

Headlines:

- Comprehensive coastal monitoring saves taxpayers millions by better targeting of problems.
- High quality data drives good decisions.
- Costly restoration avoided by effective monitoring.
- Good science guides sustainable economic development.

Results at the end of five years:

- Water quality data collected around the Gulf of Mexico is of documented quality and increased comparability.
- Monitoring in the Gulf of Mexico is coordinated to maximize the information collected and minimize cost.

- Gaps in monitoring are identified, and a strategy has been developed for filling necessary gaps in the monitoring system.
- A publicly accessible database is available on the web that contains information about what programs are monitoring water quality in the Gulf of Mexico, including the details of their effort (what, when, where, and how they monitor).
- A pilot project has been conducted that links GIS, land-use, and water quality as well as circulation models to help guide changes in coastal land use.
- New tools are available to help coastal resource managers access information on water quality, including data, models, and interpretive frameworks.

Who will lead and support this action: see Activities Matrix

Why do this?

- To provide improved and consistent information on which to base Gulf – wide decisions
- To support expanded users and uses of available data, pool resources, and minimize costs
- To help guide resource-allocation and water-quality-assessment decisions
- To guide development of a monitoring framework for the Gulf of Mexico
- To guide selection of locations for research in the Gulf region
- To help assess the suitability of data for different uses
- To help protect coastal water quality through informed land-use and management decisions
- To support development of the Nutrient Criteria Framework and coastal nutrient criteria

Action Steps:

WQ-4.1: Improve data comparability across the Gulf of Mexico

Action Items:

WQ-4.1.1 Continue data comparability efforts, including analytical and field round robins, methodology improvements and standardization where appropriate.

Task 1 Carry out three analytical round robins per year.

Task 2 Identify field SOPs for use in GOMA programs using results from 4.1.3.

Task 3 Carry out at least four field round robins per year. Should use the GOMA SOPs in task 3 and the agency's SOPs.

WQ-4.1.2 Determine the analytical methods' adequacy for measuring ambient concentrations of the core analytes.

Task 1 Document ranges in result values for coastal, nearshore, and open Gulf values of core analytes.

Task 2 Determine areas needing to be sampled because of low levels and collect samples and send to low-detection limit values labs.

Task 3 Compile detection and quantitation limits for methods.

Task 4 Prepare report comparing methods versus needs.

WQ-4.1.3 Create a QA/QC guidance document for sample collection, sample analyses, and data handling so that comparability among the states can be assessed.

Task 1 Inventory coastal monitoring programs' QA/QC methodologies for sample collection, sample analyses, and data handling, and assess them for comparability.

Task 2 Get QA/QC guidance document being developed by the Nutrients Team.

Task 3 Assess the Nutrients Team document for applicability.

WQ-4.1.4 Hold the annual Monitoring Forum, publicize to other PITs and coordinate appropiate workshop(s).

WQ-4.2 Coordinate the collection and management of information about monitoring programs across the Gulf of Mexico and improve data dissemination tools to deliver information to resource managers.

Action Items:

WQ-4.2.1 Establish monitoring program metadata elements necessary to describe monitoring programs across the Gulf and promote adoption of these elements.

Task 1 Send out list developed by Florida to other Gulf states for them to review and comment.

Task 2 Identify additional types of information (water velocity, bathymetry, etc.) needed as identified in 4.3.1.

Task 3 Decide on final list of metadata elements.

WQ-4.2.2 Complete the comprehensive water quality monitoring inventory of state, local, and federal agencies and organizations currently involved in the collection of water quality related data and information in the Gulf.

Task 1 Identify and broadly characterize monitoring programs within the Gulf of Mexico.

Task 2 Create database and user interface to hold information.

Task 3 Identify what additional information and queries we want in the database.

Task 4 Survey monitoring programs identified to collect additional monitoring program information.

Task 5 Expand database and query capability to hold new information.

WQ-4.2.3 Develop a data portal for accessing information about real time and/or continuous monitoring data for coastal and offshore waters.

Task 1 Identify who has developed or is developing a data portal.

Task 2 Identify who is collecting real time monitoring data.

Task 3 Identify who is collecting continuous monitoring data.

Task 4 Identify which data portal to use and see if we can add additional information that was identified above.

WQ-4.3 Design a framework for a water-quality monitoring network for the Gulf of Mexico adequate to address Gulf Alliance needs. (in collaboration with Nutrients Team).

Action Items:

WQ-4.3.1 Identify the monitoring network objective, needs, and design.

Task 1 Collect initial information at the annual Monitoring Forum.

Task 2 Examine gaps in information collected from 4.2.2.

Task 3 Gather information on what the other Teams need from the monitoring network.

Task 4 Hold workshop to decide on network objectives/questions and needs of the Water Quality Team.

Task 5 Identify if a state already has a monitoring coordination group.

Task 6 Help states create a monitoring coordination plan that includes coastal waters for states if none exists.

Task 7 Create a coordinated monitoring Action Plan across the Gulf, building on state plans.

WQ-4.3.2 Incorporate remote sensing into the water quality monitoring network.

Task 1 Evaluate utility of data and information from the ROSES grant-funded projects and incorporate into the water quality monitoring network.

Task 2 Identify priorities for pursuing future RFP opportunities.

Task 3 Provide case examples for application of remote sensing information to interpolate spatially and temporally between in-situ monitoring and for calibration/verification of hydrodynamic, water quality, and ecosystem models.

WQ-4.3.3 Develop a framework (e.g., NCA) for a Gulf-wide report card that would incorporate products from all WQ Team workgroups.

Task 1 Poll the other WQ workgroups and the nutrient team for potential metrics to include in the report card.

Task 2 Evaluate existing report cards and create WQ Team format.

Task 3 Test report card format in selected locations where appropriate data is presently available and a local lead exists.

Task 4 Present report card and its utility to the public and gov agencies.

Task 5 Develop example "Decision Matrix" demonstrating how report card could be used by local/state/fed govs to guide management decisions.

WQ-4.4 Improve the knowledgebase needed to properly manage water quality in coastal waters. (in collaboration with other Priority Issue Teams).

Action Items:

WQ-4.4.1 Evaluate results from Cooperative Research and Development Agreement (CRADA) EPA/Tampa Bay project, which will develop method for determining economic values of ecosystem services.

Task 1 Assess applicability of the approach in different systems.

Task 2 Recommend other Gulf systems for economic valuation using the approach.

WQ-4.4.2 Develop at least one pilot project in the Gulf region (using existing data, models, and tools) to create a GIS-linked landscape and/or water quality modeling tool that can be used by local managers as a guide for land use decisions in coastal watersheds. Provide training to coastal managers as appropriate after the pilot.

Task 1 Support USGS in the application of the Sparrow Model to a local estuarine system. Help provide land-use and water quality data where needed.

Task 2 Create user-friendly website that coastal manager can use to evaluate different scenarios and provide training where necessary.

Task 3 Identify the areas where Sparrow Modeling can provide land-use decision making and those areas where other methods are necessary.

Task 4 Evaluate other modeling approaches for locations where Sparrow Model is not applicable.

WQ-4.4.3 Develop a plan to increase the use of real time and continuous water quality monitoring to support water quality management decisions.

Task 1 Identify current and additional uses (e.g., shellfish harvest and hydrodynamic models) of these data.

Task 2 Identify overlaps and gaps between existing real time water quality and other pertinent monitoring information relative to user needs.

Task 3 Considering the needs collected in 4.3.1, make recommendations for revisions to real-time monitoring.

WQ-4.4.4 Evaluate biocriteria for determining attainment of aquatic life-use targets for coastal waters, including tidal streams in the Gulf states.

Task 1 Develop an inventory of existing programs that use biological indicators.

Task 2 Develop a Gulf-wide, standardized approach to evaluate the states' biological assessment methods and biocriteria for coastal and marine waters.

Task 3 Look at each state's biological indicators and criteria and evaluate how well it serves the state in aquatic life-use attainment.

Task 4 Hold a forum on the "state of the science" of biological indicators.

Task 5 Develop technical working group to provide guidance.