

Design basis for the Gulf Monitoring Network (GMN): integrating key elements of remote sensing, sampling, and modeling.

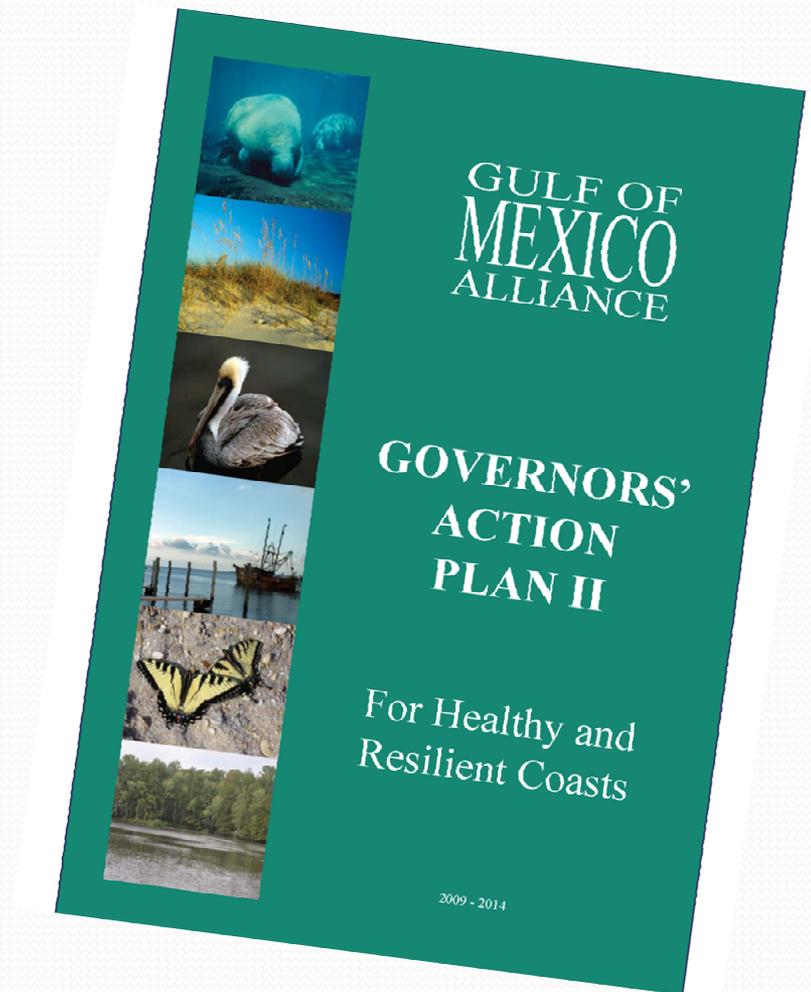


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Gulf of Mexico Alliance

- Alliance of Governors of five U.S. Gulf states.
- Supported by Workgroup of 13 Federal agencies.
- Develops and carries out targeted *Governors' Action Plan* focused on highest Gulf priorities across states.



Priority Issue Teams

- Water Quality Team is one of six GOMA Priority Issue Teams.
- Each team is composed of experts from many Gulf stakeholder agencies and entities.
- Water Quality Team consists of four Workgroups totaling ~275 people from numerous state, federal, academic, NGO, public, and private entities.

Gulf Monitoring Network (GMN)

- 1) **Why** was it created?
- 2) **How** was it developed?
- 3) **What** does it look like, and **why** does it look that way?

Gulf Monitoring Network (GMN) – Why it was developed.

1) Governors' Action Plan II:

- WQ-1.4, **improve monitoring of Gulf** water resources.

2) WQ Team's Tier 2 (detailed) Action Plan

- WQ-4.3 **Design a framework for a water-quality monitoring network** for the Gulf of Mexico adequate to address Gulf Alliance needs.
 - **4.3.1 Identify the monitoring network objective, needs, and design.** Work with other regional monitoring efforts (e.g., GCERTF, Hypoxia Task Force, Federal programs, etc.) in establishing these objectives.

Gulf Monitoring Network (GMN)

Why it was developed.

Deepwater Horizon oil blowout

- Highlighted the shortcomings of existing monitoring
- Created the need for improved monitoring to help assess Gulf recovery and the success of restoration efforts.

Gulf Monitoring Network (GMN)

WQ Team Priority: Improve Monitoring

- 1) **Why** was it developed?
- 2) **How** was it developed?
- 3) **What** does it look like, and **why** does it look that way?

Gulf Monitoring Network: Development Process

- 1) Identify the most important water quality monitoring issues for the Gulf;
- 2) For each, identify and rank the highest priority monitoring questions;
- 3) Design a monitoring system to address the priority questions;
- 4) Perform a “gap analysis” comparing the needed monitoring to that already in existence;
- 5) Prepare an implementation plan

1) Priority WQ monitoring issues

1. Nutrients and nutrient effects
 - 2a. Pathogens and their human health risk
 - 2b. Harmful algal blooms (HABs)
 - 2c. Mercury pathways into seafood

2) Priority monitoring questions

Questions grouped based on scale of monitoring that would be required:

- Estuary or coastal-segment scale;
- “Regional” scale;
- Gulf-wide scale.

“Regional” defined as anything larger than a single estuary or coastal segment, but not requiring the entire Gulf (e.g., Gulf Hypoxic Zone).

2) Priority monitoring questions

List of questions that was developed is too long to address here.

Available in GMN Design Report.

Note the basic monitoring design tenant:
One designs a monitoring system around the questions it must address.

Gulf Monitoring Network (GMN)

WQ Team Priority: Improve Monitoring

- 1) Why?
- 2) How was it developed?
- 3) **What** does it look like, and **why** does it look that way?

GMN System Design

- The GMN design results from more than two years of effort:
 - hands-on involvement in design workshops by over 40 monitoring and priority-area experts from more than 30 state, federal, academic, and NGO agencies and entities;
 - design review and modification by more than 100 additional experts.

3) Monitoring system design

Some key factors controlling design:

- Physical features have a major effect on monitoring system requirements.
- Addressing the scales of the priority questions requires monitoring carried out at multiple, very-different scales.
- Costs must be minimized.
- “Conventional” approach to water quality monitoring (e.g., that used in freshwater systems) is cost-prohibitive at this scale if resulting information is to be sufficient to support good management decisions.
- To maximize the cost/benefit ratio, the GMN design must serve as a foundational source of data that also supports other types of monitoring and goals and priorities beyond those identified by GOMA.

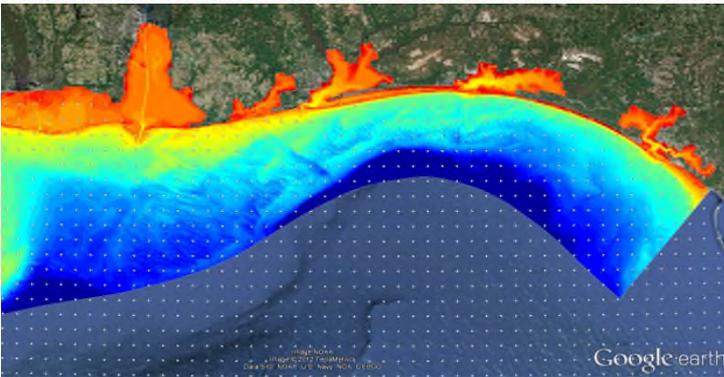
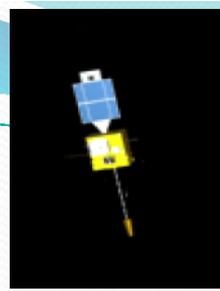
GMN System Design

Key conclusions incorporated into design decisions:

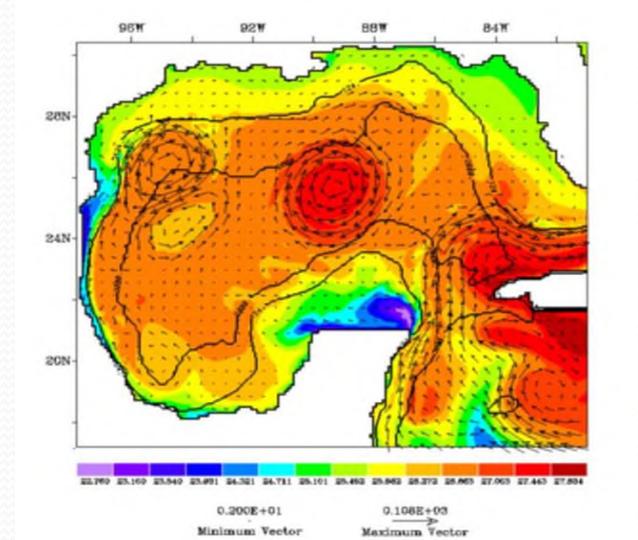
- Addressing the variety of GOMA priorities is best handled through an integrated, interlocking network of monitoring systems.
- Build on existing monitoring programs and accommodate existing monitoring-program goals.
- Design GMN as foundation on which other monitoring can be built.
- New approaches required.

The Triad

Remote sensing



Modeling of circulation, water quality, and ecosystems.



In-situ sampling and measurement



GMN System Design – three components

- 1. In-situ sampling/measurements:**
 - to provide accurate WQ and environmental-process data;
 - to validate and calibrate models, and;
 - to calibrate remote sensing.
- 2. Remote sensing, calibrated with in-situ measurements:**
 - to provide accurate, high-density spatial and temporal information about surface waters;
 - to help calibrate and validate models.
- 3. Modeling, validated with in-situ and remotely-sensed data:**
 - to provides dense 3D spatial and temporal information;
 - to provides feedback on how well environmental processes are understood.

GMN System Design – Does it have to be All Three?

- **In-situ Measurements** of sufficient density can address all information needs but are extremely expensive at these scales.
- **In-situ Measurements and Remote Sensing**, without Modeling, can reduce costs for some surficial In-situ Measurements, but provide little help in the water column.
- **In-situ Measurements and Modeling**, without Remote Sensing, does not provide sufficient validation and feedback data to develop models of sufficient accuracy for management needs in a reasonable timeframe. They also do not handle monitoring of short-term events as well.

GMN System Design – Does it have to be all Three?

- **Modeling and/or Remote Sensing**, without In-situ Measurements, do not provide sufficient accuracy for most management needs.
- **In-situ Measurements with Modeling and Remote Sensing** allows minimizing in-situ data collection and leverages that data to provide the information required to address the priority monitoring questions at the lowest cost.

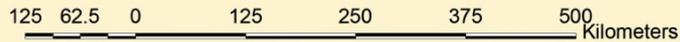
GMN System Design – the Result

The requirements of the design resulted in monitoring in four areas, of four types, at three scales.



Estuaries

(tributary mouths to coastal waters)





Coastal

Coastal

<10m

<10m

10 m

10 m

0-10 meters in depth

200 m

Shelf

Shelf

Coastal

<10m

200 m

10 m

Deep Gulf

200 m

10 m

200 m

Deep Gulf

200 m

Shelf

10 m

200 m

10 m



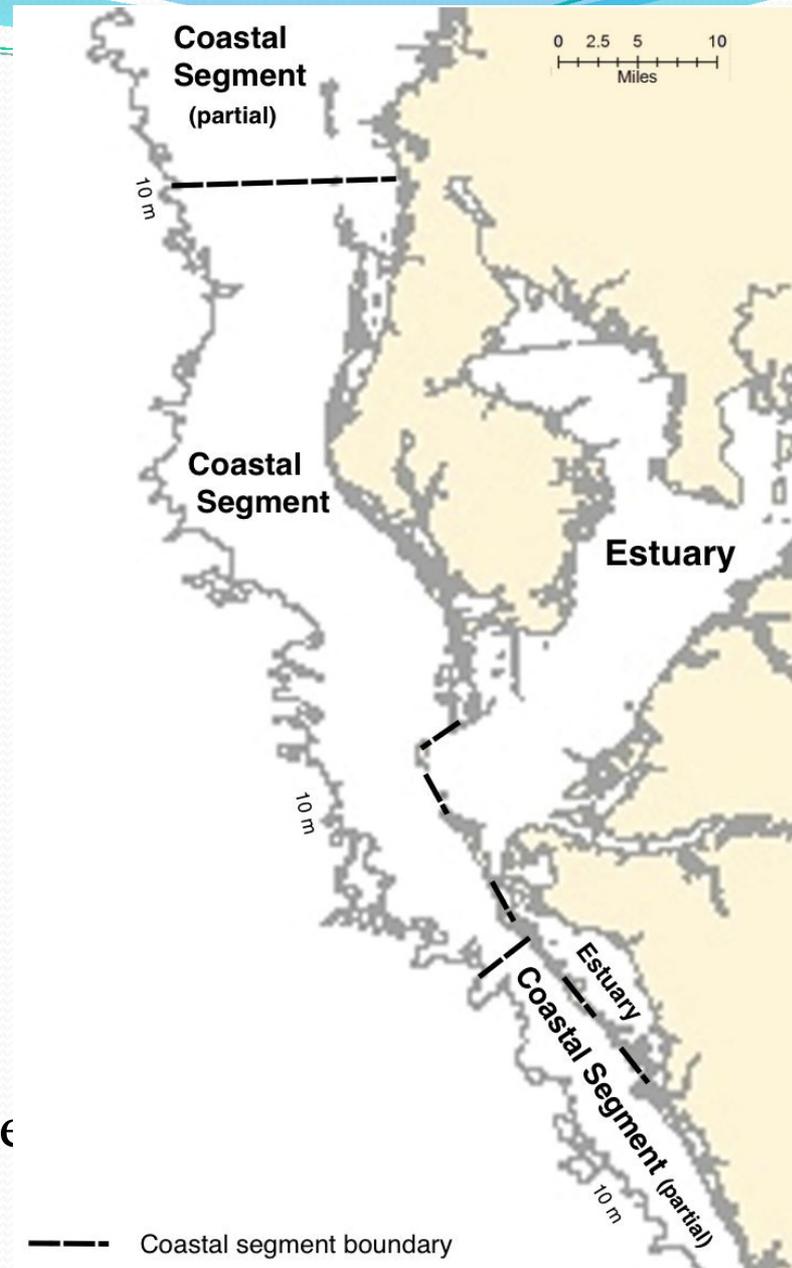
GMN System Design – Four Regions/Scales

Fundamental differences in design:

- Design *Templates* for Estuaries and Coastal Segments
- Design *Plans* for Continental Shelf and Deep Gulf

GMN System Design

- *Design Templates* for Estuaries and Coastal Segments
- Sufficient variability exists among systems that each estuary/segment needs its own design.
- Templates lay out minimum core elements to address GMN needs while allowing local monitoring needs to be the primary focus.
- Most existing monitoring systems would probably required little change to meet template requirements.



Templates for Estuary or Coastal Monitoring

Basic design rationale #1: measure flux of key constituents at “flux points”.

- To estimate the constituent fluxes into and out of the estuary or coastal segment.
- To provide boundary information for the models of adjoining areas.

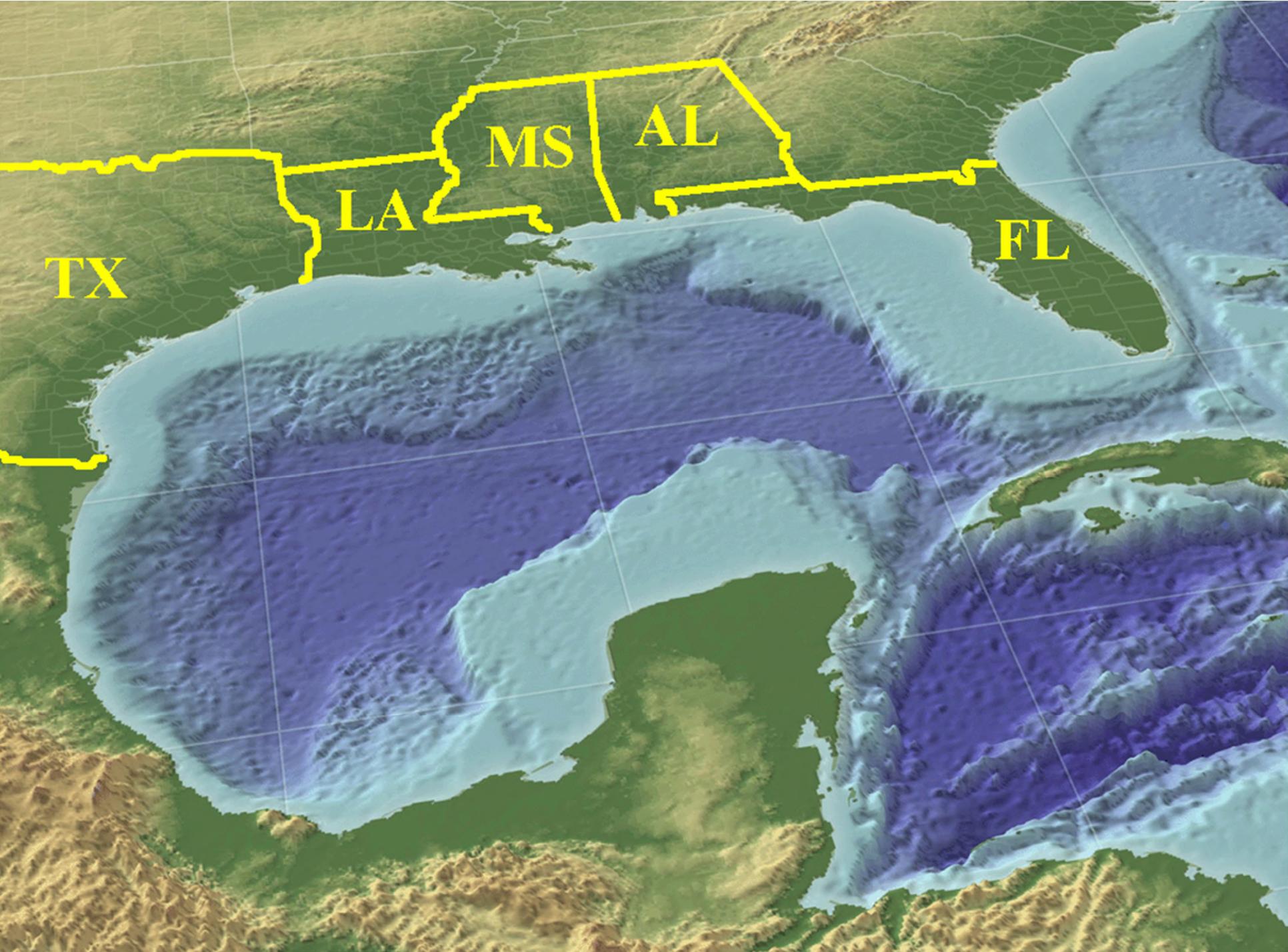
Templates for Estuary or Coastal Monitoring

Basic design rationale #2: between flux points, understand the environmental processes taking place that affect the concentrations of the key constituents and the resulting effect on biological communities.

- To provide information about the processes that affect the form and fate of the key constituents;
- To assess health-risks from coastal pathogens and HABs.
- Biological assessment provides a key monitoring endpoint.

Templates for Estuary or Coastal Monitoring

- *Monitoring environmental processes helps determine the need for management steps and aids selection of appropriate steps.*
- *For HABs, pathogens, and mercury, process monitoring also helps assess the success of management efforts.*
- *For nutrients, measuring flux alone helps determine the success of management efforts*



TX

LA

MS

AL

FL

System Design for Shelf Monitoring

Basic Design Rationale:

- provide information on boundary conditions to coastal and deep Gulf models, understand nutrient status and trends as well as fluxes delivered to and from the shelf, and identify and better understand circulation patterns;
- relate nutrient changes to ecosystem shifts (and changes in ecosystem services).

System for Deep Gulf Monitoring

Basic Design Rationale:

- provide data on boundary conditions for shelf models;
- understand nutrient and other key constituent fluxes between deep water and the shelf, including upwelling zones;
- identify and better understand circulation patterns;
- Understand patterns and magnitude of nutrients and other key constituents flowing into and out of the Gulf as a result of Loop Current flow;
- relate nutrient changes to ecosystem shifts (and changes in ecosystem services).

Gulf Monitoring Network – Design-Basis Wrap-up

GMN Design focused on:

- Minimum monitoring necessary to address the monitoring priority questions;
- Flexibility to add monitoring for additional goals upon this monitoring foundation;
- Monitoring of ecosystem, with emphasis on biological community response, with sufficient physical-chemical monitoring for initial assessment of potential causes of observed community conditions;

Gulf Monitoring Network – Design-Basis Wrap-up

Overall design requires strong water quality and ecosystem models. These require:

- Physical-chemical monitoring to properly drive the hydrodynamic underpinnings of the models;
- Models developed for all monitoring areas, with supporting WQ monitoring data to provide sufficient information on transport of key constituents across the boundaries between models and regions.

Gulf Monitoring Network - Summary

- States generally have fairly robust FW monitoring, the GMN addresses estuarine and marine waters.
- GMN is about WQ and addresses specific GOMA priorities, but is intended to support many others.
- WQ monitoring forms a part of many of the non-WQ monitoring programs (e.g., fisheries, ocean observing), which the GMN is intended to complement, not duplicate.
- To control in-situ sampling costs, the GMN incorporates extensive use of remote sensing and modeling.

GOMA Gulf Monitoring Network Design Report

www.GulfofMexicoAlliance.org