Integration of Data and Expert Knowledge to Characterize Ecosystem Condition through Environmental Scorecards: NOAA/NOS Studies

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3 Examples of NOAA/NOS Partnership-Based Studies

I. The State of Coral Reef Ecosystems of the United States and Pacific Freely Associated States: 2008

II. National Estuarine Eutrophication Assessment: Effects of Nutrient Enrichment in the Nation's Estuaries: 1999 & 2007
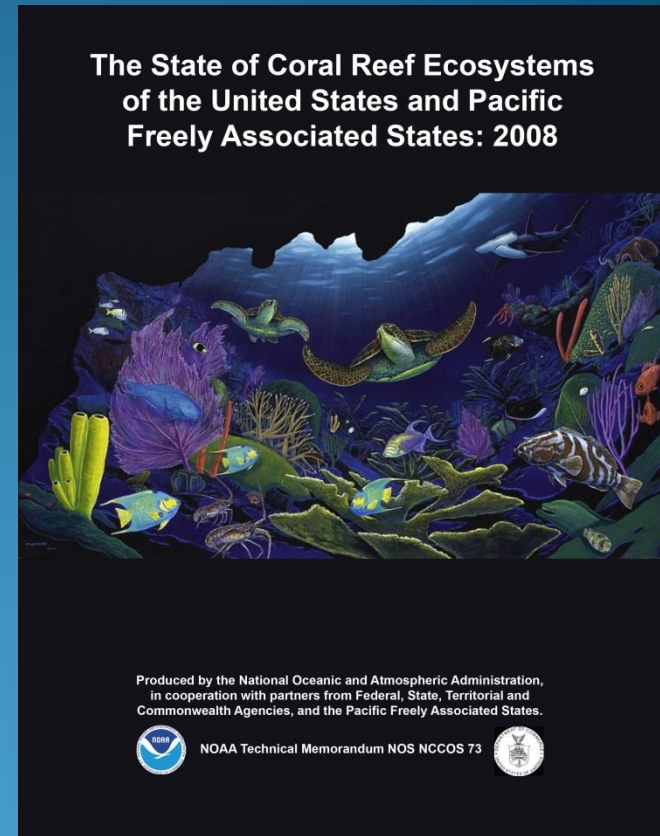
III. National Marine Sanctuary System: Condition Report 2013

Example I
2008 State of Coral Reef Ecosystems Report

National Summary Chapter
Description

- **Goal:** To assess and compare the condition of coral reef ecosystems across 15 jurisdictions featured in the report

- **Problem:** Standardized monitoring program, methods or data to compare the state of resources did not exist

- **Solution:** Collect using a multiple-choice questionnaire

The State of Coral Reef Ecosystems of the United States and Pacific Freely Associated States: 2008

Produced by the National Oceanic and Atmospheric Administration, in cooperation with partners from Federal, State, Territorial and Commonwealth Agencies, and the Pacific Freely Associated States.

NOAA Technical Memorandum NOS NCCOS 73

2008 State of Coral Reef Ecosystems Report

National Summary Chapter Methods

- Each jurisdiction's report coordinator and/or writing team completed the questionnaire

- The first half of the questionnaire addressed the current condition of 6 resources in the present, short-term, long-term and the jurisdiction's ability to monitor these resources

- The second half of the questionnaire addressed the level of impact from each of 10 threats using the following categories: absent, low, medium, high or unknown

Excerpts from questionnaire

Resource / Other	The overall condition of _____ in my jurisdiction is…	Since the last Coral Report the trend in the condition of _____ is…	The long-term (10- 25 yrs.) trend in the condition of _____ is…
Water Quality	Poor Fair Good Excellent Unknown	Increasing About the same Decreasing Not Applicable Unknown	Increasing About the same Decreasing Not Applicable Unknown
Live Coral Cover	Poor Fair Good Excellent Unknown	Increasing About the same Decreasing Not Applicable Unknown	Increasing About the same Decreasing Not Applicable Unknown

2008 State of Coral Reef Ecosystems Report

National Summary Chapter Questionnaire Results

- Responses were tallied separately within these regions and averaged to determine the regional condition of each resources and threat

- Results from the six Caribbean/Atlantic/Gulf of Mexico jurisdictions:

Resources		UNKNOWN	POOR	FAIR	GOOD	EXCELLENT	OVERALL
	Water Quality	0	2	1	2	1	FAIR
	Living Coral Cover	0	2	3	0	1	FAIR
	Reef Fish Populations	0	2	3	1	0	FAIR
	Harvested Reef Fish and Macroinvertebrates	0	3	2	1	0	FAIR

Threats		UNKNOWN	HIGH	MED	LOW	ABSENT	OVERALL
	Climate Change and Coral Bleaching	0	3	1	2	0	MED
	Coral Disease	0	4	0	2	0	MED
	Tropical Storms	0	3	2	1	0	MED
	Coastal Development	0	3	1	1	1	MED
	Tourism and Recreation	1	3	1	2	0	MED
	Commercial Fishing	2	2	2	0	0	HIGH
	Subsistence and Recreational Fishing	1	2	2	0	0	HIGH
	Vessel Damage	0	3	2	2	1	MED
	Marine Debris	0	1	4	2	0	MED
	Aquatic Invasive Species	0	0	2	4	0	LOW

2008 State of Coral Reef Ecosystems Report

National Summary Chapter Questionnaire Results

- Responses were mapped to show spatial patterns in resource condition and high threats among jurisdictions.

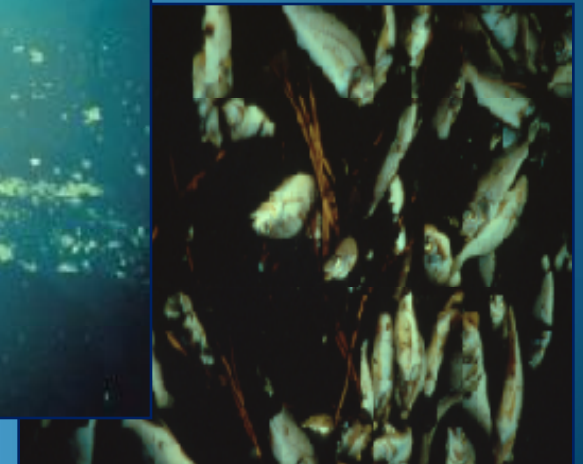- Mapped survey results for the Caribbean/Atlantic/Gulf of Mexico jurisdictions:
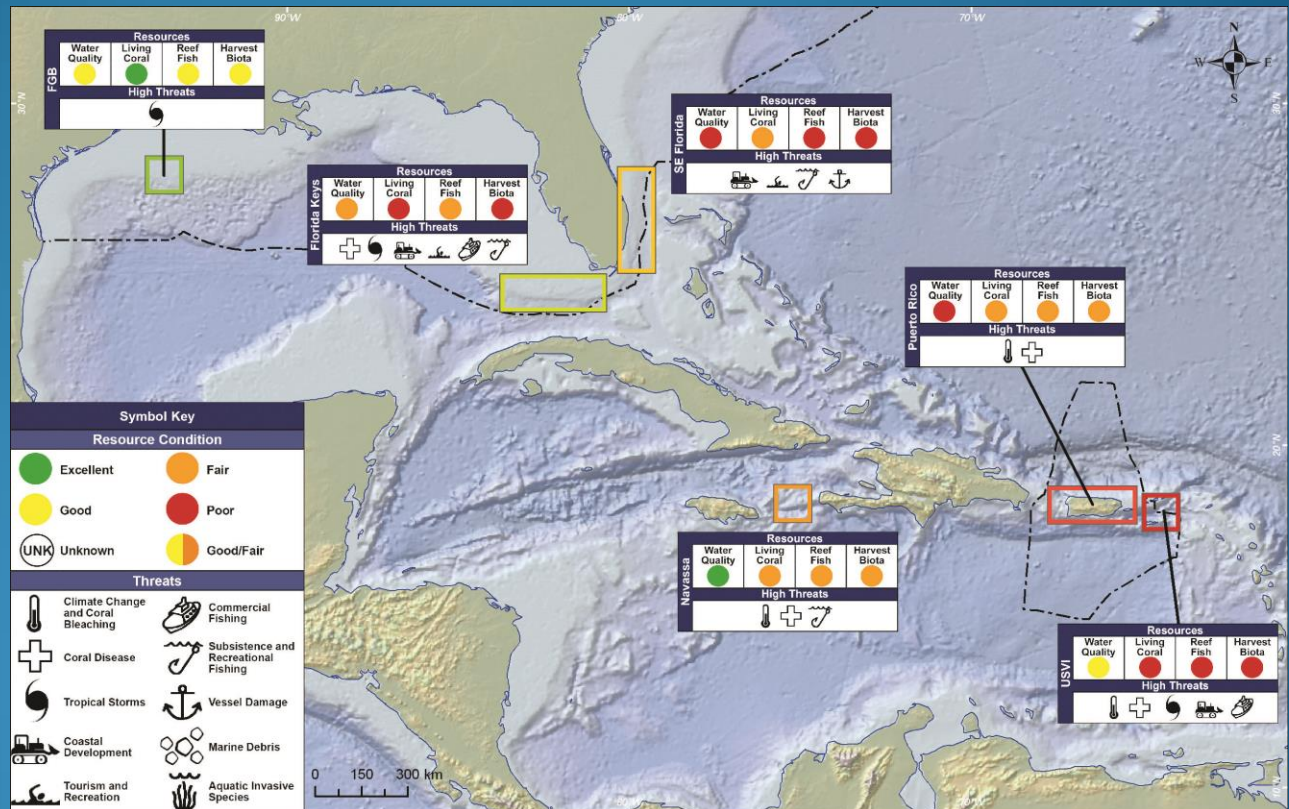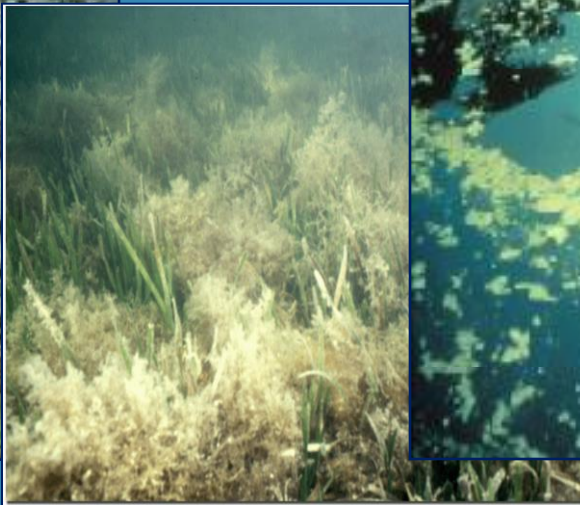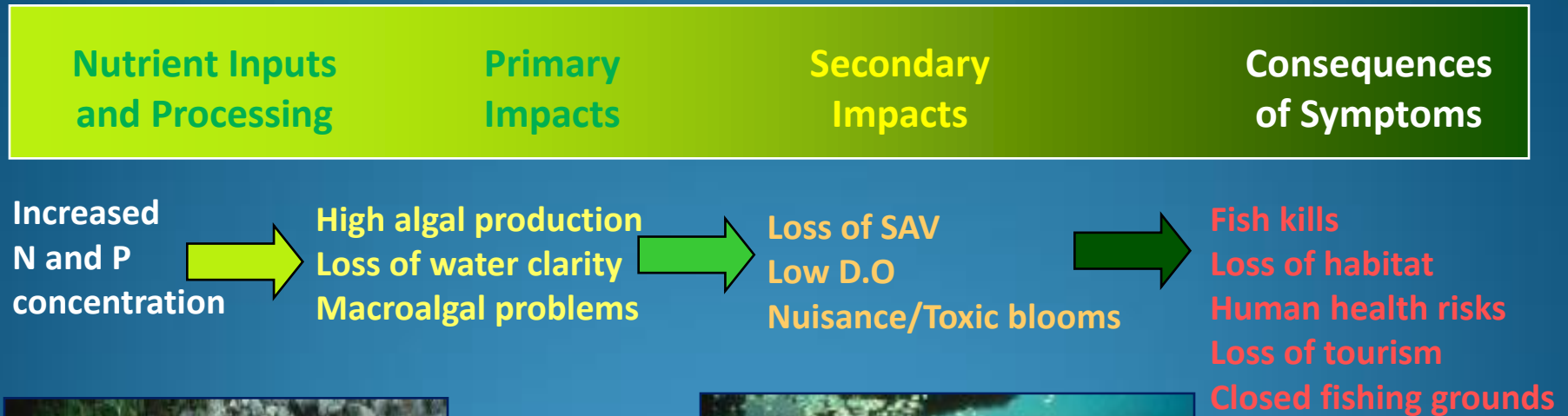
2008 State of Coral Reef Ecosystems Report

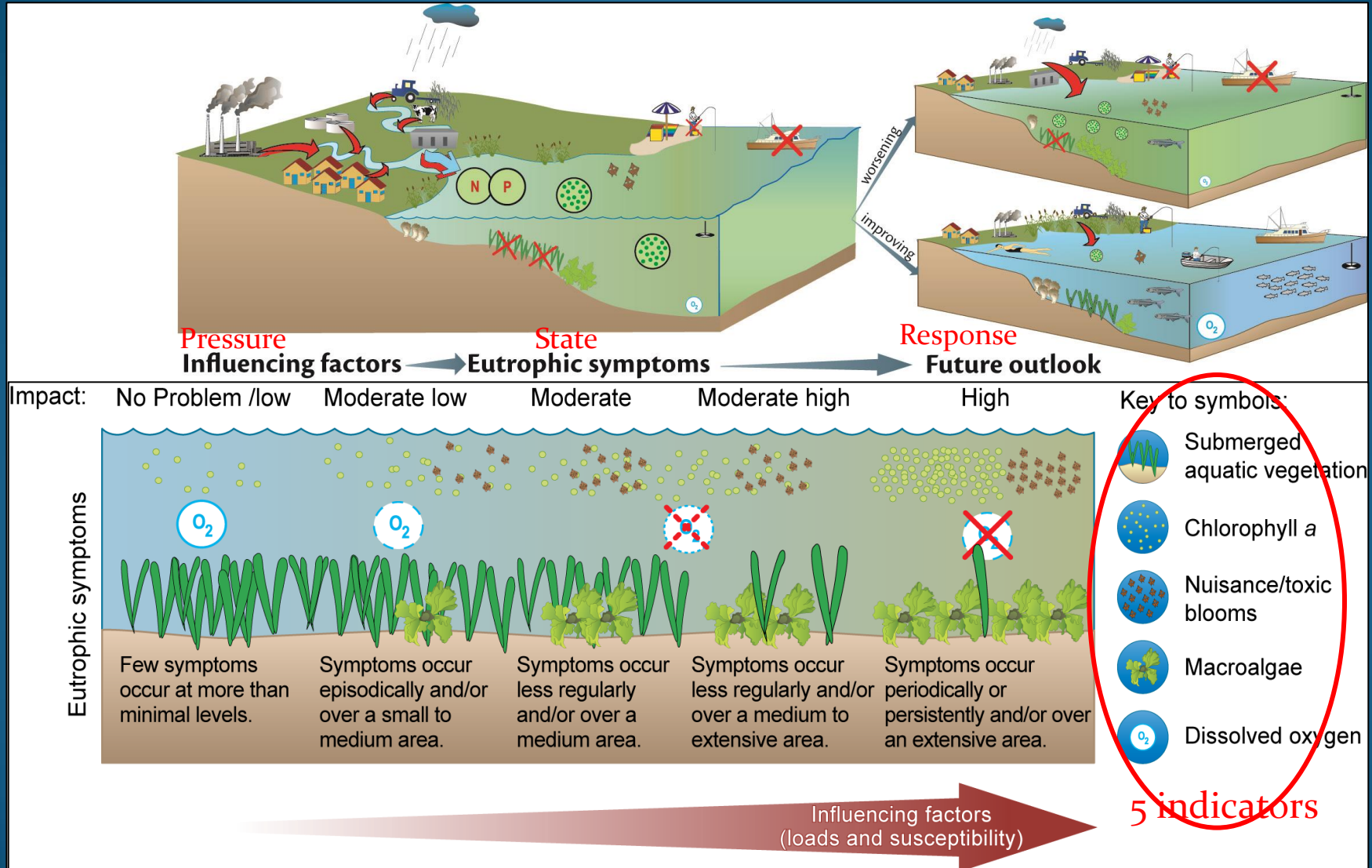## National Summary Chapter Recommendations

- Without standardized monitoring protocols the ability to provide strictly quantitative comparisons across all jurisdictions is limited.

- No consistently collected metrics exist by which all the jurisdictions can be equally measured and compared. Consistency in measurement and reporting of metrics is needed across U.S. jurisdictions.

- Action Taken: In 2013 the NOAA CRCP is implementing a modified National Coral Reef Monitoring Program (NCRMP) and a select suite of consistent biological and physical parameters will be collected over time in most major US coral jurisdictions.

Example II: National Estuarine Eutrophication Assessment 1999 & 2007

Symptoms and Consequences of Nutrient Enrichment

Nutrient Inputs and Processing	Primary Impacts	Secondary Impacts	Consequences of Symptoms

Increased N and P concentration →

High algal production
Loss of water clarity
Macroalgal problems →

Loss of SAV
Low D.O
Nuisance/Toxic blooms →

Fish kills
Loss of habitat
Human health risks
Loss of tourism
Closed fishing grounds

National Estuarine Eutrophication Assessment 1999 & 2007

National Estuarine Eutrophication Assessment 1999 & 2007

Assessment of Estuarine Trophic Status (ASSETS)

The ASSETS approach includes three steps:

- ✓ **Division of estuaries into homogeneous areas**
- ✓ **Evaluation of data completeness and reliability**
- ✓ **Application of indices**

- ● **Tidal freshwater (<0.5 psu)**
- ● **Mixing zone (0.5-25 psu)**
- ● **Seawater zone (>25 psu)**

- · **Spatial and temporal quality of datasets (completeness)**
- · **Confidence in results (sampling and analytical reliability)**

Pressure: **Influencing Factors index** (susceptibility + nutrient load)

State: **Eutrophic Condition index** (Chl, macroalgae, HABs, DO, SAV loss)

Response: **Future Outlook index** (susceptibility + future nutrient load)

★ **Guide for management, research, monitoring**

National Estuarine Eutrophication Assessment 1999 & 2007

Pressure - State - Response:

Influencing Factors + Eutrophic Condition + Future Outlook → ASSETS

Influencing Factors (IF)

	Low	Moderate	High
High	Moderate	Moderate High	High
Moderate	Moderate Low	Moderate	Moderate High
Low	Low	Low	Moderate Low

Susceptibility (vertical axis) / **Nutrient Pressures** (horizontal axis)

Eutrophic Condition (EC)

	Low	Moderate	High
High	Moderate	Moderate High	High
Moderate	Moderate Low	Moderate	High
Low	Low	Moderate Low	Moderate High

Primary Symptoms (vertical axis) / **Secondary Symptoms** (horizontal axis)

Future Outlook (FO)

	Decrease	No Change	Increase
Low	Improve High	No Change	Worsen Low
Moderate	Improve Low	No Change	Worsen Low
High	Improve Low	No Change	Worsen High

Susceptibility (vertical axis) / **Future Nutrient Pressures** (horizontal axis)

Susceptibility
dilution & flushing

+

Nutrient Inputs
land based or oceanic

↓

Influencing Factors

Primary Symptoms
Chlorophyll a
Macroalgae

Average of ratings that combine extreme conditions over annual cycle, spatial coverage, frequency of occurrence

Secondary Symptoms
Dissolved Oxygen
Nuisance/toxic blooms
SAV change in spatial coverage

Worst case rating of the 3 is used, ratings as per primary symptoms

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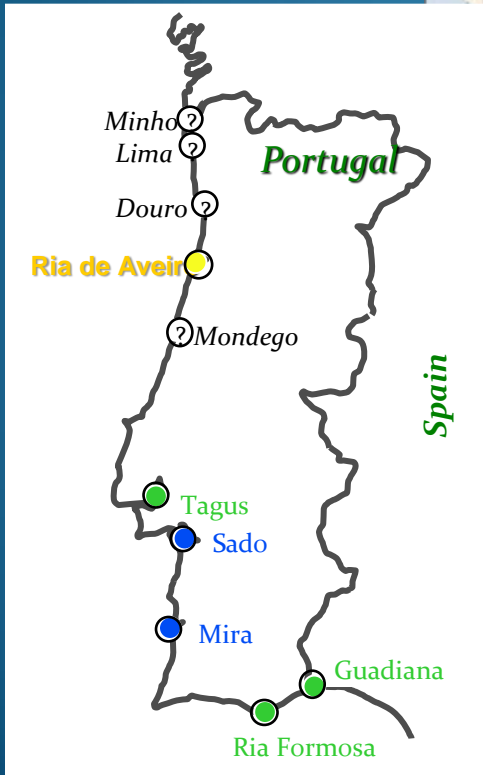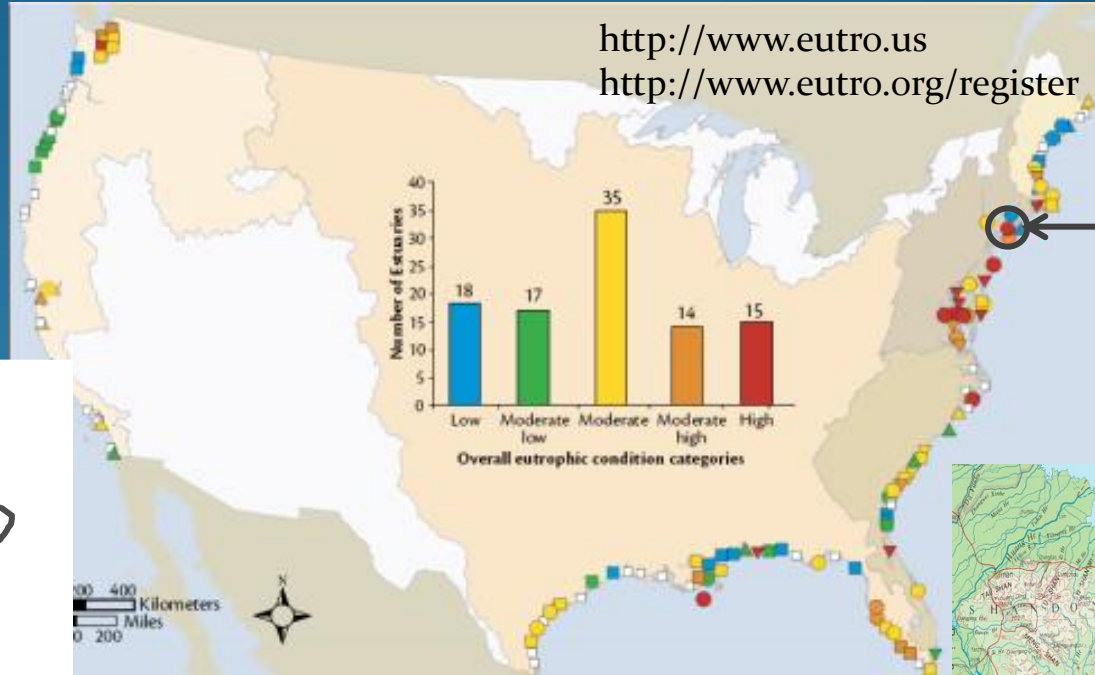**Susceptibility** is the capacity of a system to dilute or flush nutrients

Nutrient pressure changes are based on expected population changes, future treatment and remediation plans and changes in watershed use (particularly agricultural

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IF + EC + FO = ASSETS

National Estuarine Eutrophication Assessment 1999 & 2007

Overall Eutrophic Condition (early 2000s)

Combined indicators:
Chlorophyll (measure of phytoplankton),
macroalgae,
Dissolved Oxygen, seagrass, nuisance and toxic algal blooms

http://www.eutro.us
http://www.eutro.org/register

Long Island Sound

Portugal

Minho ?
Lima ?
Douro ?
Ria de Aveiro
? Mondego
Spain
Tagus
Sado
Mira
Guadiana
Ria Formosa

China

? *Unknown*
🔴 **High**
🟠 **Moderate High**
🟡 **Moderate**
🟢 **Moderate Low**
🔵 **Low**

65% of assessed systems M to H
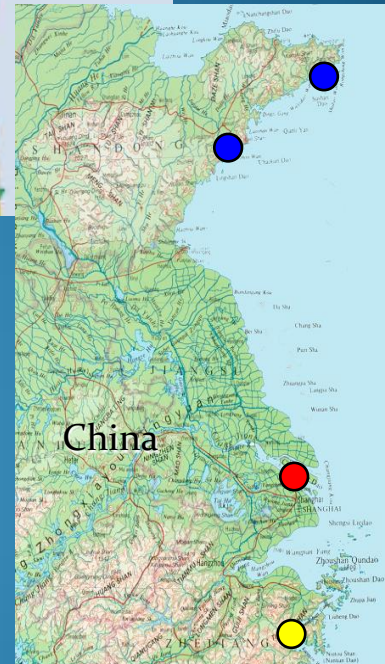
National Estuarine Eutrophication Assessment
1999 and 2007

Highly Eutrophic

Overall Eutrophic Condition of Long Island Sound
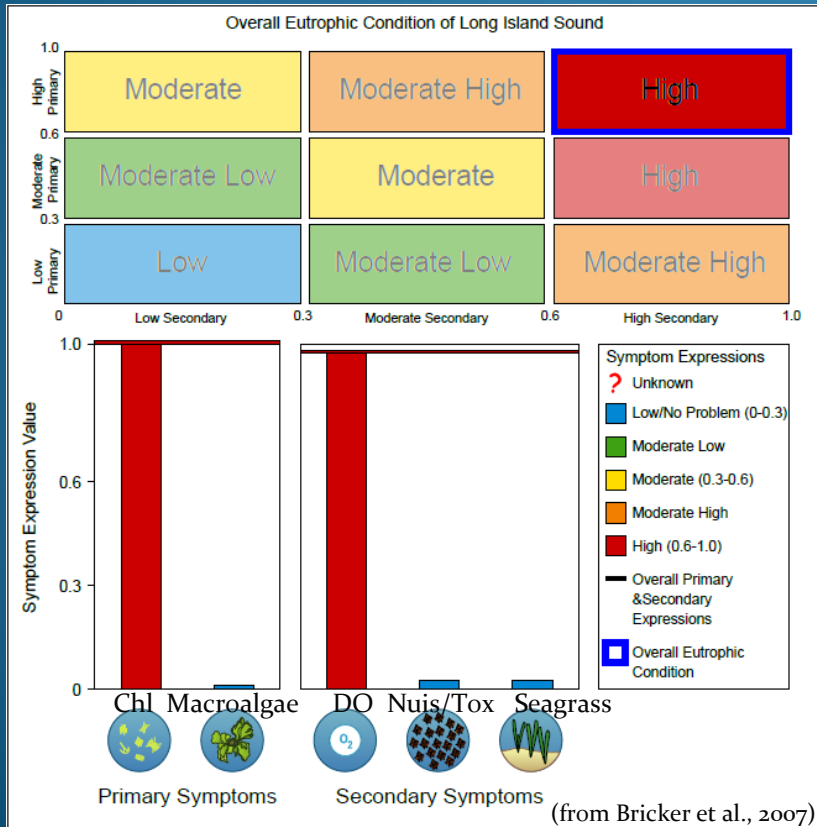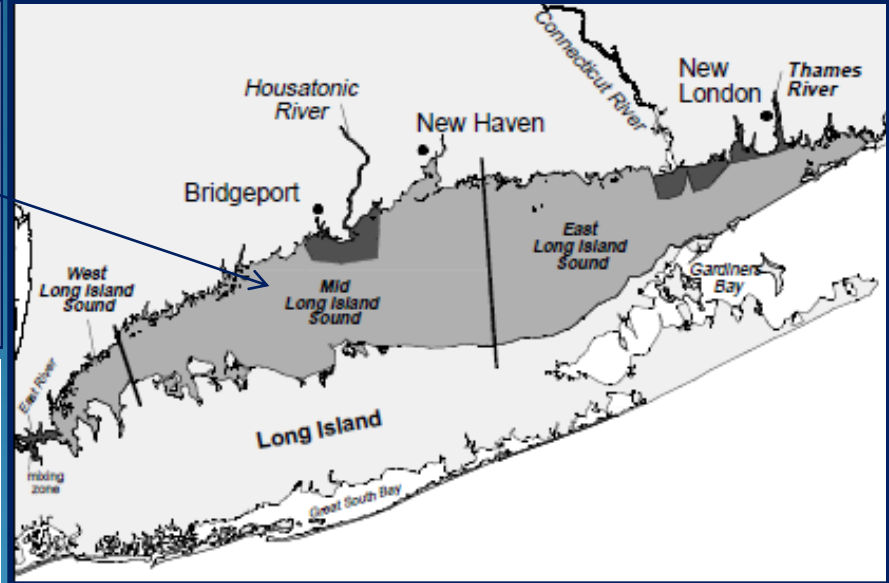
Large areas, long durations of hypoxia
Significant areas of high Chlorophyll a
Loss of commercial and recreational fish species

(from Bricker et al., 2007)

National Estuarine Eutrophication Assessment 1999 and 2007

Farm-Scale Methodology

Aquaculture model (FARM)
Farm Aquaculture Resource Management model

evaluates aquaculture success

+

Eutrophication model (ASSETS)
Assessment of Estuarine Trophic Status

evaluates farm water-quality footprint

Can evaluate scenarios with and without aquaculture
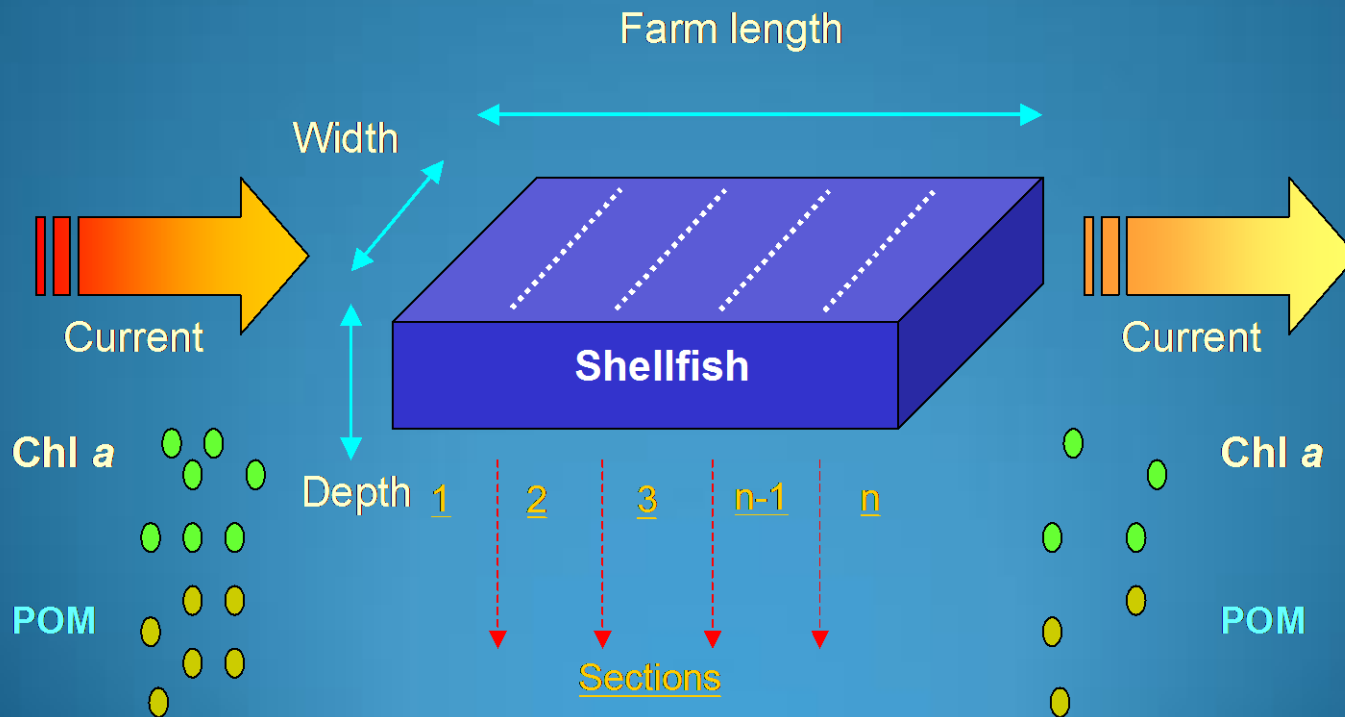
Example III: Condition Reports for the National Marine Sanctuaries
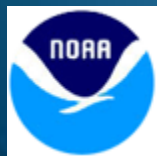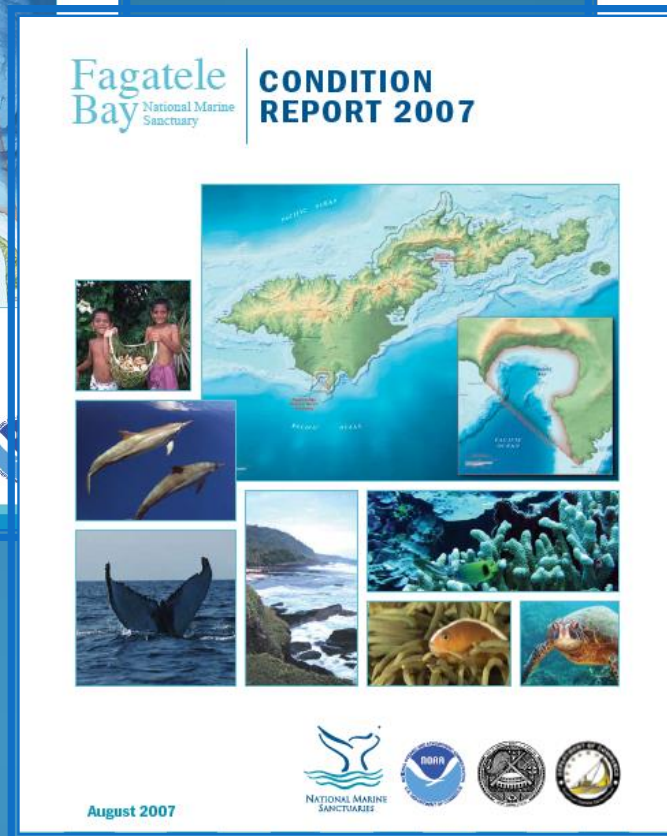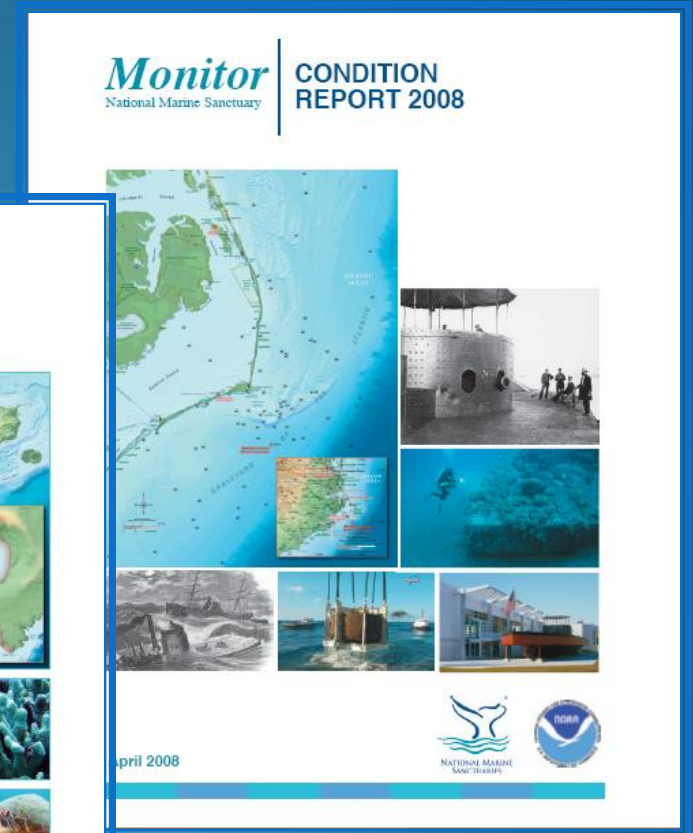
Condition Reports

Water

Subject areas:

    Water

    Habitat

    Living Resources

    Maritime Archaeological Resources

Goals:

    Periodically document resource *condition*

    Educate public for *management plan review*

    Report progress on resource protection and improvement goals; program *performance measures*

Habitat

Living

Archaeological

Condition Reports

- **Interpretation of on-going monitoring and research**

- **Executive summary level report; 30-60 pages**

- **Assessments by sanctuary staff, via subject matter experts and reviewers (SAC, region, NMFS, others)**

- **Uses quantitative data, and when necessary non-quantitative information to address each question**

- **Pressure-State-Response format**

- **Update every 5 years**

Condition Reports

State Section (Rating Status & Trends)

- **Subject areas: water, habitat, living resources and maritime archaeological resources)**

- **17 questions posed to all sanctuaries, each with six response options for status, four for trend, or N/A**

- **Experts invited to rate status and trend, provide a basis for judgment and supporting text and graphics**

- **Sanctuary is responsible for final rating**

Status:	Good	Good/Fair	Fair	Fair/Poor	Poor	Undet.

Trends:	Conditions appear to be improving	▲
	Conditions do not appear to be changing	—
	Conditions appear to be declining	▼
	Undetermined trend	?
	Question not applicable	NA

Condition Reports

17 Questions: Status and Trends

Water
- Multiple stressors
- Eutrophication
- Human health risks
- Human activities

Habitat
- Distribution
- Biological structure
- Contaminants
- Human activities

Living Resources
- Biodiversity
- Fishing impacts
- Non-indigenous species
- Key species status
- Key species health
- Human activities
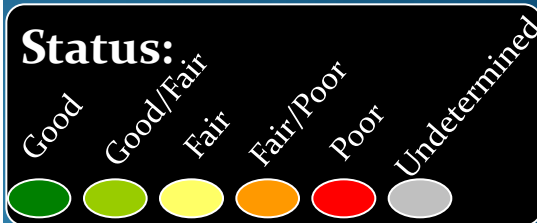
Maritime Archaeological Resources
- Integrity
- Environmental hazards
- Human activities

Condition Reports

Rating Trends

Questions/ Resources	Rating	Basis For Judgement	Description Findings	Sanctuary Response
HABITAT				
5. What are the abundance and distribution of major habitat types and how are they changing?	−	Reduction in habitat complexity by bottom-tending gear; short-term impacts from fishing gear and cable installation.	Selected habitat loss or alteration has taken place, precluding full development of living resource assemblages, but it is unlikely to cause substantial or persistent degradation in living resources or water quality.	Sanctuary and partners map and characterize deep habitats and the extent of human impacts and convey information to fisheries managers; large areas have been closed to fishing that uses bottom trawl gear to protect sensitive habitats; negotiated reburial of exposed fiber optic cable; began marine debris removal efforts.
6. What is the condition of biologically structured habitats and how is it changing?	?	Damage by bottom-tending gear in some deep biogenic habitats.	Selected habitat loss or alteration may inhibit the development of living resources, and may cause measurable but not severe declines in living resources or water quality.	
7. What are the contaminant concentrations in sanctuary habitats and how are they changing?	−	Prior studies indicate low levels of contaminants.	Contaminants do not appear to have the potential to negatively affect living resources or water quality.	
8. What are the levels of human activities that may influence habitat quality and how are they changing?	▲	Decrease in bottom trawling and presumably impacts to hard-bottom habitats.	Selected activities have resulted in measurable habitat impacts, but evidence suggests effects are localized, not widespread.	

Status:

Good Good/Fair Fair Fair/Poor Poor Undetermined

Trend:

▲ Improving

− Not changing

▼ Declining

N/A Not applicable

? Undetermined

Condition Reports-System Wide

Status Questions	Channel Islands	Cordell Bank	Fagatele Bay	Florida Keys	Flower Garden Banks	Gray's Reef	Gulf of the Farallones – Coastal and Offshore	Gulf of the Farallones – Estuarine and Lagoon	HI Isl. Humpback Whale	Monitor	Monterey Bay – Nearshore	Monterey Bay – Offshore	Monterey Bay – Estuarine	OCNMS	PMNM	Stellwagen Bank	Thunder Bay
WATER																	
1. Are specific or multiple stressors, including changing oceanographic and atmospheric conditions, affecting water quality and how are they changing?	?	—	▼	?	▼	—	—	?	—	—	—	—	—	?	▼	—	
2. What is the eutrophic condition of sanctuary waters and how is it changing?	—	—	—	—	—	?	?	?	—	N/A	—	—	—	—	—	—	
3. Do sanctuary waters pose risks to human health and how are they changing?	—	—	?	—	?	—	—	?	—	—	—	—	—	—	—	—	
4. What are the levels of human activities that may influence water quality and how are they changing?	—	?	▼	▲	—	—	▲	▲	—	—	▼	▲	—	—	▲	—	
HABITAT																	
5. What is the abundance and distribution of major habitat types and how is it changing?	?	—	?	—	—	?	▲	—	▼	▲	—	▲	▼	?	▼	—	
6. What is the condition of biologically-structured habitats and how is it changing?	—	—	—	▼	—	?	?	▼	N/A	?	—	▲	▼	?	▼	—	
7. What are the contaminant concentrations in sanctuary habitats and how are they changing?	▲	?	—	?	?	—	?	?	—	—	—	—	—	—	—	—	
8. What are the levels of human activities that may influence habitat quality and how are they changing?	▲	▲	—	▼	—	?	—	—	▼	—	—	▲	—	▲	—	▼	
LIVING RESOURCES																	
9. What is the status of biodiversity and how is it changing?	?	—	—	▼	—	?	▲	▼	▲	?	▼	▼	—	▲	—	▲	
10. What is the status of environmentally sustainable fishing and how is it changing?	▲	—	—	—	?	▼	▲	—	N/A	N/A	—	▲	—	?	▲	—	
11. What is the status of non-indigenous species and how is it changing?	▼	—	—	—	—	▼	—	—	?	—	—	—	—	▼	?	▼	
12. What is the status of key species and how is it changing?	—	—	—	—	?	▼	?	▼	▲	N/A	—	—	▼	?	?	—	
13. What is the condition or health of key resources and how is it changing?	?	—	▼	▼	▼	?	▲	?	▼	N/A	—	▼	?	?	?	—	
14. What are the levels of human activities that may influence living resource quality and how are they changing?	—	▲	?	▼	?	?	—	▼	▼	—	▼	▲	—	▲	—	—	
MARITIME ARCHAEOLOGICAL RESOURCES																	
15. What is the integrity of maritime archaeological resources and how is it changing?	▼	N/A	N/A		N/A	N/A	?	?	—	?	?	—	?	▼	▼		
16. Do maritime archaeological resources pose an environmental hazard and is this threat changing?	▼	N/A	N/A	—	N/A	N/A	▼	—	?	—	—	▼	—	—	—		
17. What are the levels of human activities that may influence maritime archaeological resource quality and how are they changing?	▲	N/A	N/A		N/A	—	?	?	▼	—	?	?	—	?	▲	▼	

Condition Reports Drive Management

- Gray's Reef managers used their report to support a decision to prohibit spearfishing in the sanctuary.

- Information from condition reports is used to support sanctuary management plan updates.

- Across the sanctuary system, condition reports are used to identify local monitoring gaps and science needs.

- The condition report at *Monitor* NMS led to a partnership with the North Carolina Aquarium to improve water quality monitoring in the sanctuary.

- The condition reports drive improvements in the long-term monitoring program for the coral reef ecosystems of the Flower Gardens Sanctuary.

- Condition reports often generate considerable media attention.

- The Commission on Environmental Cooperation has adopted the condition report model to document status and trends in marine protected areas in Canada, the U.S., and Mexico.

- The condition report is part of a training curriculum for Monterey Bay NMS volunteers.

- International resource management agencies are trained in the preparation and use of condition reports.

Concluding Comments:
Common Elements

- Up front planning required on what and how to collect data, define metrics of ecosystem condition that are relevant to management, research, and monitoring actions.

- Requires integration of existing data with targeted new data collections.

- Maximum use of quantitative data, but ultimately requires expert review and consultation via workshops and 1:1 discussions.

- Upcoming efforts to use "Environmental Report Cards": approach to characterize severity of harmful algal bloom forecasts, Lake Erie pilot; NCRMP data analysis and presentation.