

# NOAA's Integrated Ecosystem Assessment Program

## An Approach for the Gulf of Mexico Large Marine Ecosystem

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### Integrated Ecosystem Assessment (IEA):

A framework for organizing and synthesizing science to inform multi-scale, multi-sector Ecosystem Based Management (EBM)

**Objective: to provide evaluation of management strategies and advice, through:**

- Comprehensive integration of diverse ecosystem information and best-available science
- Incorporating economic and social science data
- Evaluating benefits and risks to social and ecological sectors posed by management actions
- Continuous performance evaluation and review

The United States National Oceanic and Atmospheric Administration (NOAA) is evolving towards an Ecosystem Approach to Management for its eight Large Marine Ecosystems (LME). To this end, NOAA is initiating an Integrated Ecosystem Assessment (IEA) effort within the Gulf of Mexico LME, a tropical/sub-tropical, partially isolated body of water that encompasses several international coastlines and a growing human population. An IEA is a synthesis and quantitative analysis of information on relevant physical, chemical, ecological and human processes in relation to specified ecosystem management objectives. The primary goal of our IEA is to unify the critical components of the ecosystem into one integrated model, such as Atlantis or Ecosim-Ecopath, and evaluate trade-offs in resource utilization between the components using a management strategy evaluation framework. We are currently undertaking an IEA for the Gulf of Mexico by laying the groundwork for a single unified data management system which incorporates and combines the catalog and web service functions of EcoWatch and Environmental Research Division's Data Access Program (ERDDAP). Our efforts to date are focusing on creating a sound database structure that will serve as the basis for several individual IEAs within the overall LME, each addressing specific management questions. IEA management objectives will involve the collection of new data, and rely on making the best use of data that already exist in numerous, distributed databases housed at government agencies, academic institutions, and non-governmental organizations. These distributed data will be discoverable through NOAA's EcoWatch catalog and ERDDAP web services both currently in operation.

### NOAA's IEA Program

IEA's Regions are Based on NOAA's Eight Large Marine Ecosystems

**The IEA loop**  
(Levin et al., 2008, 2009)

```

    graph TD
        A[Identify goals of EBM and threats to achieving goals] --> B[Develop ecosystem indicators and targets]
        B --> C[Risk Analysis]
        C --> D[Assessment of ecosystem status relative to EBM goals]
        D --> E[Management Strategy Evaluation]
        E --> A
        E --> F[Implementation of Management Action]
        F --> G[Monitoring of Ecosystem Indicators and Management Effectiveness]
        G --> A
        G --> H[Adaptive Management and Monitoring]
        H --> A
    
```

**Critical Characteristics of a NOAA IEA:**

- Is geographically specified
- Incorporates multiple indicators of the physical environment, human factors affecting ecosystems, and the trophic dynamics and production of ecosystem goods and services
- Establishes target levels and thresholds for important ecosystem components,
- Evaluates the impacts of management options and risks of not attaining target ecosystem states.
- Provides an ecosystem-based management tool, product and process.

**IEA PROCESS DRIVER-PRESSURE-STATE-IMPACT-RESPONSE (DPSIR)**

```

    graph TD
        Driver[Driver: agricultural & urban runoff] --> Pressure[Pressure: coastal nutrients]
        Pressure --> State[State: hypoxia]
        State --> Impact[Impact: abundance of LMRs]
        Impact --> Response[Response: change inputs]
        Response --> Driver
        Response --> Management[Management Evaluation]
        Management --> Driver
        Response --> Forecasts[Forecasts & Risk Assessments]
        Forecasts --> Response
    
```

IEAs contain multiple DPSIRs

### Adaptive Management And Monitoring

### Monitoring of Ecosystem & Indicators

The Gulf of Mexico region is a dynamic economic engine and ecological treasure that is home to thirty-four percent of the U.S. population, contributes over two trillion dollars annually to the U.S. economy, and represents one-third of the continental U.S. coastline. Variations in the health of the GOM ecosystem can have profound positive or negative socio-economic and ecological effects for the region and the nation. Increasing stress on the GOM ecosystem from natural phenomenon (e.g. hurricanes and harmful algal blooms) and human induced sources (e.g. overfishing, pollution, and habitat loss) requires precise observation and sophisticated modeling to detect early signs of ecosystem change, forecast the consequences of such change, and support appropriate coordinated ecosystem based management. Two central questions that the planned GOM integrated ecosystem assessment can address are: what is the current status of the GOM ecosystem and what are the consequences of change to this ecosystem and those dependent upon it.

### Management Strategy Evaluation

Management Strategy Evaluation involves assessing the consequences of a range of management options and making obvious the trade-offs in performance across a range of management objectives.

### Scoping

**Phase I Management Concerns:**

- Mitigating Harmful Effects to Coast Water Quality
  - Hypoxia/local estuarine hypoxia/hypoxic zone
  - Harmful Algal Blooms (HAB)
- Mitigating the Impacts of and Adapting to Climate Changes
  - Climate Change/Sea Level Rise
- Improving Ecosystem Health
  - Habitat Loss and Degradation
- Sustaining Gulf Economy
  - Sustainable Grouper/Snapper Shrimp Fisheries
  - Tourism
  - Impacts of Energy development

### Data / Indicator Development

### Risk Analysis

High	D	A	High risk
		B	
Low	C	E	Low risk
High	Susceptibility to threats		Low
			High
			Low
			Resiliency to change

### Assessment of Ecosystem Status and Simulation

**Atlantis System Model**

```

    graph TD
        Define[DEFINE OBJECTIVES] --> Implementation[IMPLEMENTATION]
        Implementation --> Performance[PERFORMANCE MEASURES]
        Performance --> Judging[JUDGING OUTCOMES]
        Judging --> Define
        Judging --> Management[MANAGEMENT]
        Management --> Implementation
        Management --> Assessment[ASSESSMENT]
        Assessment --> Performance
        Assessment --> Simulation[SIMULATION CYCLE]
        Simulation --> Define
    
```

**Ecopath with Ecosim**

No fish is an island

It signifies that all living organisms are linked together. In the ocean, for example, despite our great impact, we are only one of many predators. We must learn to behave responsibly in a realm where we are the intruders.