APPENDIX A

INVITATION, AGENDA, AND PARTICIPANT LIST

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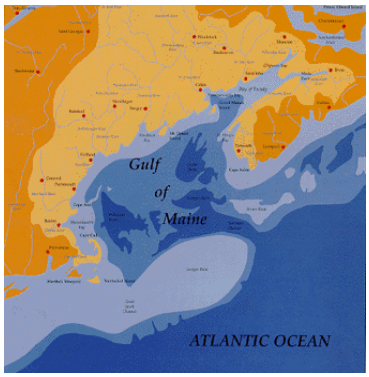


Northeast Coastal Indicators Workshop

New England Center, University of New Hampshire, Durham, NH
January 6-8, 2004

The Northeast Coastal Indicators Workshop (NCIW) Steering Committee invites you to participate in a workshop to develop a list of indicators that apply to the northeast coastal region of the United States (from New York to Maine) and Canada (Gulf of Maine). The 2000 Coastal Research and Monitoring Strategy, developed in partnership with EPA's Office of Wetlands, Oceans and Watersheds, Coastal Management Branch, NOAA, USGS, and the U.S. Department of Agriculture, recommends the development of issue-based regional coastal monitoring efforts supported by the National Coastal Survey. The monitoring efforts developed under this strategy are meant to concentrate on specific issue-based problems (*e.g.,* eutrophication, sediment contamination, habitat loss) with particular emphasis on regional outlooks. The first workshop, the Atlantic Northeast Coastal Monitoring Summit, was held in December of 2002 to begin coordinating regional monitoring efforts. This second workshop will focus on developing a list of suggested indicators to answer questions on the status of the regions ecosystems.

This workshop is an **extremely** important initiative for identifying indicators to track the status of the region. It will also provide EPA, regional entities, and state monitoring programs with important input regarding their coastal monitoring, assessment, and ecological indicators development. Discussions will include indicator use throughout the region within six categories: fisheries, eutrophication, contaminants, land use, aquatic habitat, and climate change. Presentations and discussion of current monitoring\indicator efforts and future needs will be an important part of the workshop.

Agenda and Workshop Materials
Attached please find a working draft of the workshop agenda. A Northeast Coastal Indicators Workshop website [www.gulfofmaine.org/nciw/] will be maintained to supply additional workshop materials on the January 2004 workshop and background information from the December 2002 workshop. The website will also include additional information for the poster session, a list of Steering Committee members, and updates as appropriate.

Poster Session Instructions
We encourage participants to develop and present posters on indicators developed for their programs especially for the following topics: fisheries, contaminants, eutrophication, aquatic habitats, land use, and climate change. The poster presentations are intended to help inform participants of current indicator activities, provide information on the location and scale of active programs, show where present monitoring links to the ecological basis of the indicators being developed, and provide opportunities of participants to network with each other. Poster presentations should be designed to support the workshop discussions and expected outcomes by presenting information that addresses the following: Purpose and goal(s) of the indicators including any regulatory mandates, Agencies/entities funding the program and parties conducting the indicator development, Questions being addressed, and the type, location and frequency of measurements. Presentation of indicator data and results should be at a summary level and limited to information that will support discussions on the strategy and framework. Please contact Melissa Manley at the address below if you plan to bring a poster.

Workshop Registration Information

Early registration is encouraged due to limited space. Registrations mailed prior to December 4, 2003 will be allowed to register at the discounted conference fee of $200 for the full conference (includes all breaks, receptions, and meals) or $150 for the two-day rate. Registrations mailed after December 4, 2003 will be subject to the full conference fee of $240 for the full conference or $190 for the two-day rate. It is important that participants have an understanding of the decisions made during the breakout sessions, thus we are not offering a one-day fee. Please see the attached registration form for specifics.

Payment must be made by check IN ADVANCE (made out to the U.S. Gulf of Maine Association) and can be mailed to:

Edna Cayford
NW Atlantic Indicators Conference
State House Station #38
Augusta, Maine 04333

Hotel Reservations

A block of rooms have been reserved at the New England Center for those who need to stay overnight. The rate is $89.00 per night plus tax. Hotel reservations must be made as specified on the separate hotel reservation form. Please note that Battelle and all other affiliates of the workshop are not responsible for any portion of the room reservation process or billing. ***Payment, reservations, and cancellations for hotel accommodations are the responsibility of each individual attendee.*** Cancellations or changes must be made with the facility before December 22, 2003 or the attendee will be responsible for full payment of the evenings reserved.

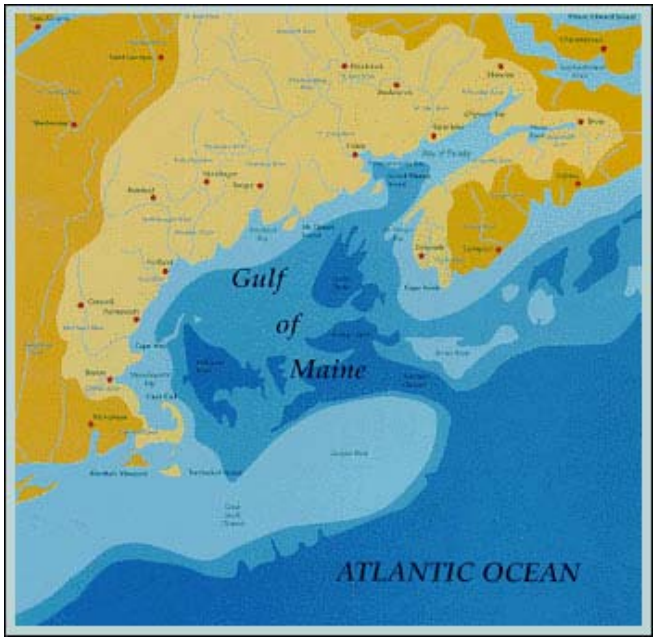
Travel Assistance

Limited funds are available for travel support to those that would otherwise be unable to attend. These funds are limited, thus they are available on a first-request basis to those individuals with insurmountable travel obstacles. Please contact Mr. Barry Burgan at (burgan.barry@epa.gov) if you need travel support.

We look forward to a very productive workshop! If you have any questions regarding logistical information please contact:

Melissa Manley, Battelle
Phone: 781-952-5365
Email: manleym@battelle.org

Northeast Coastal Indicators Workshop



January 6-8, 2004

New England Center, Durham, NH

Sponsored By:

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Gulf of Maine Council on the Marine Environment

SPO Maine State Planning Office Maine Coastal Program

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Agenda

Vision – A sustainable Northwest Atlantic ecosystem that ensures environmental integrity and that supports and is supported by economically viable, healthy human communities.

Mission – To track the status and trends in ecosystem integrity throughout the Northwest Atlantic region through collaborative partnerships. To provide information for management decisions at regional and local scales.

Indicators Workshop Goal – Consensus on a list of key indicators for which regional data will be compiled and tracked to indicate changing trends in ecosystem integrity through the Northwest Atlantic region.

This "working summit" will:

- Review present efforts to coordinate monitoring and indicator development throughout the region.
- To develop indicators that apply to the northeast coastal region of the United States (from New York to Maine) and Canada (Gulf of Maine) under six categories fisheries, eutrophication, contaminants, land use, aquatic habitat, and climate change.
- Report the findings of the indicator development to senior environmental policy managers and discuss how these indicators might be incorporated into programs throughout the region in the near future.

Day 1: Tuesday, January 6, 2004

11:00 - 1:00 Registration

1:00 - 1:30 Workshop Welcome - Barry Burgan
Introductions and Workshop Charge - Carlton Hunt

1:30 – 1:45 Review of December 2002 Monitoring Workshop Recommendations & Progress - David Keeley

1:45 – 2:10 Role of the National Coastal Assessment and Findings - Hal Walker

2:10 – 2:20 Implementing a regional indicators effort – A "straw-man" – David Keeley

2:20 – 3:00 Results of Fall 2003 Indicators Survey - Carlton Hunt

3:00 – 3:15 Break

3:15 – 4:00 **Keynote Speaker - Dr. Ken Sherman, NMFS – The Use of Indicators in International Large Marine Ecosystem Program in Relation to the Northeast**

4:00 – 5:00 **Charge to the Breakout Sessions and Logistics - Carlton Hunt**

5:00 – 6:30 **Poster Session & Reception -- Sponsored by the Alliance for Coastal Technologies (ACT)**

6:30 **Dinner**

Day 2: Wednesday, January 7, 2004

7:30 – 8:30 **Continental Breakfast**

8:00 – 3:30 **Developing Regional Indicators -- Breakout Sessions**

Workshop participants will be divided into six topics: fisheries, contaminants, eutrophication, aquatic habitat, coastal development, and climate change. Breakout sessions will run concurrently and each will discuss conceptual models, topic issues, questions and indicators developed during pre-workshop activities.

Approximate schedule:

8:00 – 10:00	Session # 1
10:00 - 10:15	Break
10:15 - 12:15	Session # 2
12:15 - 1:30	Lunch
1:30 – 3:30	Session # 3

3:30 – 3:45 **Break**

3:45 - 5:00 **Keynote Speaker Congressman Tom Allen, Maine**

Congressman Tom Allen of Maine is a co-chair of the bipartisan House Oceans Caucus. He also serves on the subcommittees on Energy & Air Quality and Environment & Hazardous Materials.

5:00 - 6:30 **Evening Reception**

6:30 **Dinner**

Day 3: Thursday, January 8, 2004

7:30 - 8:00 **Continental Breakfast**

8:00 - 9:00 **Report Out from each Break-out Session**

9:00 - 11:30 Senior Management Panel
The panel of senior environmental policy managers will respond to outcomes of the breakout session including question and clarification discussions among all participants and indicate how the outcomes might be incorporated into future regional environmental management efforts. Panel members committed to participate include:

- Dr. Priscilla Brooks, Conservation Law Foundation;
- Secretary Ellen Roy Herzfelder, Executive Office of Environmental Affairs, Massachusetts Department of Environmental Protection;
- Mr. Byron James, New Brunswick - Deputy Minister of Agriculture, Fisheries, and Aquaculture;
- Ms. Faith Scattolon, Fisheries and Oceans, Canada;
- Dr. John Boreman, NOAA;
- Dr. Rick Spinrad, National Ocean Service;
- Ms. Betsey Wingfield, Connecticut Department of Environmental Protection; and
- Ms. Katrina Kipp, EPA Region 1

11:30 - 11:50 Next Steps

11:50 - 12:00 Closing Remarks

Northeast Coastal Indicators Workshop
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APPENDIX B

WORKSHOP PRESENTATIONS

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Charge to Workshop
Dr. Carlton Hunt, Battelle

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Northeast Coastal Indicators Workshop

Durham, NH

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2

Northeast Coastal Indicators Workshop

January 6, 2004

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Messages taken from Scott Nixon keynote at September 2003 ERF meeting regarding our coastal programs

- "It is time to look at the macro scale more, we have become too reductionistic and mechanistic."
- From Odum: Always select the scale one size larger than your problem because it is half driven from the large scale, that is the first principle of the system approach

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Background Information

- In 2002, efforts began on developing a coordinated regional monitoring effort throughout the northeast Atlantic region
  - Area under consideration Atlantic Ocean from New York to Maine and the Bay of Fundy, Canada
  - Ecologically based focus on three areas: Habit loss, contaminants, nutrient over enrichment
- This workshop expands upon this original work to develop regional indicators in six important focus areas

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Background Information

- **Regional Effort to Coordinate Monitoring\Indicators**
  - **Vision** – A sustainable Northwest Atlantic ecosystem that ensures environmental integrity and that supports and is supported by economically viable, healthy human communities.
  - **Mission** – To track the status and trends in ecosystem integrity throughout the Northwest Atlantic region through collaborative partnerships. To provide information for management decisions at regional and local scales.
- **NCI Workshop Goal** – Consensus on a list of key indicators for which regional data will be compiled and tracked to indicate changing trends in ecosystem integrity through the Northwest Atlantic region.

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Background Information

- **NCI Workshop will**
  - Review present efforts to coordinate monitoring and indicator development throughout the region.
  - Develop indicators that apply to the northeast coastal region under 6 focus areas
    - Fisheries
    - Contaminants
    - Eutrophication
    - Coastal Development
    - Aquatic Habitat
    - Climate Change
  - Discuss how indicators could be measured and managed, including incorporation into existing programs, in the near future.

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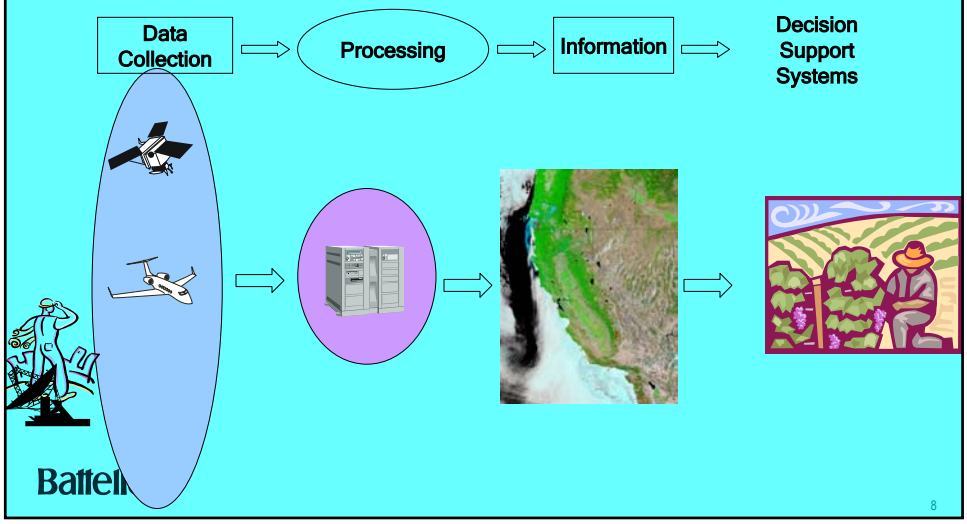
Similar Regional Efforts

Pacific Northwest Regional Collaboration



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NCI Workshop Participation

- EPA (Region and NCA), NEPs
- Environment Canada
- State environmental management and protection agencies plus regulatory agencies
- New England Fisheries Management Council
- Fisheries and Oceans, Canada
- Research Reserves
- Sea Grant Programs
- Gulf of Maine Council
- GoMOOS
- NOAA
- Others

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Overview of the Workshop Schedule

- Today – Overview of background information on Indicator Development efforts and the goals of the workshop
- Wednesday – Using focused breakout groups agree on key regional questions that need to be answered and the indicators that should be used to answer them
- Thursday – Report out to participants and senior managers the findings of the breakout sessions and discuss how these efforts might be implemented throughout the region

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Workshop Background Information Products

- National Indicator Development Initiatives
- Tapping the Indicators Knowledge-base:" Lessons learned" by developers of environmental indicators
- Relevant Definitions for the Indicator Workshop
- Straw Ecological Concept models to support indicator development
  - Fisheries
  - Contaminants
  - Eutrophication
  - Aquatic Habitat
  - Coastal Development
  - Climate Change
- Draft List of Key Questions and Indicators
- Bibliography of Indicator Reports

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Why a regional effort?

- Regional councils are gaining visibility and importance
  - Pew Commission recommended coastal coordinating councils
  - Integrated Ocean Observing systems
  - Ocean Commission
- Why
  - Consistency in informing decision-makers and public on progress in coastal protection and restoration
  - Making sure we monitor for the right things

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Why a regional effort?

- Address gaps between monitoring and management by
  - Reaching out to managers to ensure our work is relevant
  - Working on constituency and meeting management needs
  - Figuring out the questions to ensure timely, relevant information is produced
- Pressing need for
  - Application of consistent (though not identical) methods
  - Consistent monitoring approaches (but not identical)
  - Aggregation of information from local to regional and higher levels
  - Consistent set of drivers, champions, support, and coordination

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Why a regional effort?

CONCLUSION

There is imminent opportunity for this region to become one of the leaders of integrated coastal monitoring along with groups such as SCCWRP. Great Lakes, and Chesapeake Bay.

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Expectations from the Workshop

- By the end of the workshop we hope to finalize for each focus area (i.e., breakout group)
  - Conceptual Model
  - List of key issues and questions
  - List of indicators for the top 3 to 5 issues/questions
    - Identify up to 3 indicators for monitoring throughout the region
    - Identify information conveyed by the indicators identified and users
    - Spatial and temporal effectiveness of each indicator
    - Methods to communicate status of the region
    - Whether additional data collection efforts are needed
  - Develop a plan to implement these regional indicators into present programs

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15

2002 Northeast Monitoring Workshop & Progress Forward

David Keeley, Maine State Planning Office

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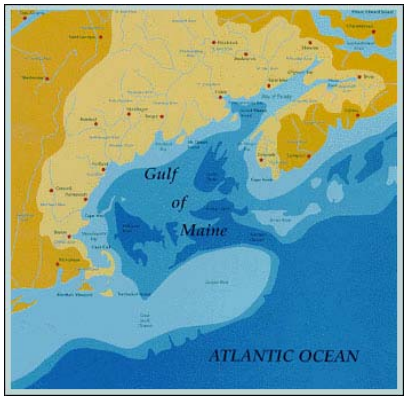
2002 Northeast Monitoring Workshop & Progress Forward



Setting a Context

I. December 2002 Monitoring Workshop

- Focus
- Results
- Next Steps

II. Progress Attained

- Data Aggregation
- Organizational Development

Workshop Focus

- What are the benefits and challenges from coordinated regional monitoring;
- How this would help solve pressing regional environmental issues;
- How a monitoring network might be organized; and
- What new monitoring and research is needed.

Workshop Results

- Significant merit in working on environmental issues at a regional scale;
- Focus an integrated network on specific questions;
- Involve major monitoring programs (e.g., 800 lb) to attain critical mass and identity;
- Address inherent challenges and promote benefits

Workshop Products

- Rationale, definition on the expectations, and framework for an ecologically driven coordinated regional monitoring program
- Inventory of monitoring programs
- Regional monitoring and research gaps
- Lessons learned from other coordinated monitoring programs
- Website www.atlantic-ne-monitoring.net

Recommended Next Steps

- Identify products critical to management;
- Develop regional monitoring strategy;
- Locate a fiscal agent to manage finances & secure initial resources;
- Convene indicators summit; and
- Develop State of the Environment report.

"we had high expectations but what happened?"

II. Progress Attained (selected examples)

Data Aggregation

- Contaminants: Mercury Synthesis & Template
- Nutrients: Metrics & Indices
- Monitoring Inventory
- Stock Assessment & Tissue Analysis
- Spatial data framework for the Gulf of Maine to support benthic habitat mapping for resource management
- Northern Shrimp Project
- Prototype Biophysical Maps - Census for Marine Life

Progress

Organizational Development

- Environmental Information Exchange Proposal
- *Vital Signs* initiative
- GOM Ocean Data Partnership
- EPA Regional Commitment & Northeast Coastal Indicators Workshop
- Gulf of Maine Summit in October 2004
- Regional Ocean Observing Systems – data streams
- Monitoring and Observing Integration Pilot Funds
- Increased Monitoring & Indicator Funding

Conclusions

- Significant progress was attained since 12/02
- Increasing appreciation for scope & complexity
- Success in other regions is compelling
- “old fashioned” commitment is a pre-requisite
- Key building blocks exist
- Funds are available & horizon is promising

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The Role of the National Coastal Assessment and Findings

Dr. Hal Walker, EPA

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The Role of the National Coastal Assessment and Findings

Henry Walker [1], John Kiddon [1], Harry Buffum[2], Michael Charpentier[2], Gerald Pesch[1], Donald Cobb[1], and Walt Galloway[1]

[1] Atlantic Ecology Division
National Health and Environmental Effects Research Laboratory
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Narragansett, Rhode Island 02882

[2] CSC Corporation
Narragansett, Rhode Island 02882

A Growing Partnership

RESEARCH & DEVELOPMENT

Building a scientific foundation for sound environmental decisions

The Role of the National Coastal Assessment

Broad – National Coastal Survey

Key NCA Contacts in the Northeastern U.S.

Name	State
Walker, Henry	EPA-AED
Kiddon, John	EPA-AED
Bengi, Sandy	EPA-AED
Paul, John	EPA-NHEERL
Pesch, Gerald	EPA-AED
Galloway, Walt	EPA-AED
Cobb, Don	EPA-AED
Berry, Walter	EPA-AED
Latimer, James	EPA-AED
Dettmann, Edward	EPA-AED
Buffum, Harry	EPA-AED
Copeland, Jane	CSC
Charpentier, Mike	CSC
Simcox, Alison	EPA Region 1
Robinson, Keith	USGS
Moore, Richard	USGS
ANNOTATED NCA Contacts List	
Arthur D. Little Lab	C2000
TRAC Laboratories	C2000
Barry Vittor and Assoc.	C2000
EFII Lab	NCA
TAI Environmental	NCA
Banach, Fred retired	CT
Lyman, Matt	CT
Hoffman, Gus	CT
Howell, Penny	CT
Johnson, Mark	CT
Millus, Julie	CT
Olsen, Christine	CT
Perkins, Chris	CT
Simpson, Dave	CT
Stacey, Paul	CT

Anderson, Ben	DE
Fikslin, Tom	DE
Huerta, Sergio	DE
Kineon, Forsyth	NJ & DE
Knowles, Kathy	DE
McCleary, Barbara	DE
McQuaide, Dave	DE
Onken, Gary	DE
Otto, Carolyn	DE
Santoro, Ed	NJ & DE
Adams, Darvene	EPA
Braun, Randy	EPA
Craven, George	EPA
Gould, Diane	EPA
Heath, Ellen	EPA
Kurtenback, Jim	EPA
Libertz, Catherine	EPA
Macauley, John	EPA
Nolan, Peter	EPA
Stoob, Hilary	EPA
Summers, Kevin	EPA
Tedesco, Mark	EPA
Thompson, Rag (retired 12/2002)	EPA
Baker, Jason	MA
Bucholtz ten Brink, Marilyn	MA
Gardner, Bernie	MA
Howe, Arnie (retired 11/2002)	MA
Johnson, Arthur S.	MA
Keay, Ken	MA
Krahforst, Christian	MA
Smith, Jan	MA
Snow-Cotter, Susan	MA
Turner, Jefferson	MA
Wallace, Gordon	MA

Barker, Seth	ME
Bagley-Smith, Elsevelg	ME
Churchill, Lureese	ME
Courtemanch, Dave	ME
Doggett, Lee	ME
Groves, Katherine (departed 9/02)	ME
Langton, Rick	ME
LaPointe, George	ME
Lazrari, Mark	ME
Leyden, Kathleen	ME
Mendall, Linda	ME
Sherman, Sally	ME
Towle, Jason	ME
Young, Karen	ME
Baczynski, Robert	NH
Currier, Paul	NH
Dreisig, John	NH
Jones, Steve	NH
Lamson, Deb	NH
Landry, Natalie	NH
McLaughlin, Joanne	NH
Nash, Chris	NH
Fleiche, Paul	NH
Shaq, Dave	NH
Trowbridge, Phil	NH
Belton, Tom	NJ
Buchanan, Gary	NJ
Connell, Bob	NJ
Danko, Mike	NJ
Eberle, Bill	NJ
Hughes, James	NJ
Litvin, Steve	NJ
McGeorge, Leslie	NJ
Mumman, Jim (retired 12/2002)	NJ
Weinstein, Mike	NJ
Johnson, Sandra	NOAA

Aldous, Kenneth	NY
Cerrato, Italo retired	NY
Chgrato, Karen (out of NCA 10/02)	NY
deQuilfeldt, Charles	NY
Foley, Mike	NY
Myers, Jeff	NY
Nuzzi, Robert	NY
Roethel, Frank	NY
Swanson, Larry	NY
Viggins, Mark	NY
O'Neil, Steve	PA
Deacutis, Chris	RI
Gibson, Mark	RI
Lynch, Jim	RI
O'Shea, Stephen	RI
Oviatt, Candace	RI
Pomeroy, Skip	RI
Powell, Chris	RI
Satchwell, Dick	RI
Scott, Tim	RI
Tate, Andrew	RI
Webb, Paul	RI

RESEARCH & DEVELOPMENT

Building a scientific foundation for sound environmental decisions

The Role of the National Coastal Assessment and Findings

Talk Outline:

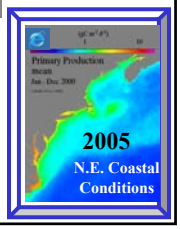
Role & Implementation of the NCA

- Goals
- Strategy
- Approach

Broad – National Coastal Surveys

- Preliminary Findings

- Next Steps for Analysis & Reporting
  - Electronic Web-Based Reporting, possibly with active links to: 1) NCA data, 2) Analysis Tools, 3) National Estuary Programs, & 4) States



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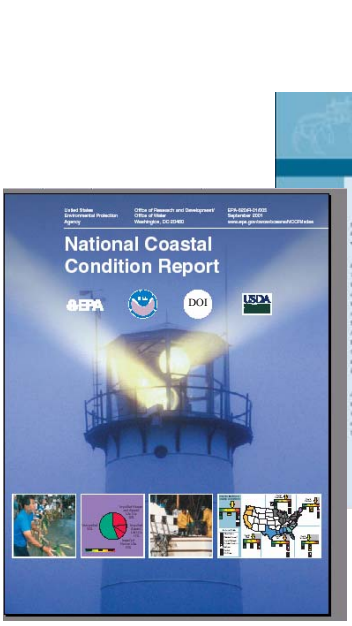
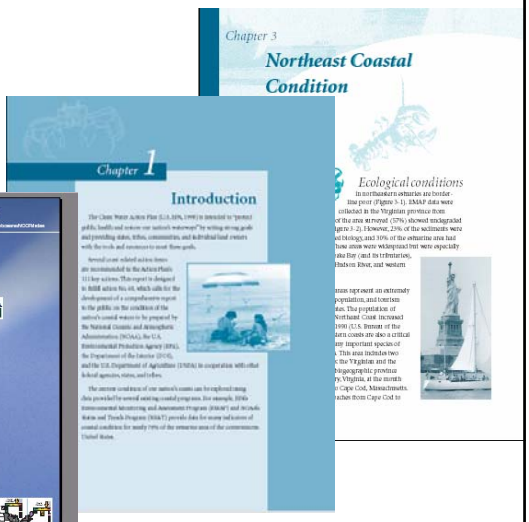
Building a scientific foundation for sound environmental decisions

The Role of the National Coastal Assessment





National Coastal Condition Report

September 2001

http://epa.gov/owow/oceans/nccr/downloads.html

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Building a scientific foundation for sound environmental decisions

Consistently Measured Indicators Coastal 2000 / NCA Core Indicators:

Water Quality
- dissolved oxygen
- salinity
- temperature
- pH
- depth
- light attenuation
- secchi depth
- dissolved nutrients
- chlorophyll a
- total suspended solids (*TSS*)

Sediment Quality
- sediment contaminants
  . (organics & metals)
- sediment TOC
- sediment toxicity (amphipod)
- percent silt/clay

Biota

Fish/Shellfish
- community structure (*fish*)
- tissue contaminants
  . (*organics & metals*)
- external pathology (*fish*)

Benthos
- community structure

Habitat
- SAV (presence/absence)
  west coast & gulf coast
- basic habitat type
  (*e.g., open water, tidal flat*)
- marine debris (*presence/absence*)

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Building a scientific foundation for sound environmental decisions

The Role of the National Coastal Assessment

NCA will help address some basic questions:

- What are the conditions of estuarine resources in the U.S., how are they changing, and what are the causes of those changes?
  - To document conditions, we need to systematically gather data, in addition to taping into expert opinion
- How well different coastal condition indicators, and monitoring designs work?

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Building a scientific foundation for sound environmental decisions

The Future – A National Strategy:

Research and Monitoring within an Integrated Assessment Framework

- **Tier 1: Characterization of the Problem**
  - Broad scale response properties
  - (surveys, automated collection and / or remote sensing)
- **Tier 2: Diagnosis of Causes**
  - Issue or resource specific surveys and observations
  - (focusing on cause and effect interactions)
- **Tier 3: Diagnosis of Interactions and Forecasting**
  - Intensive monitoring and research index sites with higher spatial and temporal resolution to determine specific mechanisms of interaction.
  - Needed to build cause and effect models

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Building a scientific foundation for sound environmental decisions

The Role of the National Coastal Assessment

Broad – National Coastal Survey

Goals:

- Assess the ecological condition of estuarine resources.
  - Based on unbiased data of know quality
- Determine reference conditions for studies on ecological responses / stressors.
- Build infrastructure in states and EPA Regions.

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The Role of the National Coastal Assessment

Broad – National Coastal Survey

Strategy:

- Partner with state resource agencies for collection, processing, and analysis of samples
- Develop state and regional infrastructure
- Develop state and regional understanding

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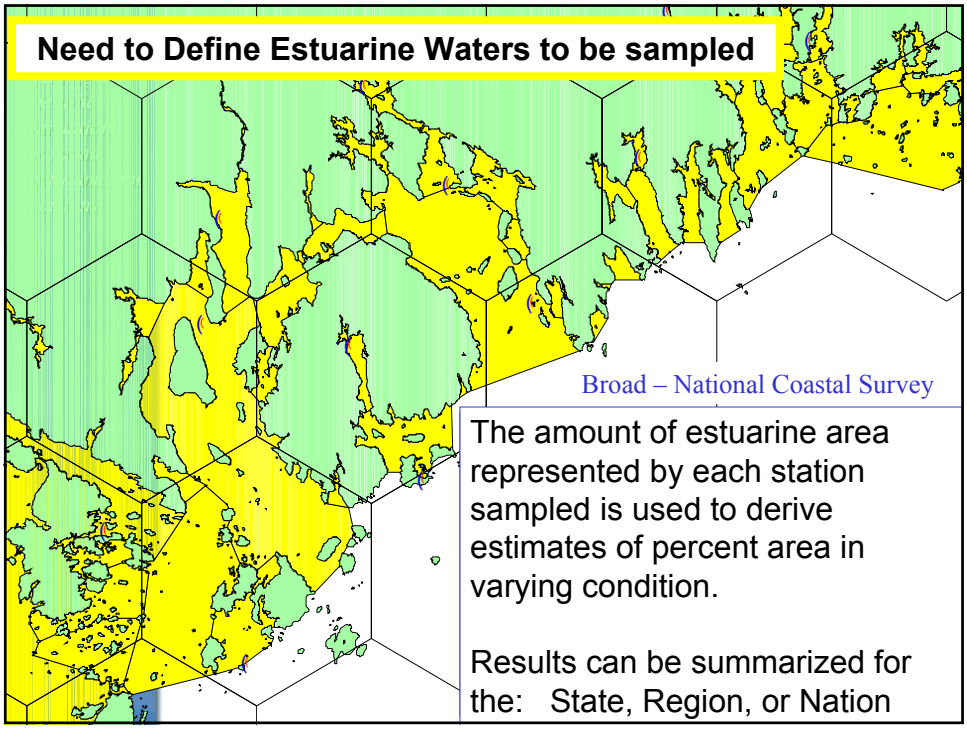
The Role of the National Coastal Assessment

Broad – National Coastal Survey

Approach:

- Utilize consistently measured indicators to assess and help explain estuarine condition
- Utilize Probability surveys
  - Extrapolates to all of estuarine waters
  - Addresses 305(b) requirements & GPRA
  - 100% assessed waters
- Incorporate existing monitoring programs, & develop hybrid monitoring designs

Need to Define Estuarine Waters to be sampled



Broad – National Coastal Survey

The amount of estuarine area represented by each station sampled is used to derive estimates of percent area in varying condition.

Results can be summarized for the: State, Region, or Nation

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The Role of the National Coastal Assessment

Broad – National Coastal Survey

Approach in Northeast

Consider Merger of Existing Monitoring Programs with Probability Survey Designs

Existing Programs –

fiscal and human resource investment

valuable environmental information

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The Role of the National Coastal Assessment

Broad – National Coastal Survey

Choices for Existing Programs

Replace all existing sites with randomly selected stations

- lose ability to track trends
- loss of investment in data

Use existing sites

- inferences to non-sampled sites?

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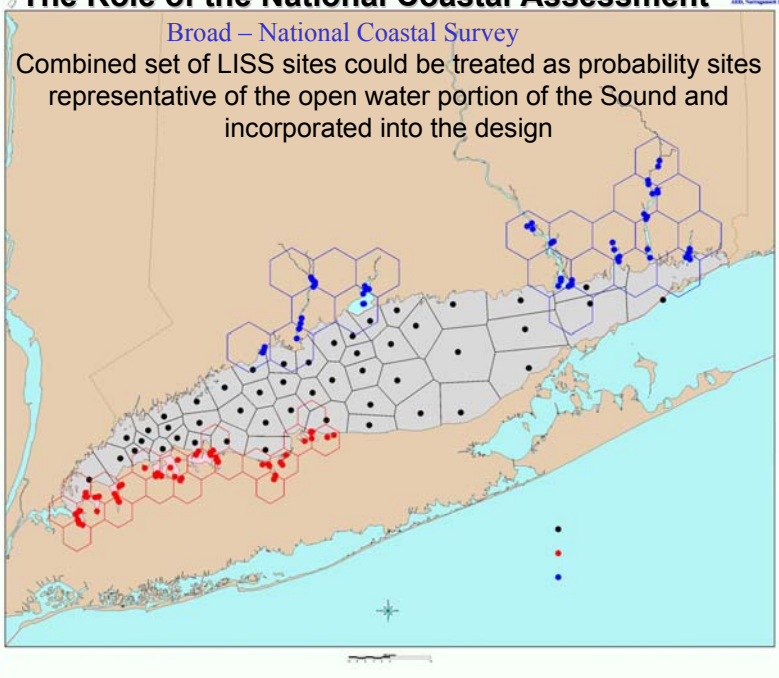
Building a scientific foundation for sound environmental decisions

The Role of the National Coastal Assessment

Broad – National Coastal Survey

Combined set of LISS sites could be treated as probability sites representative of the open water portion of the Sound and incorporated into the design



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Implementing a Regional Monitoring and Indicators Initiative

David Keeley, Maine State Planning Office

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Making it happen

Implementing a regional monitoring and indicators initiative

Year-One Deliverables

- Produce a region-wide monitoring and indicators strategy
  - Principles
    - Priority management issue and question driven
    - Partner relations intensive
    - Phased implementation schedule
    - Resource sensitive
    - Demonstration oriented

Core Components

- Determine the scope and logistics to create an integrated monitoring program producing products of regional value
- Ground-truth with audience their needs for regional indicators, possible applications and elements of a pilot project

Phase I. Integrated Monitoring

- Set priorities among pressing management issues and questions
- Identify required monitoring and research needs
- Select essential monitoring programs that can respond
- Determine sampling design & sampling protocol, statistical sampling design, data management & analysis plan, type & intent of products, etc.
- Analyze and integrate pertinent monitoring data
- Deliver synthetic products to managers, regulators, decision-makers, scientists, etc.

Phase II. Indicators Pilot Project

- Initiate demonstration pilot
  - Define goals, audiences, uses
  - Content
    - Region-wide (1 theme) or sub-regional (multiple themes & indicators)
  - Apply indicators
    - Education, communication, outreach methods & materials

"a process of producing and communicating policy relevant information on key interactions between people and the natural environment"

Organizational

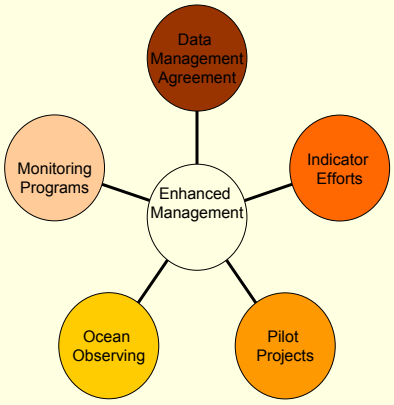
Form

- Ongoing stakeholder-based & inclusive committee representing the region w/ work groups
- Negotiate institutional host agreement
- Nonprofit governance model
- Seed funded (grants & contributions)
- Staffing (initially 1-3 people)

Critical Linkages

- Management & regulator community involvement to frame need & buy in
- Monitoring & observing community to provide data & create synthetic products
- Scientific community to guide expanded monitoring and identify research needs
- People/Programs with lessons to share

Basic Building Blocks



Next Steps

"create solid foundation for sustained effort"

Form committee; set terms of reference, goals & work plan; secure seed funds & hire staff; and commence work on region-wide monitoring and indicators strategy	Spring 2004
Disseminate concept & solicit comments	Summer & Fall
Produce strategy & seek seed-funds	Winter 2004/05

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Results of the Fall 2003 Indicators Survey

Dr. Carlton Hunt, Battelle

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Northeast Coastal Indicators Workshop
Web Survey results

January 6, 2004

Carlton D. Hunt, Ph.D.
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Duxbury, MA 02324
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Huntc@Battelle.org

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The Survey's Intent

- Obtain information on relative importance of the six identified workshop issue areas
- Understand the relative importance of key topics within each issue area
- Understand the relative importance of the key themes for communicating status and trends within issue area
- Provide back drop for straw indicators provided to the breakout sessions

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2

Who took the survey?

- 215 individuals
  - 28% science
  - 23% manager
  - 21% educator
  - 15% policy maker
  - 14% other
- Sector
  - 61% Public
  - 22% NGO
  - 11% Private
  - 7% Citizen

JobArena	Educator	Manager	Policy-maker	Scientist	Other	Total Responses
Citizen	3	2	5	3	6	**19**
Non-governmental	12	16	7	12	14	**61**
Private	11	2	2	11	3	**29**
Public	31	42	28	51	15	**167**
Total	**57**	**62**	**42**	**77**	**38**	**276**

NOTE: THE SAME PERSON OFTEN SELECTED MORE THAN ONE JOB DESCRIPTION

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3

Who took the survey?

- ME – 38%
- CT, MA – 12% each
- NB, NS – 7% each
- NH – 4%
- NY – 3%
- RI – 1%
- Other (federal?) – 17%

Jurisdiction	Educator	Manager	Policy-maker	Scientist	Other	Total Responses
Connecticut	5	10	5	9	3	**32**
Maine	31	19	17	26	12	**105**
Massachusetts	7	5	5	11	4	**32**
New Brunswick	4	4	2	4	4	**18**
New Hampshire	1	6	3	1	1	**12**
New York	4	1		3	1	**9**
Nova Scotia	3	3	2	5	5	**18**
Rhode Island	1	1		2		**4**
Other	1	13	8	16	8	**46**
Total	**57**	**62**	**42**	**77**	**38**	**276**

NOTE: THE SAME PERSON OFTEN SELECTED MORE THAN ONE JOB DESCRIPTION

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4

Who took the survey?

- Scientist (29%)
- Educator (21%)
- Manager (21%)
- Policy maker (15%)
- Other (15%)

JobDescrip	Embayment	Estuary	Harbor	Open Coastal Waters	Other	Total Responses
Educator	18	35	14	15	29	**111**
Manager	21	29	12	17	30	**109**
Policy-maker	12	19	8	12	24	**75**
Scientist	25	47	20	30	27	**149**
Other	11	19	13	15	20	**78**
Total	**87**	**149**	**67**	**89**	**130**	**522**

NOTE: THE SAME PERSON OFTEN SELECTED MORE THAN ONE JOB DESCRIPTION

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5

Where do we work?

- Estuaries (29%)
- Embayment and open coastal waters 17% each
- Harbors (13%)
- Other 25%
  - Navigable waters, coastal rivers and streams, coastal wetlands, watershed scale, coastal superfund sites, inland watersheds, mid shore to off shore, Gulf of Maine, open waters to continental shelf, coastal environments globally, estuaries outside of the northeast

JobDescrip	Embayment	Estuary	Harbor	Open Coastal Waters	Other	Total Responses
Educator	18	35	14	15	29	**111**
Manager	21	29	12	17	30	**109**
Policy-maker	12	19	8	12	24	**75**
Scientist	25	47	20	30	27	**149**
Other	11	19	13	15	20	**78**
Total	**87**	**149**	**67**	**89**	**130**	**522**

NOTE: THE SAME PERSON OFTEN SELECTED MORE THAN ONE JOB DESCRIPTION

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6

Where do we work?

- Most jurisdictions cover a range of scales in their work
- Estuaries and other dominate scale
- Embayment and open coastal waters are about equally represented

Jurisdiction	Embayment	Estuary	Harbor	Open Coastal Waters	Other	Unknown	Total Responses
Connecticut	4	12	2	3	11	1	**33**
Maine	20	20	12	20	27	1	**100**
Massachusetts	9	10	5	2	4	1	**31**
New Brunswick	4	4	2	9	4		**23**
New Hampshire	2	3	2	2	4		**13**
New York		5	1		1		**7**
Nova Scotia	3	6	2	3	5		**19**
Rhode Island	1	2	1	1			**5**
Other	5	14	4	9	20	1	**53**
Total	**48**	**76**	**31**	**49**	**76**	**4**	**284**

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7

Where do we work?

- ME, NH, and RI tend to work evenly across the scales
- NB has high percent in open waters
- Estuaries scale tend to dominate by jurisdiction

Percent of juristiction category

Jurisdiction	Embayment	Estuary	Harbor	Open Coastal Waters	Other	Unknown
Connecticut	12	36	6	9	33	3
Maine	20	20	12	20	27	1
Massachusetts	29	32	16	6	13	3
New Brunswick	17	17	9	39	17	0
New Hampshire	15	23	15	15	31	0
New York	0	71	14	0	14	0
Nova Scotia	16	32	11	16	26	0
Rhode Island	20	40	20	20	0	0
Other	9	26	8	17	38	2

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Survey Results

- Survey included three elements
  - Management issues
  - Management topics
  - Indicator Themes
- Cross cut by
  - Scale
  - Jurisdiction
  - Job description

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9

Was scale important to the leading management issues?

- Response was uneven across the scales and issues
  - Climate change received highest number of responses
  - Coastal development and health of fisheries received fewest number of responses
- Estuaries and open water seemed to be scales receiving the most responses within each issue,
  - although importance varied across the management issues
- Further analysis required to draw conclusions

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10

How important are the following leading management issues?

- All six management issues were rated as important to very important
- Many chose to only address issues with which they were familiar, thus the number of responses among the issues varied from 81 to 207
  - Climate change and coastal eutrophication received the most responses
  - Contaminants in the food chain and human effects on aquatic habitats received the next highest number of responses
  - Effects of coastal development and land use and health of fisheries received the fewest responses

Issue	Very Important	Important	Somewhat Important	Not Important	Total Respnse
Climate change on the environment	124	77	6	0	207
Contaminants in the food chain	100	47	0	0	147
Effects of coastal development and land use change on the environment	62	12	0	0	74
Effects of coastal eutrophication	106	57	2	0	165
Health of fisheries	66	15	0	0	81
Human effects on aquatic habitats	93	15	0	0	108
Other	23	3	3	0	29

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Topic issue responses

Issue area	Respondents	Percent ranking topic issues
Fisheries	~112	27 to 49
Contaminant	~105	25 to 52
Eutrophication	~117	35 to 71
Coastal development	~181	23 to 45
Marine habitat	~126	16 to 68
Climate change	~90	32 to 62

- Almost all respondents rated topic issues as important/very important

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12

Importance of topic issues by jurisdiction and scale

- Unevenness in the number of respondents by jurisdiction makes it hard to determine if there are differences in emphasis across the jurisdiction and scale
- Estuaries and open water tended to be scales receiving most responses within each issue topic but the actual indication of importance varied across the issue topics
- A substantial number of responses under other topic issues were made
- Further analysis required to draw conclusions
- Following presentation focuses on overall response to the issues and themes

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13

How important are the following fisheries issues?

- Affect of changing fish stocks on coastal (biological?) communities (49%) received highest response
- Fishing practices on non target species slightly fewer responses
- Levels of commercial stock and changes in species composition lowest response

Issue	Very Important	Important	Somewhat Important	Not Important	No Response	Percent Responding
Affect of changing fish stocks on coastal communities	40	15	0	0	57	49.1
Changes in species composition and biomass	29	2	0	0	83	27.2
Fish harvesting practices on non-target species and habitats	47	5	0	0	62	45.6
The levels of commercial and recreational fish stocks	29	4	0	0	81	28.9

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14

How important are the following contaminant issues?

- Changes in contaminant sources had highest response (52%)
- Fate and transport (41%) and lethal sublethal effects (42%) were lower but similar
- Extent of contamination received the lowest response

Issue	Very Important	Important	Somewhat Important	Not Important	No Response	Percent Responding
Changes in the sources of contaminants	45	10	0	0	50	52.4
Extent of contamination in the marine environment	20	6	0	0	80	24.5
Fate and transport of contaminants	30	12	0	0	61	40.8
Lethal and sub-lethal effects of contminants on fisheries and people	38	5	1	0	60	42.3

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15

How important are the following eutrophication issues?

- Potential for eutrophication (71%) and effects on human use (73%) had highest response
- Extent of eutrophication received the next highest response (51%)
- Rate, sources, and marine effects were lowest in that order

Issue	Very Important	Important	Somewhat Important	Not Important	No Response	Percent Responding
Concern for potential eutrophication	58	21	2	0	33	71.1
Effect of eutrophication on human use	48	32	5	0	32	72.6
Effect of eutrophication on the marine ecosystem	33	7	1	0	76	35
Extent of eutrophication in the region	41	18	1	0	57	51.3
Major sources of nutrients	43	2	1	0	71	39.3
Rate of eutrophication in the region	32	17	3	0	65	44.4

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16

How important are the following coastal development issues?

- Fragmentation on priority species (45%) and land use change on terrestrial habitats (42%) highest response
- Changes in land cover was next (26%)
- Changes in water and hydrology received lowest response

Issue	Very Important	Important	Somewhat Important	Not Important	No Response	Percent Responding
Changes in land cover	39	8	0	0	134	26
Changes in water quality and hydrology	36	6	0	0	140	23.1
Effect of fragmentation on priority species	64	17	0	0	100	44.8
Effect of land use change on terrestrial habitats	55	21	0	0	106	41.8

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17

How important are the following marine aquatic habitat issues?

- Type, location and effects of restoration (68%) and (66%) had highest response
- Coastal armoring and sediment management next (55%) followed by change in extent and quality of submerged aquatic vegetation (42%)
- Changes in coastal and tidal wetlands received lowest response (16%)

Issue	Very Important	Important	Somewhat Important	Not Important	No Response	Percent Responding
Changes in sediment character and quality	51	29	3	0	43	65.9
Changes in the extent and quality of coastal and tidal wetlands	16	4	0	0	106	15.9
Changes in the extent and quality of submerged aquatic vegetation	39	13	0	0	72	41.9
Coastal armoring and sediment management practices	51	15	3	0	57	54.8
Health and diversity of aquatic habitats	29	7	0	0	87	29.3
Type location and effects of restoration activities	61	22	3	0	40	68.3

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18

How important are the following climate change issues?

- Effect of sea level rise and changing weather patterns on coastal infrastructure and erosion receive fewest responses (32%)
- Effect on hydrology and fresh water inputs and biodiversity changes from temperature received the most responses (62%) followed closely by climate related shifts on biota (60%)

Issue	Very Important	Important	Somewhat Important	Not Important	No Response	Percent Responding
Climate-related regime shifts in biota	40	13	0	0	36	59.6
Effect of climate change and changing weather patterns on hydrology and fresh water inputs	45	11	0	0	34	62.2
Effect of sea level rise and changing weather patterns on coastal infrastructure & erosion	23	6	0	0	63	31.5
Effect on biodiversity related to water temperatures	36	19	1	0	34	62.2

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19

How useful are the following themes in communicating the status and trends of the fishery?

Theme	Very Useful	Useful	Somewhat Useful	Not Useful	No Response	Percent Responding	>somewhat useful
Populations of harvested species	20	2	0	0	39	36.1	22
• Increase/decrease in species diversity	20	3	0	0	43	34.8	23
• Status of commercial finfish stocks	22	3	0	0	40	38.5	25
• Status of forage fish species abundance/distribution	31	4	0	0	29	54.7	35
• Status of lobster stocks	23	6	2	0	33	48.4	31
Bottom type	22	18	7	0	16	74.6	47
Catch per unit effort	29	8	4	0	22	65.1	41
Commercial by-catch of non-target fish species and protected resources	30	7	0	0	26	58.7	37
Days fished by commercial/recreational vessels	24	26	4	0	11	83.1	54
Direct recreational fishing expenditures/multiplier effect in the regional economy	21	29	2	0	11	82.5	52
Economic contribution of fisheries and related industries in coastal communities	22	14	0	0	29	55.4	36

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20

How useful are the following themes in communicating the status and trends of the fishery?

Gear deployment information	27	17	6	0	13	79.4	50
Miles of stream open to fish migration	21	18	2	0	24	63.1	41
Relative fish abundance	30	5	1	0	29	55.4	36
Shellfish landings	23	12	2	0	24	60.7	37
Value of commercial landings	22	18	2	0	22	65.6	42

- Top themes
  - Days fished by commercial/recreational vessels
  - Direct recreational fishing expenditures/multiplier effect in the regional economy
  - Gear deployment information
  - Bottom type
  - Value of commercial landings
  - Stream reach open to fish migration
  - Fish abundance and shellfish landings
  - Status of forage fish species abundance/distribution

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21

How useful are the following themes in communicating the status and trends of contaminants??

Theme	Very Useful	Useful	Somewhat Useful	Not Useful	No Response	Percent Responding	>somewhat useful
Tissue contamination levels	18	2	0	0	36	35.7	20
• clams & mussels	17	4	0	0	38	35.6	21
• fish	17	6	0	0	37	38.3	23
• marine birds and mammals	26	8	0	0	24	58.6	34
Bathing beach closures	16	12	3	0	29	51.7	31
Loading of contaminants to the marine environment	21	7	1	0	26	52.7	29
• atmospheric	31	9	1	0	19	68.3	41
• land-based	22	8	1	0	29	51.7	31
Sediment and water contamination levels	22	6	0	0	34	45.2	28
Shellfish acreage closed to harvesting	21	10	2	0	28	54.1	33

- **Top themes:** loading, bathing beach closures, shellfish acreage closed, contaminant levels in birds and mammals, levels of contaminants in sediment and water

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22

How useful are the following themes in communicating the status and trends of eutrophication?

Theme	Very Useful	Useful	Somewhat Useful	Not Useful	No Response	Percent Responding	>somewhat useful
Change in SAV abundance	28	5	3	0	21	63.2	36
Chlorophyll A concentrations	27	14	3	0	17	72.1	44
Dissolved oxygen levels	17	5	0	0	41	34.9	22
Epiphyte abundance	27	16	3	0	13	78	46
Macroalgal abundance	25	10	4	0	22	63.9	39
Nutrient concentrations	19	16	0	0	27	56.5	35
Nutrient loading	15	9	0	0	38	38.7	24
Presence of harmful algae	20	8	1	0	30	49.2	29

- Top themes
  - Epiphyte abundance
  - Chlorophyll a concentrations
  - Macro algal abundance
  - Change ins SAV abundance
  - Nutrient concentrations
  - Harmful algal blooms
  - Nutrient loading

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23

How useful are the following themes in communicating the status and trends of coastal development?

Theme	Very Useful	Useful	Somewhat Useful	Not Useful	No Response	Percent Responding	>somewhat useful
Aerial extent of priority terrestrial habitats	53	9	1	0	43	59.4	63
• Acreage of farmland conversion to urban uses	36	17	1	0	53	50.5	54
• Acreage of large undeveloped blocks remaining	27	6	0	0	74	30.8	33
• Acreage of undeveloped land	28	8	0	0	70	34	36
Acreage of land protected/conserved	38	12	0	0	57	46.7	50
Demographics (by watershed): changes in population density	45	6	0	0	57	47.2	51
Housing starts	52	24	2	0	26	75	78
Land Conversion	24	3	0	0	70	27.8	27
Status of threatened or endangered plant and animal species	52	17	0	0	39	63.9	69
Status of wildlife species	53	23	0	0	33	69.7	76
Trends in impervious surfaces coverage	35	4	1	0	66	37.7	40
Vehicle miles traveled	46	40	10	0	9	91.4	96

- **Top themes:** Vehicle miles traveled, Housing starts, status of wild life, status of threatened endangered species, extent of priority terrestrial habitats, acreage protected/conserved, watershed demographics

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24

How useful are the following themes in communicating the status and trends of marine aquatic habitats?

Theme	Very Useful	Useful	Somewhat Useful	Not Useful	No Response	Percent Responding	>somewhat useful
Biodiversity index	26	16	3	0	24	65.2	45
Extent and distribution of various benthic habitats (e.g. eel grass wetlands)	14	3	0	0	53	24.3	17
Extent and location of non-native species	33	4	1	0	32	54.3	38
Shoreline armoring and sediment movement	37	9	1	0	23	67.1	47
Water quality (temperature salinity dissolved oxygen light transmissivity turbidity)	23	9	0	0	38	45.7	32

- Top themes
  - Shoreline armoring and sediment movement
  - Biodiversity index
  - Non native species
  - Water quality

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25

How useful are the following themes in communicating the status and trends of climate change?

Theme	Very Useful	Useful	Somewhat Useful	Not Useful	No Response	Percent Responding	>somewhat useful
Appearance of sentinel species tied to seasonal climate changes	24	2	0	0	18	59.1	26
Biodiversity index	18	8	2	0	16	63.6	28
Days with unhealthy levels of ozone pollution	13	13	2	0	18	60.9	28
Number of extreme storm events	16	6	1	0	21	52.3	23
Rate of sea level rise	15	3	0	0	28	39.1	18
Species at risk with changes in climate	15	7	0	0	23	48.9	22

- Top themes
  - Biodiversity index
  - Days of unhealthy ozone
  - Sentinel species tied to seasonal climatic changes

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26

Straw regional indictors - Fisheries

Commercial fish/shellfish landings (Metric: Total annual landing by species state [port] [watershed])

Changes in target trophic level species (i.e., % top predators, % prey species, etc.), (Metric: Average annual abundance by water body [state] [port])

Average size/age class of landings (Metric: Annual distribution of age/size class by species by port)

Annual recreational fishing days logged (Metric: Total annual recreational fishing days by port/state)

Total annual number recreational fish caught (Metric Total annual recreational fish caught by port/state)

Miles of stream open to fish migration (Metric: Miles open to migration by watershed [state])

Fisheries (fish and shellfish) populations (Metrics: by state water body type

- Annual estimate of commercial stocks
- Annual change in abundance of "key species"
- Standing stock of oysters, scallops, m. mercenaria, mussels, etc.
- Abundance, biomass, species richness, species evenness)

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Gear deployment characteristics (Metric: By gear type the total deployments and miles or area fished annually)

27

Straw regional indictors - Contaminants

Chemical loading to the coastal zone: (Metric: Annual input from point, nonpoint source, atmosphere by water body [state])

Beach closures (metric: Number of beach closing by year by state [water body]

Tissue contamination levels (shellfish, fish, birds, mammals) (metric: yearly average concentration of contaminants [which ones?] in representative species by water body [state?]

Shellfish closures (metric: days of closure per year by state, [acre days of activity])

Sediment contamination levels (Metric: Area of impacted sediments by state [water body] by year)

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28

Straw regional indictors - Eutrophication

Epiphyte distribution and abundance (Metric: annual estimate of acres of epiphytes by water body [state?])

Chlorophyll concentration (Metric: annual [seasonal?] [surface waters?] aerial based average chlorophyll concentration by water body)

SAV distribution and abundance (Metric:
- annual estimate of acres of epiphytes by water body [state?])
- Seagrass Nutrient Pollution Index

Macroalgal distribution and abundance (Metric: annual estimate of acres of epiphytes by water body [state?])

Nutrient concentrations in receiving waters –Annual [seasonal] average [dissolved inorganic nitrogen], [particulate organic nitrogen], [particulate organic carbon], [TDN], [ammonium], [nitrate/nitrite], [total dissolved phosphorous], [phosphate], [silicate] by water body type [state])

Harmful algal species (metric: Annual frequency and duration of occurrence by species by water body [state])

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Nutrient loading to the coastal zone: (Metric: Annual input from point, nonpoint source, atmosphere by water body)

29

Straw regional indictors – Land use/coastal development

Coastal development (Metric: by watershed [state?]
- Annual rate of coastal population growth of development)
- Area and changes in impervious surfaces
- Vehicle miles traveled

Regional Habitat types (Metric: by watershed and water body [state]
- extent [acres] and distribution of habitat types (which type?]
- quality of habitat by type which type?])

Priority habitat types (Metric: by watershed [state] by year
- Extent of unfragmented forests by watershed)
- Acres of restored salt marsh and tidal wetlands
- Extent of forest buffers
- Riparian Forest Buffer Conservation and restoration
- Areas of lands conserved
- Terrestrial Protected Areas- the percentage of land protected through legal mechanisms

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30

Straw regional indictors – Marine aquatic habitat

Miles of stream open to fish migration (Metric: Miles open to migration by watershed [state] by year)

Regional Habitat types (Metric: by watershed and water body [state]
- extent [acres] and distribution of habitat types (which type?]
- quality of habitat by type which type?])

Priority habitat types (Metric: by watershed [state] by year
- Acres of salt marsh and tidal wetlands [lost; restored]
- Areas of lands conserved
- Eel grass distribution
- Macro algae extent /diversity
- Biodiversity by habitat

Non native species (Metric: Distribution and abundance [presence?] of non native species by water body type [state?])

Water quality: (Metric: Average annual [seasonal] by coastal water type [state?]
- water temperature
- light penetration [turbidity]
- nutrient condition

other??

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31

Straw regional indictors – Climate Change

Climate Change: (Metric:
- Annual [seasonal] water temperature by water body type [state?])
- Annual [seasonal] air temperature by watershed [state?])
- Annual rate [height] of sea level rise by state [harbor]
- Annual number and frequency of extreme storm events [define extreme]
- Annual Carbon dioxide emissions [change in CO2 in atmosphere]

Levels of unhealthy ozone (Metric: number of days annually by state [watershed] of ozone levels above state standards [area of unhealthy levels?].

Biodiversity (Metric:
- changes in biodiversity by habitat and water body type [link to climate change metric?])
- Number of at risk species per watershed [habitat][state] per year
- Changes in species range expansions or declines)

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32

On to the breakouts

- "It is time to look at the macro scale more, we have become too reductionistic and mechanistic."
- From Odum: Always select the scale one size larger than your problem because it is half driven from the large scale, that is the first principle of the system approach.

From Scott Nixon's keynote address to the 2003 ERF meeting regarding our coastal programs

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33

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The Use of Indicators in International Large Marine Ecosystem Program in Relation to the Northeast

Dr. Ken Sherman, NMFS

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The Use of Indicators in International Large Marine Ecosystem Programs and a Baseline for the U.S. Northeast Shelf

Northeast Coastal Indicators Summit

UNH

6 to 8 January 2004

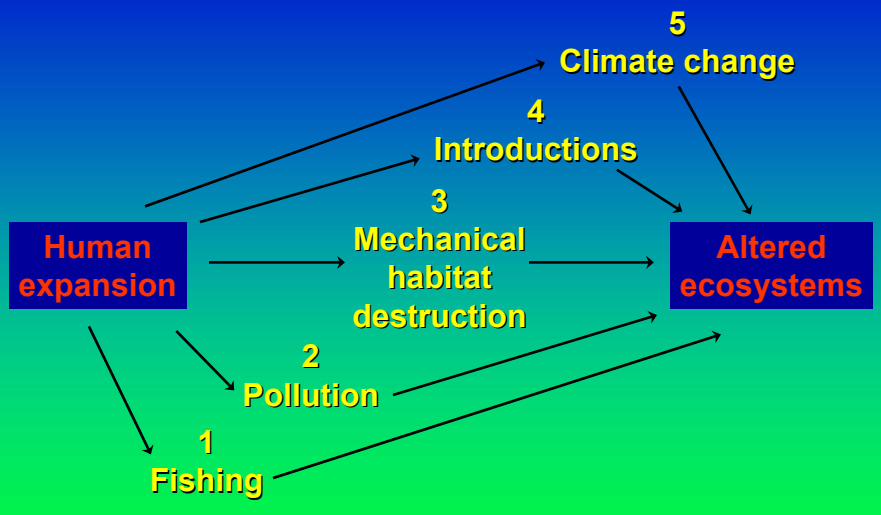
WORLD SUMMIT ON SUSTAINABLE DEVELOPMENT: ACTIONS AND TARGETS

- **Strengthen regional cooperation**
- **Encourage the application of the ecosystem approach-- by 2010**
- **Maintain or restore fish stocks to levels that can produce maximum sustainable yield (MSY)-- on an urgent basis and, where possible, no later than 2015**

From the Secretariat: "Guide to Oceans, Coasts and Islands at the WSSD and Beyond: Integrated Management from Hilltops to Oceans" Dec. 2002 report

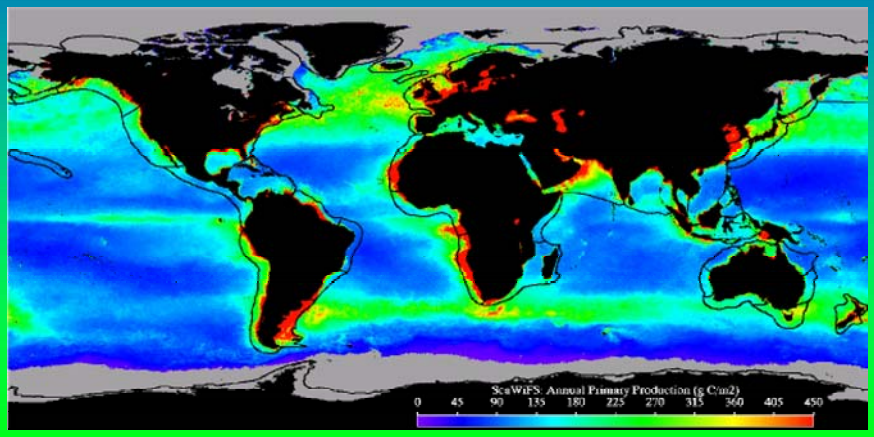
Selected, Ecosystem Related WSSD Targets and Program of Action (POI)

- Land-based Sources of Pollution
  POI – Substantially reduce by 2006
- Ecosystem-based Approach
  POI – Introduce by 2010
- Marine Protected Areas
  POI - Designated Network by 2012
- Restoration and Sustainability of Fisheries
  POI – On an urgent basis and where possible to MSY by 2015



(from Jackson *et al*., *Science* vol. 293, 27 July 2001)

95% of the World's Annual Marine Fishery Catches are Produced in 64 LMEs

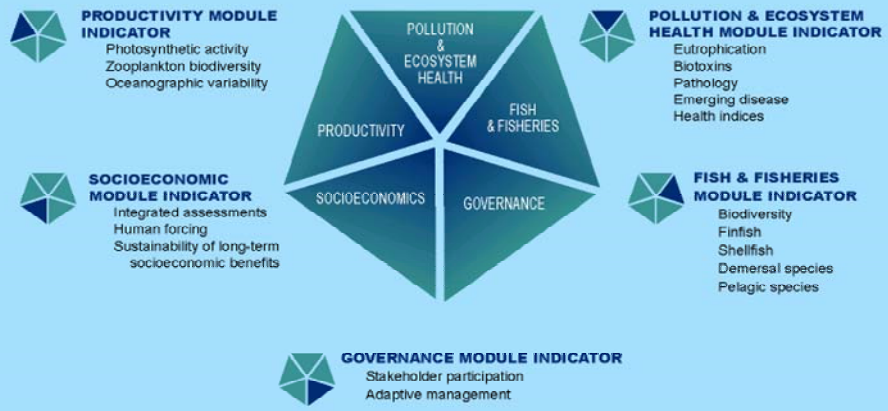


ECOLOGICAL CRITERIA USED TO DETERMINE AREAL EXTENT OF LMES:

- Bathymetry
- Hydrography
- Productivity
- Trophodynamics

Modular Assessments

Support LME Restoration and Sustainable Development



Funding support from the Global Environment Facility, for projects linking environmental protection to resource development and sustainability

First tranche of projects:
Supported at $2.1 billion funding level, 1994-1998

Second tranche of projects: supported at $2.7 billion funding level, 1999-2002

Third tranche of projects: supported at $3.0 billion funding level, 2002-2005

Categories for funding include:
- Global climate change (ozone)
- Biodiversity
- International waters

126 Developing Countries Participate in LME Assessment and Management Projects in Africa, Asia, Latin America and Eastern Europe.

GEF and Country Investment in Projects as of January 2004 = $650 million.

LMEs ARE GLOBAL CENTERS OF EFFORTS TO:

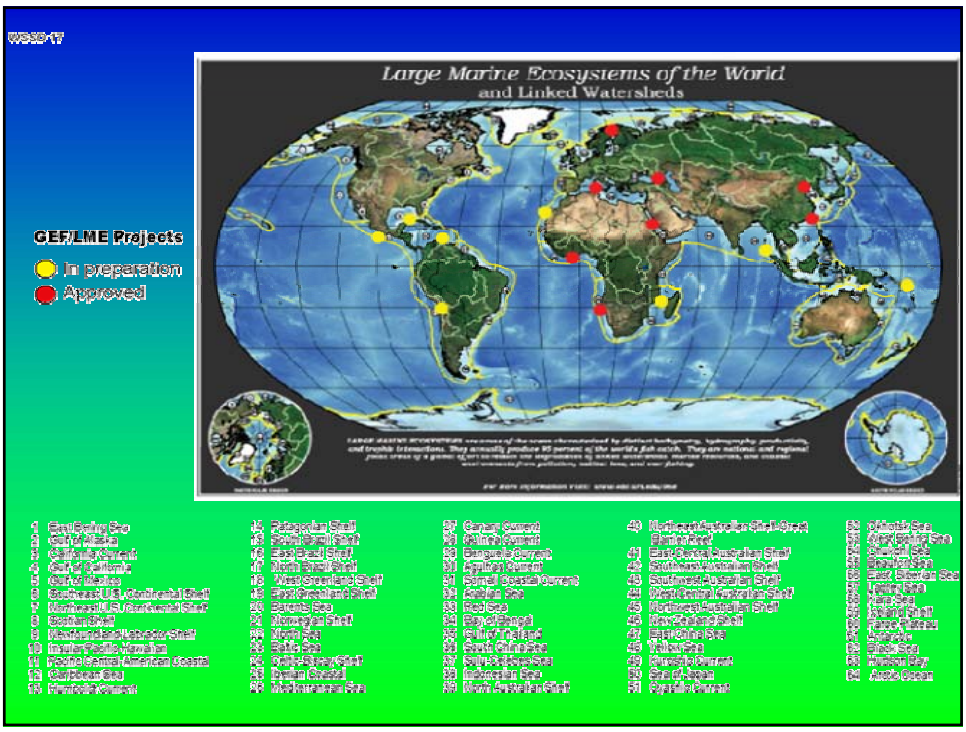
- **REDUCE** coastal pollution
- **RESTORE** damaged habitats (Coral reefs, mangroves, sea grasses)
- **RECOVER** depleted fishery stocks

GEF International Waters Operational Strategy

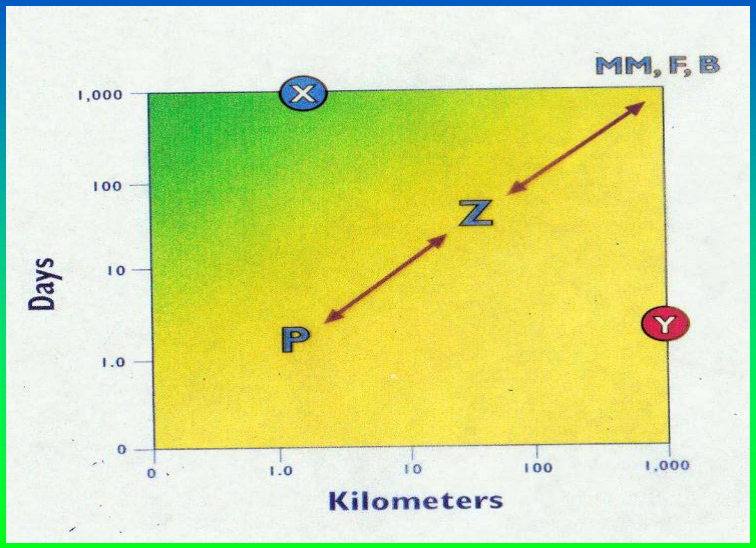
Supports New Paradigm

- Ecosystem-based LME Restoration Actions

- TDA/SAP Priority Actions



TEMPORAL AND SPATIAL SCALE RELATIONS FOR SELECTED INDICATORS



INDICATORS OF CHANGING ECOSYSTEM STATES:

Productivity

Fish and Fisheries

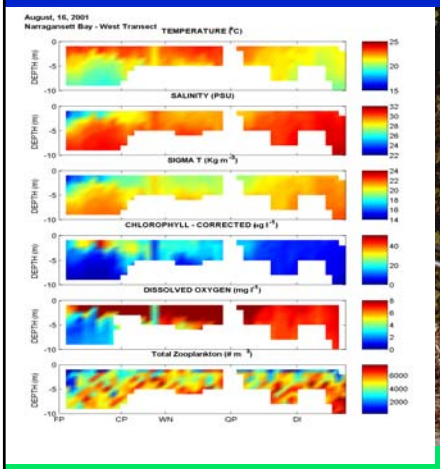
Pollution

Socioeconomic

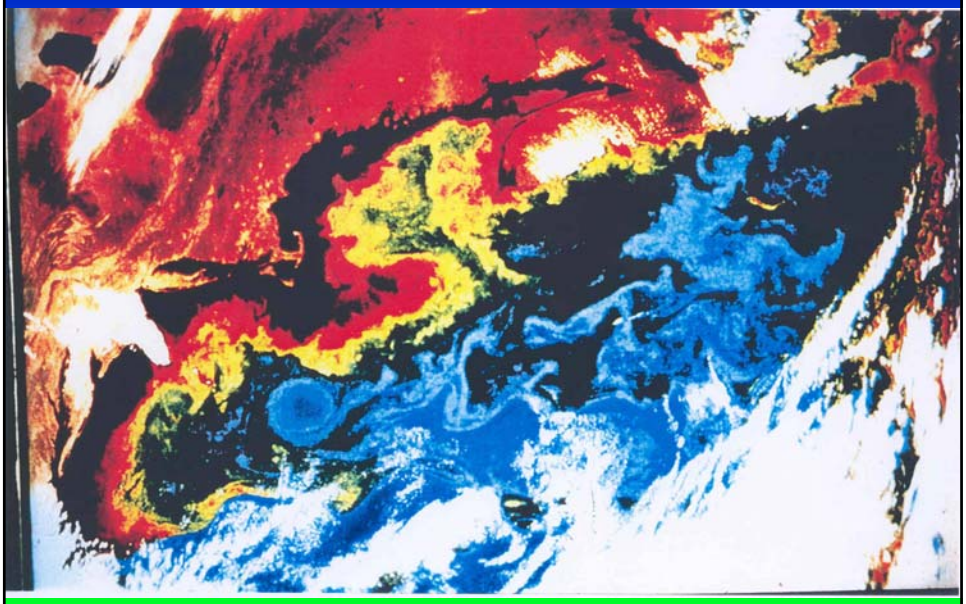
Governance

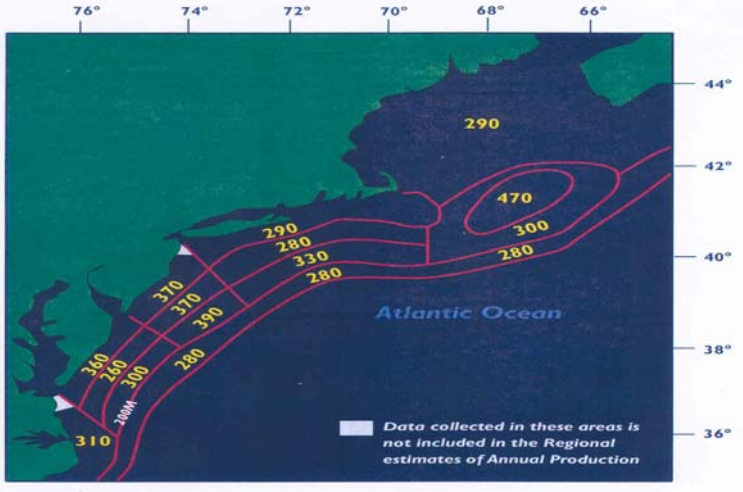
PRODUCTIVITY INDICATORS:

- Primary productivity (gc/m^2/y^1)
- Chlorophyll *a* (*µ g/ l)*
- SST; water column temperature
- Photosynthetically active radiation (PAR)
- Nitrogen
- Zooplankton biomass (cc/100m^3)
- Zooplankton biodiversity (n/100m^3)

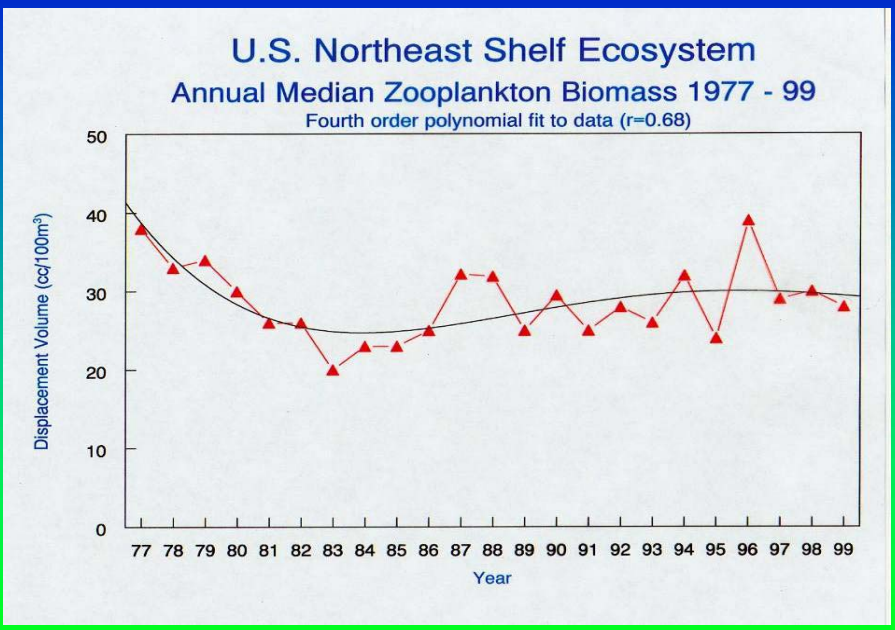


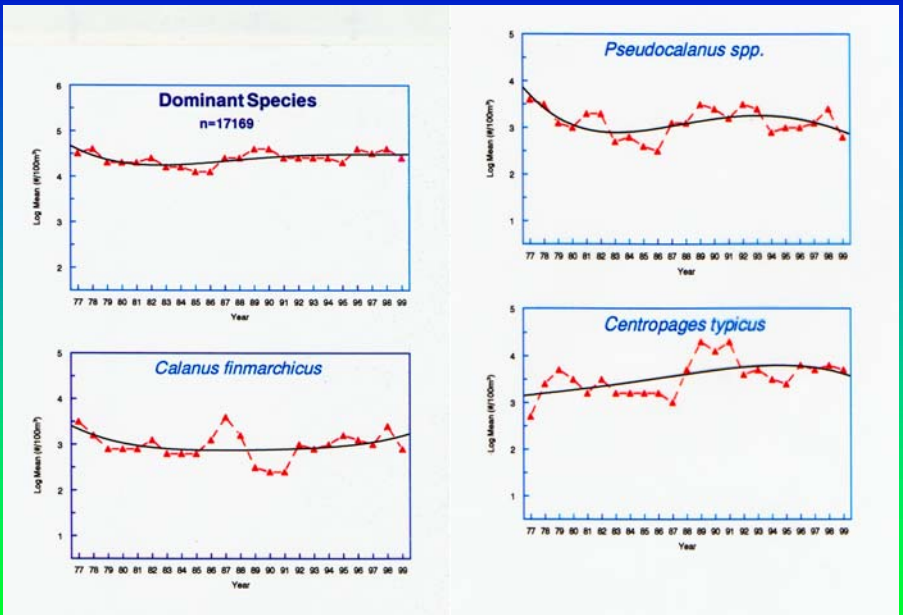
An undulating oceanographic recorder (above), towed behind a ship, is used to collect ecological parameters needed to assess the state of the marine ecosystem (left).

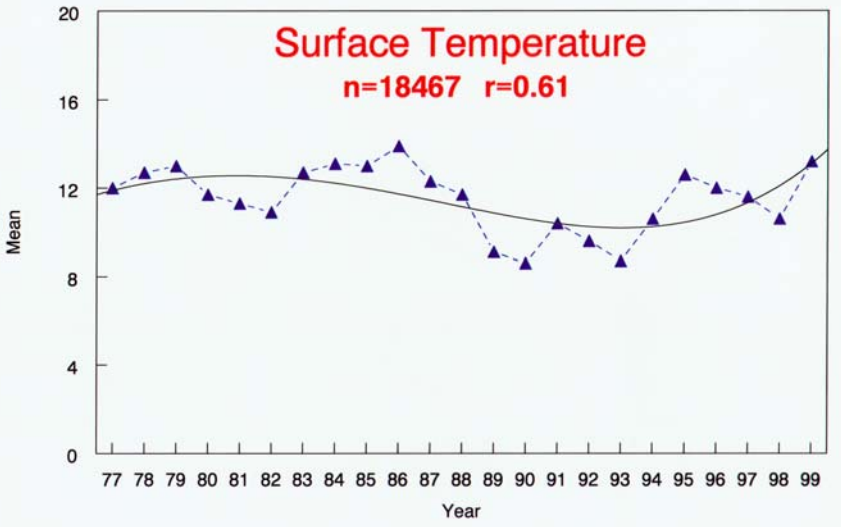




Estimates of annual phytoplankton primary production by region (particulate + dissolved organic carbon); gC m^{-2} y^{-1}


U.S. Northeast Shelf Ecosystem
Annual Median Zooplankton Biomass 1977 - 99
Fourth order polynomial fit to data (r=0.68)
Displacement Volume (cc/100m³)
50
40
30
20
10
0
77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99
Year


Dominant Species
n=17169
Log Mean (#/100m³)
Year
Calanus finmarchicus
Pseudocalanus spp.
Centropages typicus

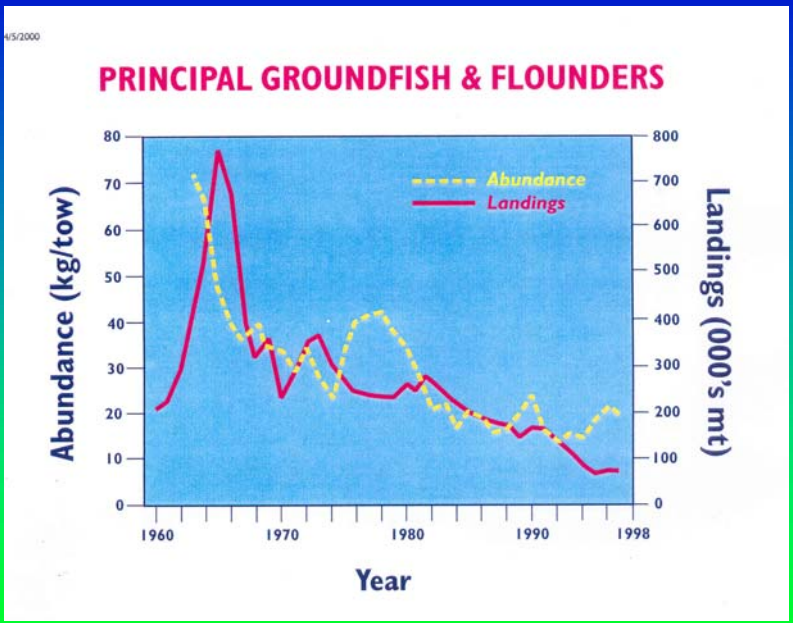


FISH AND FISHERIES INDICATORS

- Demersal species surveys
- Pelagic species surveys
- Ichthyoplankton surveys
- Invertebrate surveys (clams, scallops, shrimp, lobster, squid)
- Essential fish habitat
- Marine protected areas

COMMON TERMS
from Our Living Oceans Report

- Recent average yield (RAY)
- Current potential yield (CPY)
- Long term potential yield (LTPY)
- Stock level relative to LTPY
- Status of resource utilization
- Threatened or endangered
- Potential biological removal (PBR / MMPA)



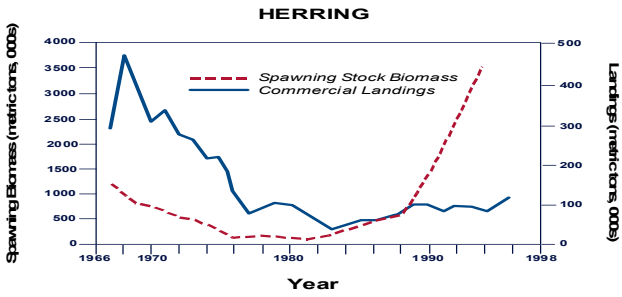
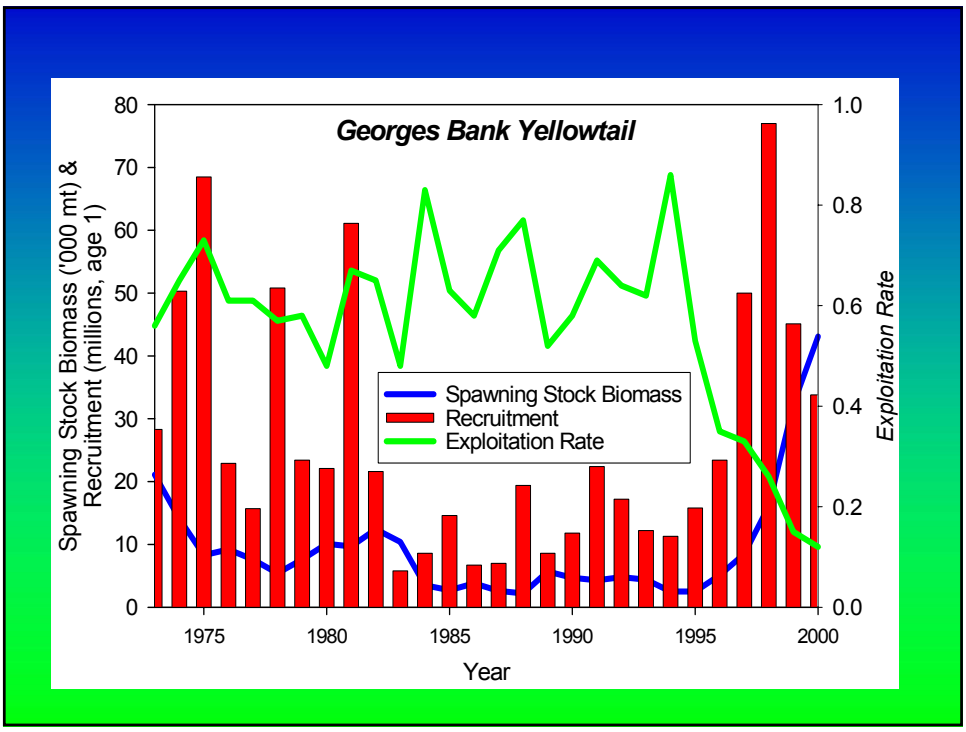
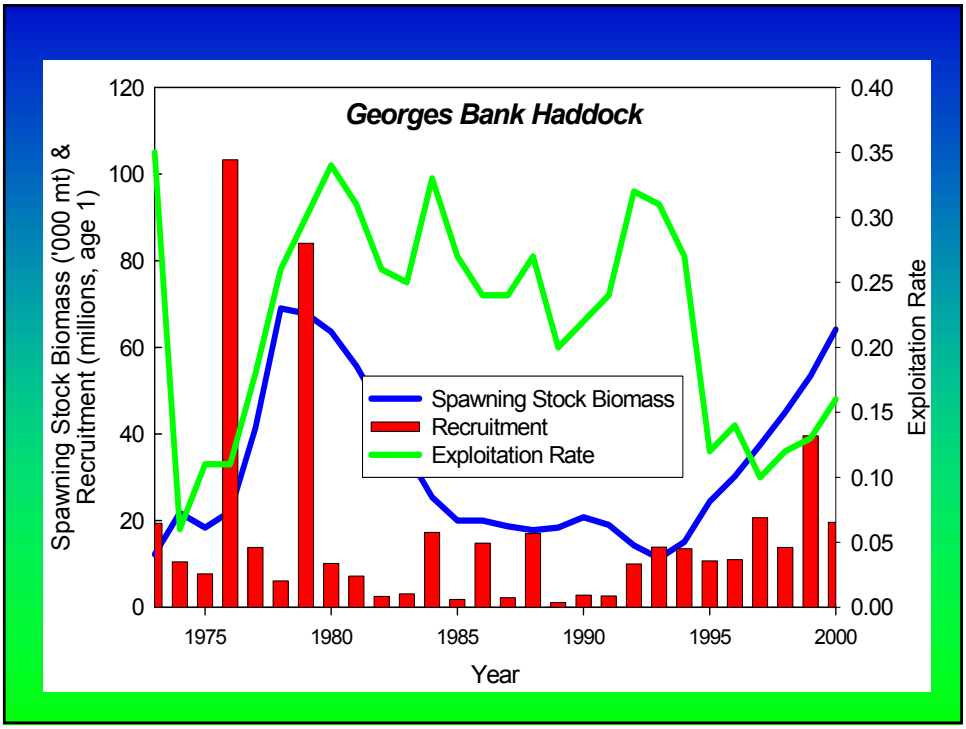
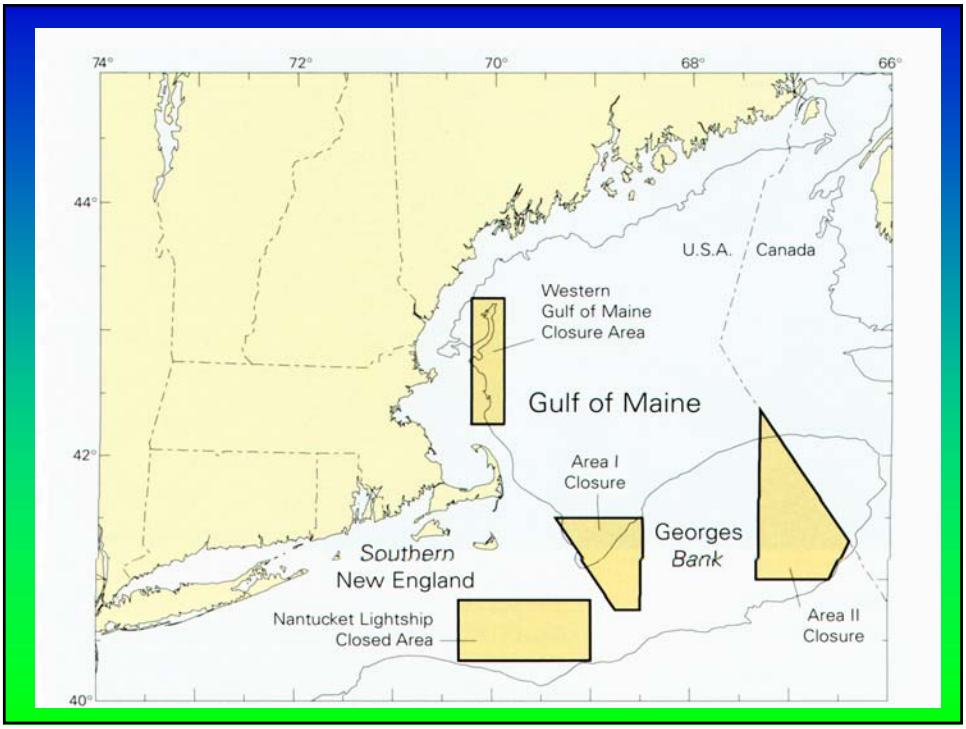


Figure 6-8. Top - Atlantic herring commercial landings and spawning stock biomass, 1967 through 1996 (thousand metric tons). Bottom - Atlantic mackerel landings and spawning stock biomass, 1963 through 1996 (thousand metric tons).




Georges Bank Haddock
Spawning Stock Biomass ('000 mt) & Recruitment (millions, age 1)
Exploitation Rate
Year
Spawning Stock Biomass
Recruitment
Exploitation Rate
120
100
80
60
40
20
0
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
1975
1980
1985
1990
1995
2000


74°
72°
70°
68°
66°
44°
42°
40°
U.S.A.
Canada
Western
Gulf of Maine
Closure Area
Gulf of Maine
Area I
Closure
Georges
Bank
Southern
New England
Nantucket Lightship
Closed Area
Area II
Closure

EPA's 2001 Coastal Condition Report Pollution and ecosystem health indicators

- National Coastal Condition Report
  - EPA
  - NOAA
  - US Dept. of Interior
  - USD
- 2004 NCCR2 and OLO

How the Indicators Are Calculated

Overall condition for each coastal area was calculated by summing the scores for the seven indicators and dividing by 7, where good = 5, fair = 3, and poor = 1. The Gulf Coast, for example, received the following scores:

Indicator	Score
Water Clarity	3
Dissolved Oxygen	5
Coastal Wetland Loss	1
Eutrophic Condition	1
Sediment Contamination	1
Benthic Index	1
Fish Tissue Contaminants	1
Total Score Divided by 7 = Overall Score	13/7 = 1.86

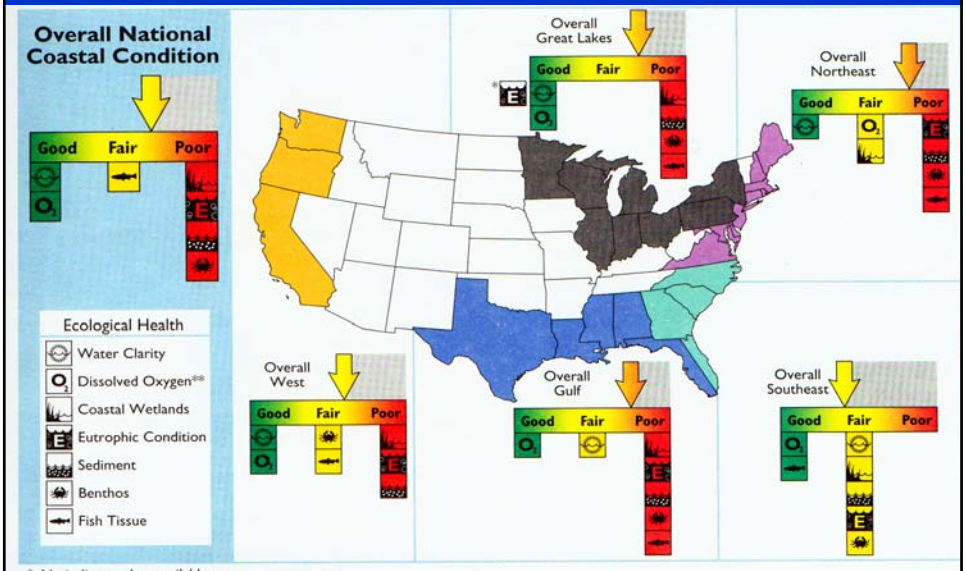
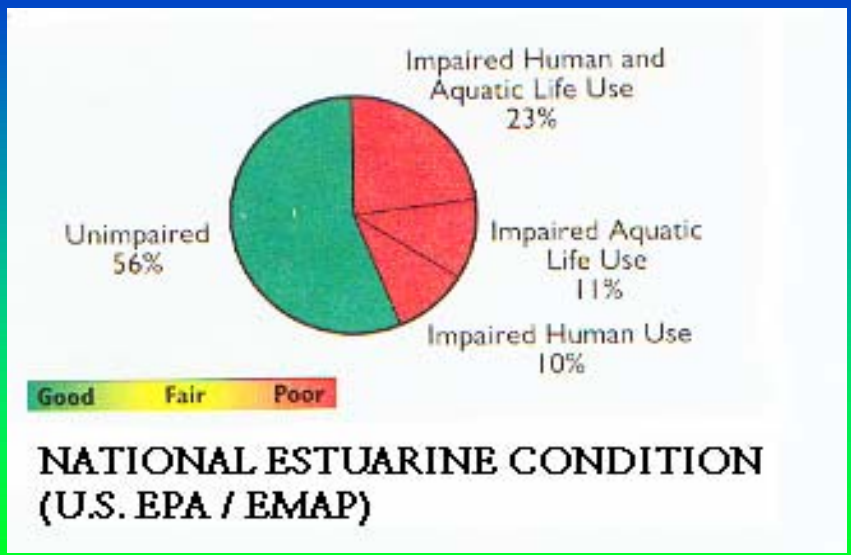


Figure 2-1. Overall national coastal condition.



Volumes of Peer Reviewed Published LME Case Studies

AAAS	5
Blackwell Science	4
Elsevier Science	3

ECOSYSTEM MANAGEMENT: A PARADIGM SHIFT

FROM →	TO
Individual species	Ecosystems
Small spatial scale	Multiple scales
Short-term perspective	Long-term perspective
Humans: independent of ecosystems	Humans: integral part of ecosystems
Management divorced from research	Adaptive management
Managing commodities	Sustaining production potential for goods and services

NOTE: Some of the substantive changes between traditional resource management and ecosystem management.

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Charge to Breakout Sessions
Dr. Carlton Hunt, Battelle

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Northeast Coastal Indicators Workshop

Charge For Breakout Sessions

January 6, 2004

Carlton D. Hunt, Ph.D.
Battelle
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Expectations from the Breakout Sessions

- To finalize for each topic
  - Conceptual Model
  - List of key issues and questions
  - List of indicators for the top 3 to 5 issues/questions
    - Identify up to 3 indicators for monitoring throughout the region
    - Identify information conveyed by the indicators identified and users
    - Spatial and temporal effectiveness of each indicator
    - Methods to communicate status of the region
    - Whether additional data collection efforts are needed
  - Develop a plan to implement these regional indicators into present programs

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Breakout Session 1

8:00 – 10:00 – Issue and Problem Definition

- Amend and Ratify
  - Conceptual Models/Papers
    - Issue is well-defined
    - Most significant management issues are included
    - Provides a clear and compelling basis for developing indicators
  - Key issues
    - Review key issues identified by the web survey
    - Remove redundancy; add missing; reword others when necessary.
  - Key questions
    - Remove redundancy; reword, or add missing

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Breakout Session 1

8:00 – 10:00 – Issue and Problem Definition

- Final Products
  - Consensus on conceptual model/papers
  - Finalized list of key issues and questions
  - Top 3 to 5 issues/questions identified for discussion in Sessions 2 and 3

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Breakout Session 2

10:15 – 12:15 – Align Questions and Indicators

- For each of the top 3-5 questions work to identify:
  - Core information to be conveyed.
  - Primary and secondary end users and their needs.
  - Choose up to 3 priority indicators that answer question
  - Indicator metrics at the most applicable spatial and temporal aggregations
  - How can the indicators be used to communicate the status of the region's ecosystem

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Breakout Session 2

10:15 – 12:15 – Align Questions and Indicators

- For each of the top 3-5 questions work to identify:
  - Ways to track indicator usage
  - Collect feedback, modifications and evaluate indicator applicability
- Final Product
  - Reach consensus on the indicators applicable to this management issue

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Breakout Session 3

1:30 – 3:30 – Make It Happen

- Required actions over the next 12-18 months to implement this indicator set.
  - Key partners to refine concepts
  - Appropriate approaches to collect data to support the indicator
  - Adequacy and shortcomings of existing data sources to support the indicators and define data gaps
  - Ways to engage end-users on potential indicators and garner their support
  - Actions we expect end-users to take when they receive and use the indicator (how will we know success?)

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Breakout Session 3

1:30 – 3:30 – Make It Happen

- Required actions over the next 12-18 months to implement this indicator set.
  - Implementation approaches
    - Existing or new group are engaged to develop
    - Possible funding sources
- Final Product
  - Consensus on the method(s) to make it happen

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Preparation for Breakout Sessions

- To assist in making discussions during tomorrows breakout sessions successful:
  - Review Conceptual Model/Papers
    - Come with any suggested changes to the conceptual model/paper
  - Review the List of Key Questions and Indicators List
    - Come prepared to discuss what you feel are the top 3 to 5 questions and suggested indicators

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Final Reminder

There is a lot to discuss and work out in each session so remember the goal is to:

Report on the status of the entire system

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Breakout Sessions

Breakout Session	Room	Name Tag Color
Fisheries	Great Bay A	Red
Contaminants	Great Bay B	Yellow
Eutrophication	Penobscot	Orange
Aquatic Habitat	Narragansett	Blue
Coastal Development	Champlain	Green
Climate Change	Kennebec	Black

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APPENDIX C

BREAKOUT SESSION REPORTS

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Senior Management Panel Introductions

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Northeast Coastal Indicators Workshop

Workshop Report-out and Senior Management Panel Response

Welcome

- Logistics
  - Weather Report
  - Fun and interesting session
  - Special thanks to our panel members
  - Intent to adjourn by noon “unless ….”
  - Lunch on your own in the restaurant

Purpose of Morning Session

- Share the results of the technical sessions with all participants and look for cross-cutting ideas
- Field-test the results with one portion of our indicators audience
- Develop strategies to move the workshop results forward

Agenda – 8:00 a.m to 12:00 p.m.

- Six technical session reports (1 hour)
- Panelist responses (1 hour)
- Audience Question and Answer (30 minutes)
- “Straw” Next Steps Proposal (5 minutes)
- Panelist Recommendations on Implementation (40 minutes)
- Audience Recommendations (30 minutes)
- Wrap-up (15 minutes)

Technical Session Reports

Indicator Topics

- Fisheries
- Contaminants
- Eutrophication
- Coastal Development
- Marine Aquatic Habitat
- Climate Change

Morning Reporters

- David Dow
- Wendy Leo
- Suzanne Bricker
- Rick D'Amico
- Ralph Cantral
- Mark Parker

Introductions

- Ellen Roy Herzfelder – Massachusetts
- Byron James – New Brunswick
- Priscilla Brooks – Conservation Law
- Rick Spinrad – National Ocean Service
- Betsy Wingfield – Connecticut
- John Boreman – National Marine Fisheries
- Faith Scattolon – Fisheries & Oceans
- Katrina Kipp – Environmental Protection Agency

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Breakout Sessions, Report to Senior Management Panel

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Northeast Coastal Indicators Workshop

Breakout Session Results

January 8, 2004

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Breakout Session Results

- Fisheries
- Contaminants
- Eutrophication
- Aquatic Habitat
- Coastal Development
- Climate Change

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Breakout Session Results

- **Fisheries**
- Contaminants
- Eutrophication
- Aquatic Habitat
- Coastal Development
- Climate Change

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Fisheries

- Top Questions
  - **What is the health of the fisheries with regard to ecosystem integrity, including targeted and non-targeted species, habitat, and fisheries activities?**
    1) **What are the trends in characteristics and the status of exploited fisheries species?**
    2) **What are the effects of fishing on non-targeted species and their associated communities?**
    3) **What are the effects of fishing and non-fishing activities on marine habitat and fisheries productivity?**
    4) **What are the trends in the socioeconomic characteristics of fisheries?**

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Fisheries

What is the trends in and the status of exploited fisheries stocks?

- Indicator(s):
  - **Proportion of stocks at or above targeted abundance or biomass**
  - **Age/Size structure of species from surveys and/or landings**
  - **Spatial distribution of fisheries species**
- Information Conveyed: **Status and trends for exploited fisheries stocks**
- Indicator Audience: **Fisheries managers, industry, public, other regulators, researchers**
- Spatial and Temporal Scales: **Range of species or stocks; Annual to every 3-5 years**

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Fisheries

What are the effects of fishing on non-targeted species and their associated communities?

- Indicator(s):
  - **Characteristics of bycatch and discards**
  - **Population levels for selected species**
  - **Species Diversity**
- Information Conveyed: **Impacts of fishing on non-targeted species and their associated communities**
- Indicator Audience: **Fisheries and environmental managers, industry, environmental interests, researchers, public**
- Spatial and Temporal Scales: **Regional based on populations or stock, biogeographic boundaries; Seasonal**

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Fisheries

What are the effects of fishing and non-fishing activities on marine habitat and fisheries productivity?

- Indicator(s):
  - **Area closed to fishing, both pelagic and/or benthic**
  - **Benthic diversity**
  - **Spatial distribution of bottom fishing**
- Information Conveyed: **Impacts of fishing and non-fishing activities on marine habitat and fisheries productivity**
- Indicator Audience: **Researchers, industry, public and environmental fisheries and habitat managers**
- Spatial and Temporal Scales: **Regionwide (based on biogeographic boundaries); 1 to 5 years depending on habitat to annually to continuous**

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Fisheries

What are the trends in the socioeconomic characteristics of fishing?

- Indicator(s):
  - **Days at sea**
  - **Fleet composition**
  - **Commercial and recreational fishing economic value**
  - **Angler satisfaction**
  - **Overcapitalized fleets**
  - **Natural capital value**
  - **Market value for consumers**
- Information Conveyed: **Are society's socioeconomic goals for fisheries being achieved?**
- Indicator Audience: **Researchers, community planners, fisheries managers, industry, public**

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Fisheries

- Key Partners Needed
  - **US and Canadian Federal agencies**
  - **State and provincial agencies**
  - **NGOs**
  - **Academic Community (Depending upon the issue)**
- Implementation Approaches
  - **Survey existing data sources**
  - **Standardize methodologies**
  - **Coordinate among groups**

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Breakout Session Results

- Fisheries
- **Contaminants**
- Eutrophication
- Aquatic Habitat
- Coastal Development
- Climate Change

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Contaminants

- Top Questions
  1) **How are contaminants in the region changing?**
  2) **How is the input of contaminants changing over time and space?**
  3) **Are management actions changing the extent and severity of human health effects?**
  4) **How well are contaminant management actions protecting ecosystem integrity?**

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Contaminants

How are contaminants in the region changing?

- Indicator(s):
  - **Area of sediments that have contaminant levels above sediment quality guidelines**
  - **Level of contaminants in representative non-migratory organisms**
  - **Area of shellfish bed closure by state by year**
  - **Days of beach closure due to bacterial contamination by state by year**
- Information Conveyed: **Where are contaminants; Where contaminants are going; Effectiveness of regulatory actions**
- Indicator Audience: **Public, regulators, legislators, educators**
- Spatial and Temporal Scales: **Specific water body scales; Event to Annual to Decadal**

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Contaminants

How is the input of contaminants changing over time and space?

- Indicator(s):
  - **Annual chemical load to water bodies by state**
  - **Number of bacterial source investigations and sources eliminated by year by state**
- Information Conveyed: **Improvements due to regulatory actions vs. stresses from population growth and development**
- Indicator Audience: **Managers and regulators; public**
- Spatial and Temporal Scales: **Water bodies Region wide; Annual to source specific**

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Contaminants

Are management actions changing the extent and severity of human health effects?

- Indicator(s):
  - **Incidences of human disease caused by consumption of fish and shellfish and recreational contact**
  - **Level of contaminants in representative fish/shellfish and at-risk humans**
  - **Annual number of beach and shellfish closures (reopenings)**
- Information Conveyed: **Effectiveness of regulatory actions**
- Indicator Audience: **Public, regulators, legislators, educators**
- Spatial and Temporal Scales: **Water bodies Region wide; Annual to source specific**

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Contaminants

How well are contaminant management actions protecting ecosystem integrity?

- Indicator(s):
  - **Sediment quality measure by triad approach**
  - **Incidence of disease**
  - **Reproductive success**
  - **Quality of habitats as affected by contaminants**
- Information Conveyed: **Effectiveness of management actions**
- Indicator Audience: **Regulators, public, legislators**
- Spatial and Temporal Scales: **Water bodies region wide; Annual to decadal scales**

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Contaminants

- Key Partners Needed
  - **State, local, regional, federal authorities**
  - **Scientific community**
- Ways to Engage End Users – **Series of state of the environment reports**
- Implementation Approaches
  - **Fund coordinating structure to support networking**
  - **Regular workshops and associated reports**
  - **Ensure sufficient early warning capacity in the indicators**

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Breakout Session Results

- Fisheries
- Contaminants
- **Eutrophication**
- Aquatic Habitat
- Coastal Development
- Climate Change

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Eutrophication

- Top Questions
  1) **What is the extent, severity, and trends of eutrophication impacts?**
  2) **What are the sources of nutrients, can they be controlled, how are they changing?**
  3) **What is the state of management measures and how can they be optimized?**
  4) **What are the appropriate indicators, thresholds, and scales?**
  5) **What are the most important data gaps and research/monitoring needs? How can they be translated to regional/national strategy?**

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Eutrophication

What is the extent, severity, and trends of eutrophication impacts?

- Indicator(s):
  - **Dissolved oxygen**
  - **Chlorophyll a**
  - **Submerged aquatic vegetation**
  - **Water clarity**
- Information Conveyed: **Areal extent, locality, severity, type of impact, and trends**
- Indicator Audience: **Resource managers and scientists, policy makers, legislators, citizens**
- Spatial and Temporal Scales: **Estuary-wide; Seasonal to annual**

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Eutrophication

What are the sources of nutrients, can they be controlled, how are they changing?

- Indicator(s):
  - **Measured and modeled loads**
  - **Land use/cover (load proxy)**
  - **Population (load proxy)**
- Information Conveyed: **Identification of sources, loads (amount of allocation), changes over time**
- Indicator Audience: **Regulators, nutrient managers, scientists, citizens, politicians**
- Spatial and Temporal Scales: **Regional; Seasonal to annual to decadal**

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Eutrophication

What is the state of management measures and how can they be optimized?

- Indicator(s):
  - **Dissolved oxygen**
  - **Chlorophyll a**
  - **Submerged aquatic vegetation**
  - **Water clarity**
  - **Measured and modeled loads**
  - **Land use/cover (load proxy)**
  - **Population (load proxy)**
- Information Conveyed: Success of management measures
- Indicator Audience: Funding agencies, managers, regulators, engineers, politicians

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Eutrophication

- Key Partners Needed
- Ways to Engage End Users
- Implementation Approaches

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Breakout Session Results

- Fisheries
- Contaminants
- Eutrophication
- **Aquatic Habitat**
- Coastal Development
- Climate Change

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Aquatic Habitat

- Top Questions
  - **How is the extent, distribution, or use of coastal habitats changing over time?**
  - **How is the ecological condition of coastal habitats changing over time?**
  - **What are the causes of coastal habitat change over time?**

Coastal Habitat = watersheds+ estuaries+ near and offshore

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Aquatic Habitat

How is the extent, distribution, or use of coastal habitats changing over time?

Indicator(s):

- **Extent per habitat type over time**
  - **Large scale mapping, small scale ground surveys**
- **Distribution per habitat type**
- **Inventory of human use**
  - **Area, percent of public vs. private**
  - **Area, percent designated for permanent habitat protection**

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Aquatic Habitat

How is the ecological condition of coastal habitats changing over time?

- Indicator(s):
  - **Community Structure**
    - **Measure of change of relative abundance of species within habitat**
  - **Trophic Structure**
  - **Species of Concern**

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Aquatic Habitat

What are the causes of coastal habitat change over time?

- Indicator(s) of most important potential causes of habitat loss and degradation (physical and hydrologic alteration, nutrient loading, resource extraction, contaminants, climate change, sediment input)
  - **Extent and percent habitat area altered by tidal restrictions**
  - **Boat registrations**
  - **Seagrass Nutrient Pollution Index**
  - **Indicators relating to other causes assumed covered by other groups**

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Aquatic Habitat

- Spatial & Temporal Scale
  - **All indicators are aggregated per habitat type**
  - **Some are measured at large scale (e.g. mapping) on frequency of ~5-year intervals**
  - **Some are measured at small scale, within habitats, at seasonal or annual frequency**

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Aquatic Habitat

- Audience
  - **Primary Users/Needs: Federal, state, local, and provincial regulators and managers, non-profit groups, decision-makers**
  - **Secondary Users: non-profit organizations, educators, advocacy groups, academic education, industry, public, agencies**

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Aquatic Habitat

- Key Partners
  - **all government agencies,**
  - **academic institutions,**
  - **private research institutions,**
  - **NGO's,**
  - **resource users,**
  - **consultants,**
  - **volunteer monitoring groups/community groups**

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Aquatic Habitat

- Ways to engage end users
  - **Reporting**
  - **Web sites**
  - **Engaging community groups in design and data collection**
  - **Media**
  - **Cooperative Extension**
  - **Small grants and technical guidance.**
  - **Public meetings**

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Aquatic Habitat

- Implementation approaches
  - **Fund coordination body for**
    - **Collaboration**
    - **Collation = data mining, data collection**
    - **Data management**
    - **Synthesis**
    - **Reporting**
  - **Initial coordination body = Coordinator, Data manager, GIS Specialist**

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Breakout Session Results

- Fisheries
- Contaminants
- Eutrophication
- Aquatic Habitat
- **Coastal Development**
- Climate Change

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Coastal Development

- Top Questions

1) **What is the type, pattern, and rate of land use change?**
2) **How are these changes impacting the integrity of coastal ecosystems?**
3) **How is the region responding to changes in coastal ecosystems?**

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Coastal Development

What is the type, pattern, and rate of land use change?

- Indicator(s):
  - **Percent change in land cover to more intensive uses**
  - **Demographic changes (population, etc.)**
  - **Types of land uses and change**
- Information Conveyed: **Status and trends in coastal land cover, land use, and demographics**
- Indicator Audience: **Government managers, regulators, program managers, policy staff, analysts/technical staff**

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Coastal Development

How are these changes impacting the integrity of coastal ecosystems?

- Indicator(s):
  - **Integrity of coastal ecosystems for:**
    - **Threatened and endangered coastal species**
    - **Migratory species**
    - **Invasive species**
- Information Conveyed: **Status and trends in the integrity of coastal ecosystems impacted by coastal development**
- Indicator Audience: **Government managers, regulators, program managers, policy staff, analysts/technical staff**

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Coastal Development

How is the region responding to changes in coastal ecosystems?

- Indicator(s):
  - **Land conservation**
  - **Habitat Restoration**
  - **Land Management (planning, regulatory, etc)**
- Information Conveyed: **Management responses to changes in coastal ecosystems**
- Indicator Audience: **Government managers, regulators, program managers, policy staff, analysts/technical staff**

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Coastal Development

- Key Partners Needed:
  - **NOAA (CZM, CSC)**
  - **EPA (NEP)**
  - **Environment Canada (e-man and indicators)**
  - **DFO (habitat and indicators)**
  - **Ocean Observing Programs (e.g., GoMOOS)**
  - **State/Provincial Governments (GIS offices)**
  - **Gulf of Maine Council**

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Breakout Session Results

- Fisheries
- Contaminants
- Eutrophication
- Aquatic Habitat
- Coastal Development
- **Climate Change**

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Climate Change

- Top Questions
  1) **What are the causes?**
  2) **What are the impacts of climate changes to: weather, atmospheric & ocean circulation, ecosystems, and society. How vulnerable are we?**
  3) **What are the societal responses?**

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Climate Change

What are the impacts of climate changes to: weather, atmospheric & ocean circulation, ecosystems, and society.

- Indicator(s):
  - **Precipitation trends**
  - **Storm frequency and intensity**
  - **Water temperature surface bottom**
  - **Relative sea level rise**
- Information Conveyed: **Provide information on the impacts of global climate change on the meteorological and physical characteristics of the northwest Atlantic region**
- Indicator Audience: **Coastal environmental managers, scientists**
- Spatial and Temporal Scales: **Regional; Annual to Decadal**

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Climate Change

What are the impacts of climate change on biotic ecosystems?

- Indicator(s):
  - **Warm vs. cold water finfish species diversity**
  - **Planktonic diversity**
  - **Wetlands extent, distribution and composition**
  - **Marine diseases indices (i.e., MSX, dermo, shell disease)**
- Information Conveyed: **Provide information on the impacts of climate change to biotic ecosystems**
- Indicator Audience: **Fisheries managers, health officials, coastal managers, scientists**
- Spatial and Temporal Scales: **Regional; Annual**

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Climate Change

- Key Partners Needed
  - **NOAA – NOS & NMFS, USGS, EPA, USF&WS, States, NGOs, Environment Canada, OURANOS, DFO**
- Ways to Engage End Users
  - **Agreements (Climate Change Action Plan, NEG-ECP Agreements)**
  - **Predictive Modeling (Canadian, US, and other Climate Change Model, Downscaling, etc.**
    - **Global and Regional Models**
  - **Education – Outreach**
    - **American Association of Land Planners, etc,**
    - **Science Museum**
    - **Boston Aquarium**

Breakout Session Summaries

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Northeast Coastal Indicators Workshop: Coastal Development Session

Chair: David Keeley, Maine State Planning Office
Rapporteur: Elizabeth Mills, NOAA

Breakout Group Participants
Ralph Cantrall, NOAA, Florida Coastal Program (during development)
Bruce Carlisle, Massachusetts Coastal Zone Management
Byron James, Department of Agriculture, Fisheries and Aquaculture, New Brunswick
Michael Johnson, NOAA
Gerald Pesch, EPA
Maxine Westhead, Department of Fisheries and Oceans
Betsey Wingfield, Connecticut Department of Environmental Protection

Conceptual Model

- The concept paper focuses on land conversion and drivers of land conversion, with the key impacts (e.g. water quality deterioration, habitat loss) addressed by other breakout sessions.
- "Coastal development" may imply first-order change whereas "land use change" implies changes in density and subsequent impacts (e.g. water quality). The word "coastal" should be included to bind the topic to coastal areas, though definitions of coastal/coasts differ between states and provinces. The group agreed the first tier of towns along the coast that border saltwater and up coastal rivers to the head of tide was a good starting point.
- Two potential scales for land use include overall land use (determined from remote sensing) and specific landscapes and habitats (e.g. seagrass beds).
- Scales may differ depending on indicators.

Audience

- In the Northeast, local communities make most land use decisions at local scales. Can regional indicators reflect the information needed by local governments? Regional indicators can provide information on trends in the region and provide context for local decisions.
- The primary audience for regional indicators should be government managers at the state, provincial, and federal levels. This includes regulators, policymakers, program managers, and analyst/technical staff. Secondary audiences include legislators, non-governmental organizations, scientists/researchers, private sector, local communities and the public.

Top Questions

1) What is the type, pattern, and rate of coastal land use change?
2) How are these changes impacting the integrity of coastal ecosystems?
3) How is the region responding to changes in coastal ecosystems?

Q1. What is the type, pattern, and rate of land use change?
Subtopics discussed:

1. Changes in land use and land cover (extent/location of types of land cover categories; public lands/protected open space/land conservation)
2. Fragmentation of large blocks of contiguous lands (perhaps with a focus on priority habitats.
3. Impervious surfaces
4. Integrity of riparian buffers
5. Demographics (population: year-round, seasonal visitors and part-time residents)

Indicator(s):
1. Percent change in land cover to more intensive uses (using a hierarchical classification of land covers)
2. Demographic changes (population growth/change: # people, # miles driven)
3. Types of land uses and change (e.g., electric company new connections by type of user)

Information Conveyed: Status and trends in coastal land cover, land use, and demographics

Indicator Audience: Government managers, regulators, program managers, policy staff, analysts/technical staff

Q2. How are these changes impacting the integrity of coastal ecosystems?
Subtopics discussed:
1. Socioeconomic impacts
2. Housing
3. Upland/freshwater wetlands/non-fish habitat
4. Public access to the shoreline
5. Infrastructure services (sewer, water, roads)
6. Water-dependent uses

Indicator(s):
1. Integrity of coastal ecosystems for:
- Threatened and endangered coastal species (animals and plants; focus more on terrestrial species because aquatic species likely covered by other fisheries or marine aquatic habitat work groups)
- Migratory species
- Invasive species (presence and abundance)

Information Conveyed: Status and trends in the integrity of coastal ecosystems impacted by coastal development

Indicator Audience: Government managers, regulators, program managers, policy staff, analysts/technical staff

Note: The group noted that some of the impacts of land use change would likely overlap with other themes, including eutrophication, contaminants, and marine aquatic habitats. Thus, the group focused its indicator on impacts that would likely not be duplicated by other theme groups.

Q3. How is the region responding to changes in coastal ecosystems?
Subtopics discussed:
1. Planning and zoning
2. Codes/standards
3. Infrastructure services (sewer, water, roads)

4. Education/outreach to increase awareness
5. Protected areas, conserved lands, habitat restoration
6. Best Management Practices

Indicator(s):
1. Land conservation
2. Habitat restoration
3. Land management (level of effort of management mechanisms including planning, regulatory, etc)

Information Conveyed: Management responses to changes in coastal ecosystems

Indicator Audience: Government managers, regulators, program managers, policy staff, analysts/technical staff

Potential Data Sources:
Q1.
- Land cover data – USGS, NOAA Coastal Services Center, state/provincial GIS offices/programs
- Population/Demographics data – state census data centers, DOC – US Bureau of Census & NOAA, Statistics Canada in Ottawa, provincial/municipal offices
- Land use data – state and local governments

Q2.
- Integrity of coastal ecosystems data– Fish and Game Departments, DEP, USFWS Gulf of Maine Office, DFO, Environment Canada

Q3.
- Land conservation data – provincial offices, Atlantic Conservation Data Center, Centers for Natural Areas (U.S.)
- Land restoration data – NMFS habitat restoration database, Gulf of Maine Council habitat restoration committee, LIS habitat restoration committee
- Land management – state CZM program laws, federal statutes, provincial environmental agencies

Note: Information can be aggregated (to the regional level) and disaggregated (to the state and/or local level). Data will be rich at the local/state level, and more useful to managers, but can be rolled-up to provide the regional perspective.

Key Partners Needed:
- NOAA (CZM, CSC)
- EPA (NEP)
- Environment Canada (e-man and indicators)
- DFO (habitat and indicators)
- Ocean Observing Programs (e.g., GoMOOS)
- State/Provincial Governments (GIS offices)
- Gulf of Maine Council

Implementation Next Steps:
- Ask organizations to pitch in
- Secure seed money for staff

- Become involved in other indicator efforts (Environment Canada, NOAA CZM, EPA NEP, Provinces, DFO)
- Tie into monitoring efforts (EPA's National Coastal Condition, NOAA/CSC's C-CAP, GoMOOS, Ocean Observing, Environmental Monitoring and Assessment Program)
- Secure a host (GoMC, NEIWPCA, NEG-ECP, IOOS regional councils)
- Identify potential sources of support, with incremental contributions on a project basis or annual contributions
- Roll-out at Gulf of Maine Summit

Northeast Coastal Indicators Workshop: Aquatic Habitat Session

Co-chairs: Tracy Hart, Maine Sea Grant and Barb Buckland, Environment Canada
Rapporteur: Hilary Neckles, USGS

Breakout Group Participants:
Dave Burdick-University of New Hampshire
Rick D'Amico-New York State Dept of Environmental Conservation
Michele Dionne- Wells NERR
Lee Doggett-Maine Department Environment Protection
Susan Farady-The Ocean Conservancy, NE Regional Office
Reginald Melanson-Environment Canada
Bryan Milstead – National Park Service
Ann Pembroke-Normandeau Associates
Marcy Scott-NOAA NMFS EFH
Fred Short-University of New Hampshire
Jan Smith-Mass Bays National Estuary Program
Kate Smukler – NOAA National MPA Center
Michele Tremblay- Gulf of Maine Council
Karen Young-Casco Bay Estuary Project

Conceptual Model
There was consensus that this model described general relationships in aquatic habitats but that some important specific details were missing. It was suggested that Invasive Species should be included under disturbances. This disturbance may be accelerated by climate change and may be an indirect effect of ballast water and aquaculture operations. Additional direct human effects include finfish and shellfish aquaculture and damming. It was observed that all disturbances included in the model are negative, whereas some alterations to habitat have positive effects (e.g. restoration and loading reductions). Indicators should be capable of detecting responses to these types of habitat enhancements as well. Given the negative implications of the word "disturbances", it was suggested that this category in the conceptual model be renamed "changes and/or agents of change" and that restoration be included as a direct human impact. The "construction" category under direct impacts was changed to "coastal and offshore infrastructure" to reflect both near and off shore activities.

Summary of changes made to the Conceptual Model:
- Under direct human impacts add: invasive species, aquaculture, restoration, damming, coastal and offshore infrastructure activities.
- Under indirect human impacts, add invasive species and aquaculture
- Add positive agents of change. Instead of "disturbances" use "agents of change"

The conceptual model has been revised (Figure 1) to reflect these changes.

Top Questions
1) How are the extent, distribution, and use of coastal habitats changing over time?
2) How is the ecological condition of coastal habitats changing over time?
3) What are the causes of coastal habitat change?

The thinking behind the questions

There was much discussion concerning what defines Aquatic Habitats – how much of the ecosystem would this indicator set cover and what is the scope of the term "coastal" in the questions. There was concern that the term "coastal" is not representative of all marine areas. Other suggestions were to broaden the scope explicitly to "Coastal and Marine" or "Coastal and Associated Systems", both having specific problems of their own. Some considered the scope of the indicator set to start at the estuary watershed and end in the far shore, deep water areas, whereas others considered just the coastal band between the watersheds and far shore to be more appropriate. There were arguments for both scopes. A State of the Gulf report would definitely cover the entire large ecosystem, but most of the indicators discussed concerned the coastal band. Also, the focus of the indicators is on detecting changes in coastal habitats not the upland, but indicators and drivers might lead back to land based sources. There was not time to properly discuss the issue of scope and no consensus was reached, but all thought it important to clearly define the scope of "Aquatic Habitats" before the full set of indicators is developed. It was also agreed that indicators should be developed per habitat type. The indicator sets for land use and fisheries should be compared to this set to avoid duplication and ensure gaps do not exist.

It was seen as important to define not just the total extent of the aquatic habitats, but also the level of use and type of protection these areas were experiencing or could experience. For example what areas are open for dredging, lease, easements, etc. and what are off-limits?

Both scientific and management indicators were seen as important to answer such questions as: What is the sum of the changes; Has it improved or is it degrading; Are the management measures meeting their stated objectives; Can we predict how coastal habitats will change in the future; How does management affect coastal habitats; and What is the rate of change. When illustrating what has changed in these habitats, it was seen as important to differentiate between human and natural causes of change.

Indicators should detect how the environment has changed to date, but there is flexibility when considering the timeline for these indicators. It was not seen as absolutely necessary to go back to a baseline. There was concern that indicator development would get hung up on defining the baseline identifying information we have from the past. Indicators should be developed with capabilities to quantify rates of habitat change and to predict future condition.

The role of marine protected areas was not specifically mentioned in the aquatic habitat concept paper, but was mentioned in the fisheries context. It was agreed that MPAs are not just a fisheries management tool, and should be considered in the aquatic habitat context as well. The first question was amended to say: changes in distribution, extent, and **use** of aquatic habitats, accepting that change in use can be a cause of habitat change. Amending to **"human use"** was later discussed, although not all were in agreement because some changes in use are not human related. For example, if cormorants colonize an island they can change it dramatically; this is not a human use, but represents a huge change in "use" of the island. It was agreed that within the category of human use were ecological services, thus even strictly protected areas had a human use.

If the management goal is to restore the historic balance of habitat types, then the distribution of habitat types in the past compared to today would define the habitat types that should have more resources dedicated. If the idea is to preserve the relative proportions of each type of habitat, it may make sense to look at the aggregate of habitats rather than dividing out per habitat type.

Indicators

Indicators for question 1

A primary indicator would include distribution, abundance, and extent of habitat type over time, with more detail than simply "area". Aerial photography could be used, but is better for some habitats than others – good for marshes, seagrass, and maybe mudflats. Metric could be frequency distribution of habitat within landscape units (watersheds, states, etc.). The indicator could be presented as a series of maps, with the resolution of the maps defined by specific management questions. The indicator is measured within habitat types. Habitat types as listed in the concept paper are for broad categories and each category includes subcategories. Habitat type has to be worked out to be inclusive and well defined.

A second indicator would include distribution, extent, and location of certain designated uses, including protected areas by their level of protection.

Q1. How is the extent, distribution, or use of coastal habitats changing over time?
Indicator(s):

1. Extent per habitat type over time
    - Large scale mapping, small scale ground surveys
2. Distribution per habitat type
3. Inventory of human use
    - Area, percent of public vs. private
    - Area, percent designated for permanent habitat protection

Indicators for question 2

Indicators are applicable to multiple habitat types and must be applicable to regional scale. Suggestions for this indicator included: Habitat suitability for target / indicator species; Biodiversity measured through community composition; Abundance of target species including measures such as biomass, density, height; Economic use; Relative abundance (of all species, or target species or habitats); Trophic and community structure.

Q2. How is the ecological condition of coastal habitats changing over time?
Indicator(s):

1. Community Structure
    - Measure of change of relative abundance of species within habitat
2. Trophic Structure
    - Number of levels, number of species at each level
3. Species of Concern
    - Invasive species, rare and endangered species, indicator species

Indicators for question 3

Ideas centered on answering the question what is the cause of habitat change? The group started by listing some specific causes and then tried to sort and prioritize them. Causes included hydrologic alterations, impervious surface, manmade structures, water quality , alterations in the shoreline, nutrient loading, altered sediment budgets, land use, recreational boating. Additional specific causes are included in the Conceptual Model. Major causes were seen as physical and hydrologic alterations, point and non-point source nutrient loading, resource extraction, contaminants, climate change, and sediment input. A land-use index might capture many of these causes, including storm-water discharge, non-point source inputs, change in impervious surface, etc. The group focused on indicators for causes not covered by other sessions. Seagrass metrics were seen as a good indicator of water quality in areas they occur.

Q3. What are the causes of coastal habitat change over time?

1. Priority causes: Physical and hydrologic alteration, nutrient loading, resource extraction, contaminants, climate change, sediment input

Indicator(s):

1. Extent and percent habitat area altered by tidal restrictions
2. Boat registrations
3. Seagrass Nutrient Pollution Index
4. Indicators relating to other causes assumed covered by other groups

Indicator Audience:
Primary Users/Needs: Federal, state, local, and provincial regulators and managers, non-profit groups, decision-makers

Secondary Users: non-profit organizations, educators, advocacy groups, academic education, industry, public, agencies

Spatial and Temporal Scale:

- All indicators are aggregated per habitat type
- Some are measured at large scale (e.g. mapping) on frequency of ~5-year intervals
- Some are measured at small scale, within habitats, at seasonal or annual frequency

Making it Happen:
Key partners:
State, federal, provincial, local agencies; academic institutions, private research institutions, NGO's, resource users, consultants, volunteer monitoring and community groups.

Engaging end users:
Engaging community groups in design, data collection, analysis, and reporting of projects. Reporting out with publicized web drafts and public meetings. Include community groups in defining questions as partners in working groups (no group consensus on this). Use Sea Grant and Cooperative Extension to provide small grants and technical guidance for user groups.

Ways to collect data:
Data are available for the regional scale, but there has not been the time and investment to bring partners together to secure collaboration and aggregation. Hold a workshop to identify and engage data collection partners, possibly developing a loose collaborative agreement. Harvest existing data and assess the existing adequacy. Create a data clearinghouse. Establish a position to lead and coordinate the clearinghouse (CICEET was suggested as a potential partner). The inventory of monitoring programs is a first step in finding and compiling the data. A targeted metadata inventory would be another important step, once indicators are clearly specified, so the data needed can be found and compiled. Standardize data and techniques among partners. There needs to be upfront investment in database management and targeted resources to funding data collection. Habitat use and landscape scale data are available and GOMMI has resources and recommendations for data mining. There are some gaps in the data on fauna, infauna, and plants.

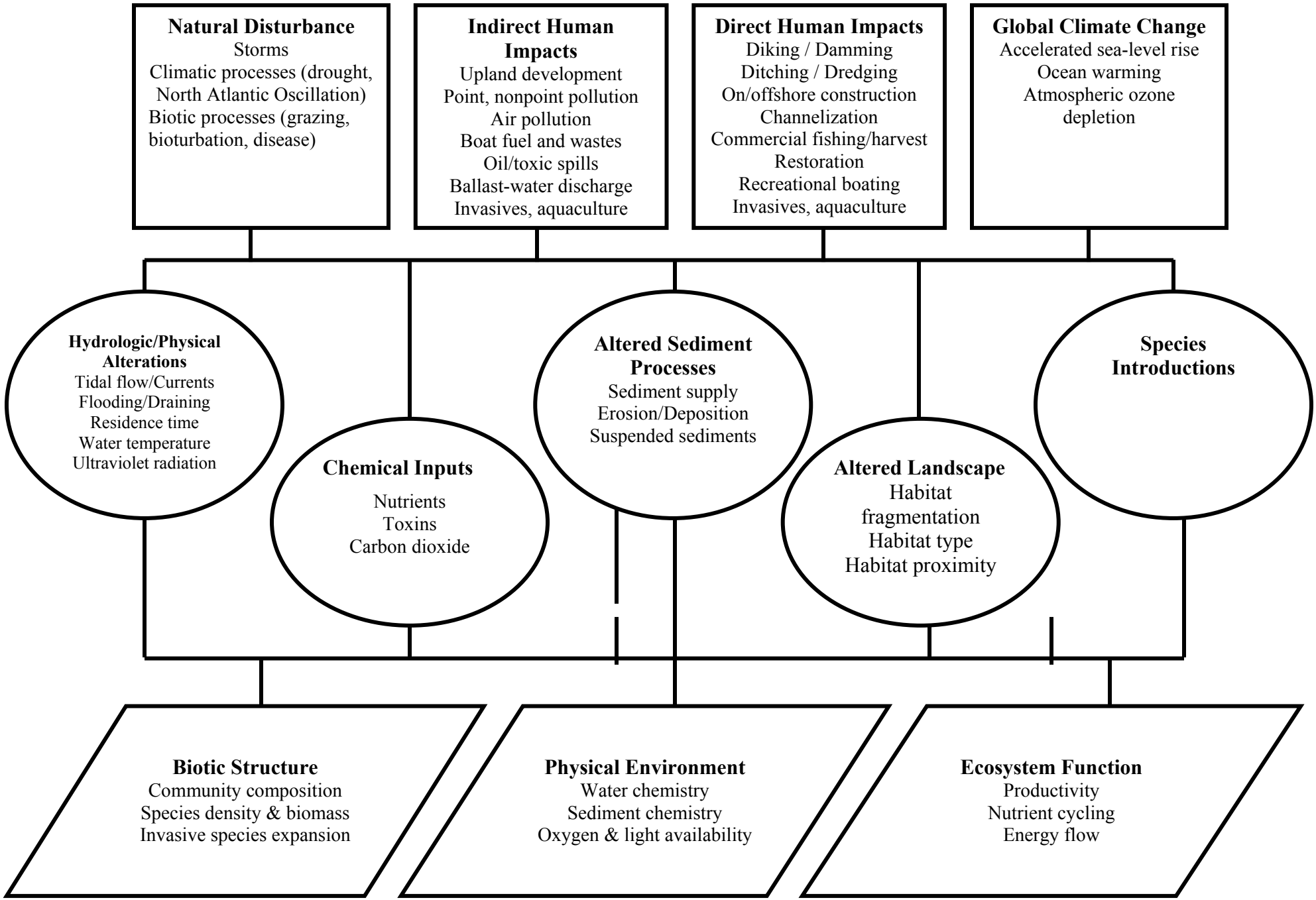
Funding:
National Coastal Assessment is amenable to using their program to answer new questions. We should explore a Northeast-wide agreement on coordination and data synthesis with NCA.

Investigate what was needed for other international efforts to succeed, for example Puget Sound – Georgia Basin and Great Lakes efforts. Agencies in-charge need to adopt this need for regional reporting and then require habitat monitoring and aggregation of habitat data. Funding is essential. We need commitments from lead agencies (e.g. NOAA, EPA, Environment Canada, DFO) to fund data coordination and aggregation. Need funding for a Coordinator, a GIS Specialist, and a data manager. Infrastructure is there with the Gulf of Maine Council, but funding is required to make it happen. Other suggested coordinating organizations include GOM Research Institute and CICEET (broader than GOM-wide).

Implementation approaches

- Fund coordination body for
    - Collaboration
    - Collation = data mining, data collection
    - Data management
    - Synthesis
    - Reporting
- Initial coordination body = Coordinator, Data manager, GIS Specialist

Figure 1. Revised model of northeastern coastal aquatic habitats: relationships among major Agents of Change (rectangles), stresses arising from those agents of change (ovals), and ecological responses (parallelograms). Adapted from National Park Service Inventory and Monitoring Program, Northeast Coastal and Barrier Network (NPS 2003).



Northeast Coastal Indicators Workshop: Fisheries Session

Co-chairs: David Dow, NMFS/NEFSC and Jack Schwartz, Massachusetts Division of Marine Fisheries
Rapporteur: Terry McTigue, NOAA/NOS

Breakout Group Participants:
Louis Chiarella, NOAA
Gary Matlock, NOAA
Linda Mercer, Maine Department of Marine Resources
Kathy Mills, Cornell University
Kathi Rodrigues, NMFS
Faith Scattalon, Oceans and Environment Branch, DFO
Dave Simpson, Connecticut Department of Environmental Protection
Brian Smith, Great Bay National Estuary Research Reserve
David Stevenson, NOAA
Kate Van Dine, NOAA

Conceptual Model
The fisheries working group was dominated by state/federal environmental managers (mostly from fisheries agencies), but they decided that the concept paper was too strongly oriented towards ecosystems-based fisheries management (EbM). The participants made substantial changes to both the questions asked and the potential indicators identified in the conceptual model. An overarching question was established, under which four sub-questions were posed:

What is the health of the fisheries with regard to ecosystem integrity, including targeted and non-targeted species, habitat, and fisheries activities?
1) What are the trends in characteristics and the status of exploited fisheries species?
2) What are the effects of fishing on non-targeted species and their associated communities?
3) What are the effects of fishing and non-fishing activities on marine habitat and fisheries productivity?
4) What are the trends in the socioeconomic characteristics of fisheries?

These questions shadow the GOMC Summit fisheries issues of: population sustainability; commercial/recreational fisheries; removal of species (target and non-target); gear impacts; marine protected areas; and invasive species impacts.
The suggested indicators are identified in the following discussion of the sub-questions.

Sub-questions
Q1. What are the trends in characteristics and the status of exploited fisheries species?

Information conveyed: Status and trends for exploited fisheries and stocks

Primary users/needs: fisheries managers, industry

Secondary users/needs: members of the public, regulators other than fisheries managers, researchers

Indicator(s) with metrics:
1. Proportion of stocks at or above targeted abundance or biomass

- Spatial aggregation: range of species or stocks
- Temporal aggregation: annual
- Audience: primary and secondary users

2. Age/size structure of species from surveys and/or landings
   - Spatial aggregation: range of species or stocks
   - Temporal aggregation: annual
   - Audience: primary and secondary users
3. Spatial distribution of fisheries species
   - Spatial aggregation: range of species or stocks
   - Temporal aggregation: every three to five years
   - Audience: primary and secondary users

Other Indicators identified by working group for consideration:

- Catch per unit effort (CPUE)
- Percentage of stocks at or below target fishing mortality or FMSY
- Target fishing mortality or FMSY
- Fisheries diseases or condition

Q2. What are the effects of fishing on non-targeted species and their associated communities?

Core information conveyed: Impacts of fishing on non-targeted species and their associated communities.

Primary users/needs: fisheries and environmental managers, industry, environmental interests

Secondary users/needs: members of the public and researchers

Indicator(s) with metrics:

1. Characteristics of by-catch and discards
   - Spatial aggregation: throughout region
   - Temporal aggregation: during fishing seasons
   - Audience: primary and secondary users
2. Population levels for selected species
   - Spatial aggregation: region-wide, based on population or stock in question
   - Temporal aggregation: seasonal
   - Audience: primary and secondary users
3. Species diversity
   - Spatial aggregation: region-wide, based on biogeographic boundaries
   - Temporal aggregation: seasonal
   - Audience: primary and secondary users

Other Indicators identified by working group for consideration:

- Community trophic structure
- Frequency of entanglements

Q3. What are the effects of fishing and non-fishing activities on marine habitat and fisheries productivity?

Core information conveyed: Impacts of fishing and non-fishing activities on marine habitat and fisheries productivity
Primary users/needs: Researchers, industry, and managers (environmental, fisheries, and habitat)
Secondary users/needs: members of the public

Indicator(s) with metrics:
1. Area closed to fishing, both benthic and/or pelagic
   - Spatial aggregation: annual
   - Temporal aggregation: region-wide
   - Audience: primary and secondary users
2. Benthic diversity
   - Spatial aggregation: based on biogeographic boundaries
   - Temporal aggregation: every one to five years, depending on habitat type and fishing intensity
   - Audience: primary and secondary users
3. Spatial distribution of bottom fishing
   - Spatial aggregation: region-wide
   - Temporal aggregation: continuous
   - Audience: primary and secondary users

Other Indicators identified by working group for consideration:
- Acreage and accessibility of habitat
- Quantitative changes in potential yield caused by changes in habitat quality/quantity
- Gear modifications and technology
- Availability of undisturbed habitat (acreage)
- Spatial availability of undisturbed benthic habitat (acreage)

Q4. What are the trends in the socioeconomic characteristics of fisheries?

Core information conveyed: Are society's socioeconomic goals for fisheries being achieved?

Primary users/needs: Researchers, community planners, fisheries managers, and industry

Secondary users/needs: members of the public

Indicator(s) with metrics:
This working group contained no social scientists or economists. We feel that these professionals need to be consulted to develop or select appropriate indicators for this sub-question.

Indicators should address issues such as:
1. What are the human components of a "healthy" ecosystem?
2. What are the socioeconomic impacts of fishing?
3. Are society's goals for fishing being achieved?
4. What are the trends in the pertinent socioeconomic characteristics of fisheries?

5. What are the fleet composition characteristics (#boats, #fisheries, number of communities) relevant to quantifying fishing pressure?

Potential indicators were discussed, but not approved:

- Days at sea
- Fleet composition
    - Number of boats
    - Type of boats
    - Number of communities
- Commercial and recreational fishing economic value
- Angler satisfaction
- Overcapitalized fleets
- Natural capital value
- Market value for consumers

Northwest Atlantic Coastal Indicators Workshop Fisheries Working Group Overview (prepared by David Dow, NMFS/NEFSC)

Jack Schwartz (Ma. DMF) and myself focused the fisheries working group concept paper on four questions identified at an August meeting of the Steering Committee in Durham, N.H. These were:

* What is the status of fish stocks?
* What is the impact of fish harvesting on non-target species?
* What is the impact of gear types on habitats and species?
* Is the fishery overcapitalized?

These questions shadow the GOMC Summit fisheries issues of: population sustainability; commercial/recreational fisheries; removal of species (target and non-target); gear impacts; marine protected areas; and invasive species impacts.

The fisheries working group was dominated by state/federal environmental managers (mostly from fisheries agencies), but they decided that the concept paper was too strongly oriented towards ecosystems-based fisheries management (EbM). After much discussion it was decided that the context should be: What is the health of fisheries with regard to ecosystem integrity, including targeted and non-targeted species, habitat, and fisheries activities? The four basic categories of indicators were the same as in the concept paper, but the context was shifted to focusing on fisheries in an ecosystem context. Since the management goals and legislative mandates for this new context are not well defined, linking monitoring/information gathering activities to management information needs via indicators was not always clear. Hopefully future discussions on operational definitions for EbM by the fishery management councils (FMCs), GOMC Summit deliberations, and regional ecosystem coordinating councils recommended by the Pew and U.S. Ocean Commissions will close this gap. A number of the SMP commenters favored a focus on living marine resources (LMRs) and not just fisheries in an ecosystem integrity context.

Our working group decided to measures the status of selected LMRs (non-target fish like sturgeon and Atlantic salmon, sea birds, sea turtles, and marine mammals) in relationship to fisheries bycatch as one indicator under non-target species, while separately characterizing

the status of exploited fisheries under the targeted species sub question with associated indicators. The focus of fishing and non-fishing activities on marine habitat and fisheries productivity was another sub question for which indicators were recommended. Since we had no socioeconomics experts in our working group, we didn't flesh out a set of indicators and associated performance measures, but simply listed a set of potential candidate indicators. A similar lack of socioeconomic expertise hampered other working groups as well, even though there is a general recognition that this is an important area that needs to be developed further.

A few general observations on the fisheries working group deliberations:

* Community indicators and not population metrics need to be developed, i.e. species diversity of non-target communities and infaunal/epifaunal benthic diversity under marine habitat were identified as indicators.

* Faith Scattalon (Canadian DFO) suggested that the U.S. and Canada develop some pilot studies on ways to estimate benthic biodiversity that would be meaningful in our emerging EbM contexts.

* A number of state fishery management agency representatives recommended better coordination of Bottom Trawl Survey (BTS) methodology/techniques with NOAA Fisheries taking the lead (above and beyond ASMFC NEAMAP effort?).

* The proportion of stocks at or above targeted abundance or biomass levels was chosen as an indicator for trends in and status of exploited fisheries stocks, but the states and Canadians apparently don't define reference points for their stocks in this fashion.

* The EPA defined NW Atlantic region was not the spatial scale of interest for many fish stocks and LMR populations, so that biogeographic and not artificial jurisdictional boundaries should be used.

* The spatial distribution of fish stocks was an important indicator for targeted species and the spatial distribution of bottom fishing was an indicator for fishing gear effects on marine habitat. Thus spatial characterization was identified as critical in indicator development.

* Defining the temporal scale for indicators should be related to the life span and biological turnover time of a population and would vary over wide ranges depending upon the species of interest.

* Even though the fisheries working group concept paper discussed indicators for the effectiveness of marine protected areas (MPAs), the aquatic habitat working group choose not to discuss MPAs in their concept paper (even though their discussion mentioned that MPAs have a habitat protection function that is separate from fisheries). The aquatic habitat working group focused on estuaries and inshore waters and left it up to the fisheries working group to discuss the relationship between habitat type and fish productivity (not well understood quantitatively). The fisheries working group tended to focus more on the offshore waters, where we lack good maps of the benthic habitat distribution/characteristics. The Aquatic habitat working group has better knowledge on the distribution/ characteristics of their inshore benthic habitats. The fisheries working group also felt that it was important to describe the pelagic habitat distribution/characteristics, which was less of an emphasis for the aquatic habitat working group. Benthic habitats of particular concern for fisheries includes: habitat areas of particular concern (HAPC), essential fish habitat (EFH), MPAs, etc.

* A number of benthic habitat mapping programs are underway including: GOMC (Jack Schwartz) and USGS (Jack Schwartz and Lou Chiarella) programs, plus efforts in Canada supported by scallop industry (Faith Scattolon). There is a need for better coordination of these benthic habitat mapping activities.

* Need to combine U.S. and Canadian data on spatial distribution of fishing effort in the GOM and GB where each country has common stocks under different management regimes (Dave Stevenson).

* Obtain information from NOAA's Marine Protected Areas Center on areas closed to fishing, either year round or seasonally (Kathi Rodrigues).

* A number of grey literature reports exist describing the effects of coastal power plants on target/non-target species and marine habitat which could provide information on non-fishing human impacts on LMR populations (Kathi Rodrigues).

Northeast Coastal Indicators Workshop: Eutrophication Session

Co-chairs: Suzanne Bricker, NOAA and Diane Gould, EPA
Rapporteur: John Bratton, USGS

Breakout Group Participants:
Veronica Berounsky, University of Rhode Island
John Brawley, Battelle
Barry Burgan, EPA
Chris Deacutis, Narragansett Bay Estuary Program
Edward Dettman, EPA
Mike Doan, Friends of Casco Bay
Blaine Kopp, USGS
James Kremer, University of Connecticut
Richard Langan, University of New Hampshire/CICEET
Jonathan Pennock, University of New Hampshire
Peter Sattler, Interstate Environmental Commission
Mark Tedesco, Long Island Sound Office
Phil Trowbridge, New Hampshire Department of Environmental Services
Dwight Trueblood, University of New Hampshire
Becky Weidman, NEIWPCC

Issue and Problem Definition

This session began with a discussion of pressure-state-response classification of indicators, and the conclusion that all were appropriate for this workshop. The facilitator mentioned the problem of overlap with other sessions and the problem of scale, and the group decided to make reasonable assumptions about appropriate demarcation between themes and to focus on the regional scale. The tension between advocating simple, existing indicators and evolving indicators in the research stage was discussed, and it was later determined that the focus should be the former, but not to the exclusion of the latter.

Conceptual Model
The clarified that the region in question extended from the Bay of Fundy to Long Island Sound, possibly including the southern coast of Long Island. Several participants raised points about the definition of eutrophic, and how this differs in the Northeast compared with other parts of the country. The ideas of a regional range of conditions, human vs. natural eutrophication, strong seasonality, classifying susceptibility to eutrophication, identifying a sequence of degradation in progressive eutrophication, and societal comfort with states of particular estuaries and embayments were mentioned. The question was raised, but not resolved, of whether decreasing nutrient delivery to coastal waters might negatively impact fishery yields. This was seen as a possible cross-cutting issue with the fisheries breakout session. The group wanted minor revisions made on the conceptual document but in general agreed that it was adequate.

The discussion then shifted to key management questions and issues, and the group worked to consolidate questions from the conceptual model document, with those identified in the on-line survey and the straw-man list prepared by the workshop organizers. The short list of questions agreed upon follows:

A. (*state questions*) What are the impacts of eutrophication, both ecologically and to human uses? What is the extent, severity, and what are the trends? What is the rate and how is it changing?

What localities are impacted, and are there particular hotspots? How will extent and severity change in 20 years?

B. (*pressure questions*) What are the sources of nutrients? How can they be controlled? How are they changing?

C. (*response questions*) What management measures have been implemented? How successfully? Where should additional measures be targeted (in terms of both remediation and preservation)?

D. (*management questions*) What are the appropriate indicator variables and thresholds to evaluate eutrophic conditions and susceptibility? What are the appropriate temporal and spatial scales over which these should be measured? What data gaps and research/monitoring needs are most critical to assess and which require the most rapid response? How can these work session results be translated into regional and national strategy?

Straw-Man Indicators

In the second session, the group moved to discussion of individual indicators, and had some difficulty engaging in the specifics of this task. Eventually, a classification distinction was made between indicators that were presently available (classified as "now"), as opposed to those that were promising or actively being developed, but that were presently still at the research stage (classified as "soon"). The group agreed to emphasize the "now" indicators, but the final list under each classification is presented here with some annotations:

"Now" Indicators	**"Soon" Indicators**
Dissolved oxygen: reported as both concentration and percent saturation (requires temperature and salinity measurements too)	Primary productivity, respiration, and metabolism
Chlorophyll a: concentration at least for surface water	Remote sensing of pigments, clarity, temperature; colored dissolved organic matter measurements
Water clarity: including cross-calibration of methods (Secchi depth, extinction coefficient, NTU, etc.)	Plankton community composition and dynamics
Submerged aquatic vegetation (SAV): esp. eelgrass presence/absence, aerial extents, Coastal Change Analysis Program protocols?	Paleoenvironmental reconstruction using proxies measured in sediment cores
Nutrient loads (N, P, Si): more valuable than nutrient concentrations but both are necessary	Macroalgal and cyanobacterial diversity and abundance
Land use and population: secondary indicator, cross-cutting issue with coastal development breakout session	SAV health indicators, including epiphytes, density, invasive species, and new methods (e.g., Fred Short's Nutrient Pollution Indicator [NPI] see attached)
Sediment organic content, suspended sediment concentration, nutrients (NH_3, NO_x, PO_4, TDN, Si): secondary indicators	Nitrogen isotope composition ($\delta^{15}N$) of dissolved and particulate N species and organic matter

One indicator, harmful algal blooms (HABs), has been used in previous eutrophication indices (see eg. Bricker et al., 1999. NOAA's National Estuarine Eutrophication Assessment), however,

there was much discussion in the group about whether this indicator should be included. The group decided that the linkage between eutrophication and HABs in this region was sufficiently controversial or unclear that it would be premature to address it in this context.

The group agreed that the higher the spatial and temporal resolution of the indicator data, the more useful it was. Weekly to monthly resolution for most parameters was identified as necessary to assess seasonal variability and interannual trends, and to determine averages and ranges of conditions at the 10^{th} and 90^{th} percentiles (see attached publication Bricker et al. 2003. Ecological Modelling 169:39-60 for explanation of Chl a 90^{th} percentile and Dissolved Oxygen 10^{th} percentile method as examples). Full water column profiles were also noted as important for delineating stratification and vertical gradients. Measuring other important phenomena, such as planktonic algal blooms or spring freshet impacts, requires data at even higher resolution. Another approach to temporal resolution identified was to select an appropriate indicator period (generally 7-10 days; best, worst, or average conditions) for intensive hourly or continuous measurements, to constrain short-term variability of conditions at particular sites due to tides, and changing day/night and weather conditions. The value of models for integrating data and guiding management decisions was highlighted, with the example mentioned of the USGS SPARROW model for studying watershed nitrogen loading.

Making It Happen

The group spent the first half of this session concluding indicator discussions from Session 2. The implementation discussion started by identifying state and federal agencies as the key partners for developing an integrated regional eutrophication monitoring program. Discussion followed on whether probabilistic (statistically representative) vs. typological (geomorphologically and hydrodynamically representative) sampling was more appropriate for scaling local or state-by-state measurements up to the regional level. There was no strong consensus, but the sense was that each has its place, depending on the question being addressed.

The group then discussed how to make indicators useful for end users; particularly the public, resource managers, and people collecting data. Regional integration was identified as allowing local managers to put their situations into a broader context. Regional data integration workshops with key regional players involved, by indicator, was identified as generally productive. Sub-regional case studies were cited as valuable prototypes for proof of concept and as models for other end users to emulate. (The example was given of a mercury pilot project in the Gulf of Maine).

Final discussions of more detailed plans for funding sources and human impacts of eutrophication were cursory due to time constrains but several significant points were made. Among these were that much effort and funding is already going into coastal monitoring and that some of this can be redirected to aid efforts at regionalization. The example was given of GOMOOS, which has been quite successful, and is actively expanding with plans for smaller buoys closer to shore in bays and estuaries. A final comment addressed whether it would be appropriate for the group to recommend creation of some sort of regionalized data management system or organization. One of the intents of this kind of system would be to have organizations such as EPA, NOAA and other groups that are presently investigating eutrophication in this region, combine and cooperate their efforts in order to avoid duplication of effort.

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Northeast Coastal Indicators Workshop: Contaminants Session

Co-chairs: Carlton Hunt, Battelle and Wendy Leo, MWRA
Rapporteur: Peter Wells, Canadian Wildlife Service, Environment Canada

Breakout Group Participants:
Steve Jones, University of New Hampshire
Christian Krahforst, Massachusetts Bays Program
Beau Ranheim, New York City Department of Environmental Protection
Susan Shaw, Marine Environmental Research Institute
Paul Stacy, Connecticut Department of Environmental Protection
James Stahlnecker, Maine Department of Environmental Protection
Marilyn ten Brink, EPA

Conceptual model
The group agreed that the conceptual model presented to them prior to the meeting was generally satisfactory, but needed some introductory information to motivate the creation of indicators. We recommend adding the following information:

- Definitions of "contaminant" and "pollutant"
    - Substances or agents introduced largely by anthropogenic activity in amounts above (pollutants) or below (contaminants) effects thresholds. – we considered both pollutants and contaminants to be part of the scope of this breakout, although we generally limited the classes of contaminants to toxic chemicals and pathogenic microorganisms.
- Statement of concern – contaminants/pollutants are important because they potentially harm human health or ecological integrity. They can cause toxic effects in humans, impair the use of marine resources, or damage ecological integrity. Humans have historically produced contaminants and will continue to do so. We need to monitor to measure impacts, understand changes in sources, and better understand cause and effect.
- Diagram of sources-fate-transformation-effects (refer to Figure 1). Possibly separate diagrams for chemical contaminants and for microbes. For chemical contaminants could include bioaccumulation/ biomagnification pathways.
- Explanation of general approach is needed: indicators should be chosen to represent classes of contaminants/pollutants (e.g. metals); however, the specific contaminants measured may change as more is learned about that class of contaminants. Include classes of inorganic and organic chemicals with known biological effects. Include those with a specific mode of action, as well as those whose effects are more general.
- Monitoring should be sensitive enough to provide early warning of unexpected effects.
- There is a need to establish what we know or don't know about various contaminants – some are well understood and/or regulated, others not. The list is always changing along with the level of understanding. Some contaminant problems are resolved while new contaminants or effects are added.
- The heading on the conceptual model- **Processes affecting availability** – should be changed to **Processes affecting bioavailability**
- After paragraph **Exposure Routes**, add paragraph:

Bioaccumulation/ Biomagnification

Because of their chemical and physical properties, certain classes of organic contaminants and metals readily bioaccumulate in aquatic food chains and become

increasingly concentrated from seawater to plankton to shellfish, fish, seabirds, marine mammals and humans. Compared with levels in seawater, these contaminants are bioaccumulated and sometimes biomagnified by several orders of magnitude in fatty tissues of top predators….etc.

- In the paragraph headed "Multiple contaminants", delete the first phrase (there are always multiple contaminants around)
- A paragraph describing "Effects" after the paragraph headed "Multiple contaminants"
- Throughout, and especially in the paragraph on "Exposure routes", more emphasis on bioaccumulation/biomagnification as an important transformation mechanism.

In the breakout session, we decided not limit the discussion to exclude nutrients, harmful algal blooms, and invasive species.

Top Questions

The questions resulting from our discussion were similar in theme to those in the web survey, but rephrased.

1) How are contaminants in the region/in our ecological system changing in space, time, and form?
2) How is the input of contaminants changing over time and space?
3) Are management actions changing the extent and/or severity of human health effects?
4) How well are contaminant management actions protecting ecosystem integrity?

Q1. How are contaminants changing?
Indicator(s):

1. Area of sediments that have contaminant levels above sediment quality guidelines or are elevated with respect to contaminant levels observed elsewhere in sediments of similar character (i.e., grain size, carbon content, AVS, etc.)
2. Level of contaminants in representative, relatively non-migratory organisms at various trophic levels that might be considered "sentinel" organisms. For example, macroalgae, mussels, lobster, flounder, colonial seabirds, harbor seals (and – on an opportunistic basis -- beached marine mammals) were suggested as sentinels at several trophic levels. Measure tissue burdens in high-risk human populations[1]. Include emerging contaminants of concern (e.g., estrogens, brominated compounds) in addition to the traditional suite[2].
3. Areas of shellfish bed closure by state by year provided it is carefully interpreted to reflect actual impact, rather than bias from administrative closures, resource values and accessibility, or natural sources of bacteria.
4. Days of beach closure due to bacterial contamination by state by year, but again with careful interpretation to ensure closures reflect an anthropogenic effect from pathogens or relevant indicator organisms.

Information Conveyed: Where are the key contaminants (location, ecosystem compartment); where contaminants are going (time, space, trophic level); effectiveness of regulatory actions (and other human activities, e.g. coastal development).

Indicator Audience: Public, regulators, legislators, educators. "State of the Environment" reports.

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[1] High-risk human populations (high background levels from diet) as modeled in the Great Lakes, The Netherlands, the Arctic

[2] All questions could state the need to measure emerging contaminants - especially those increasing in US, e.g., brominated flame retardants in fish, human breast milk

Spatial, Temporal, and Trophic Scales: Specific water body scales; Event (shellfish beds, beach closures) to Annual to Decadal (sediment contamination). Measure tissue body burdens in same season each time, but may not need to be measured every year. Measure surficial sediment contamination, but supplement with cores in focusing areas to get long-term temporal context. Generally, more temporal and spatial resolution is needed where gradients are high. Consider speciation/sorption. Use transport models, where appropriate/available. Monitoring across trophic scales would incorporate biomarkers of exposure and effects in indicator species at key points in the food chain.

Q2. How is the input of contaminants changing over time and space?
Indicator(s):

1. Annual chemical load to water bodies by state by source (point sources, combined sewage outflow (CSO), runoff, atmospheric, tributaries, spills, groundwater, flux from "legacy" contaminated sediments)
2. Number of bacterial/viral source investigations and sources eliminated by year by state (e.g. TMDLs completed, CSOs eliminated, stormwater BMPs implemented)
3. A simple inventory or list of contaminant problems affecting coastal waters throughout the region. The list would grow or shrink with each renewal, giving an overview of contamination problems and their character. Each contaminant could also be evaluated for level of understanding – e.g., emerging, known problem, thoroughly researched and understood, under management, resolved.

Information Conveyed: Overall scope of the problem plus improvements due to regulatory actions vs. stresses from population growth and development.

Indicator Audience: Managers and regulators; public; other scientists

Spatial and Temporal Scales: Water bodies Region wide; Annual to source specific (should measure at least seasonally, but aggregate to annual average.) For microbes, total annual load is not meaningful, so need to consider short-term, high-intensity events.

- Note that data analysis should integrate the source data with information on coastal development, data on distribution of tissue and sediment contamination, and understanding of transport (e.g. from OOS buoys). Also consider the residence time for various contaminants.

- Consider including "emerging" contaminants such as pharmaceuticals, estrogenic compounds

- Over time, move toward more direct measures of health risk (fecal coliform --> *Enterococcus* --> viruses)

- We also considered tracking of microbial sources (human/wildlife/livestock, runoff/POTW/ballast water) to be an important issue for which indicators should be developed, but could not develop this during the breakout session.

Q3. Are management actions changing the extent and severity of human health effects?

Indicator(s):

1. Tissue body burden in seafood species (bivalves, lobster, flounder, salmon) and in high-risk human populations. Contaminants on this list would be updated regularly to reflect continuing and new concerns. Consumption advisories are one example of how this information might be translated into potential human health effects.
2. Human disease due to fish/shellfish consumption and swimming – including infectious disease (microbial infections), cancer, neurological, endocrine and immune disruption (primarily due to chemical exposure). Need participation of epidemiologists/public health experts to develop appropriate indicator.
3. Beach and shellfish closures (and reopenings) due to microbial contamination [exclude closures due to HAB]. Note caveats under the first question with respect to interpretation.

Information Conveyed: Effectiveness of management actions

Indicator Audience: Public health community, regulators, public, fishing and aquaculture industries

Spatial and Temporal Scales: Specific water body scales; Event (shellfish beds, beach closures) to Annual to Decadal (tissue body burden). Measure tissue body burdens in same season each time, but may not need to be measured every year.

- We noted that fish consumption advisories are related to this question, but are imperfect indicators because they are not necessarily based on current data and/or may be politically influenced.

- A possible HAB indicator could measure how effective HAB monitoring is in protecting public health.

Q4. How well are contaminant management actions protecting ecosystem integrity?
Indicator(s):

1. Sediment quality measure by triad approach
2. Incidence of disease (microbial infections) and health problems associated with chemical exposure (immune suppression, disease susceptibility, endocrine disruption, reproductive impairment) at various trophic levels (seals, birds, fish, mollusks, crustaceans)• Reproductive success (or productivity, as appropriate to the species)
3. Quality of habitats as affected by contaminants (e.g. low DO due to organic material input; turbidity of anadromous fish runs due to excessive solids input)

Information Conveyed: Effectiveness of management actions

Indicator Audience: Regulators, public, legislators, industry

Spatial and Temporal Scales: Water bodies region wide; Annual to decadal scales

- Apply new available technologies[3] to measure biomarkers of exposure and effects (molecular and cellular diagnostics, reporter gene technology, genotyping, hepatic

[3] Advantages - rapid, straightforward, relatively inexpensive, some applicable to diverse tissues. Perhaps more discussion of these needed.

enzyme induction, lymphocyte proliferation) – these indicators provide rapid early warning signals of ecosystem health risks at various trophic levels (prior to overt disease or population-level impacts).

Key Partners Needed:

- State, local, regional, federal authorities
- Scientific community

Some other considerations:

- Archive sediments and tissues for future analysis of emerging contaminants. There are existing archives [EPA, USGS, Canadian Wildlife Service (CWS)/Environment Canada(EC)] but the networks between them need to be strengthened, and someone needs to fund the archival.

- Basic understanding of transport, sediment physical characteristics is needed.

- Need to standardize methods.

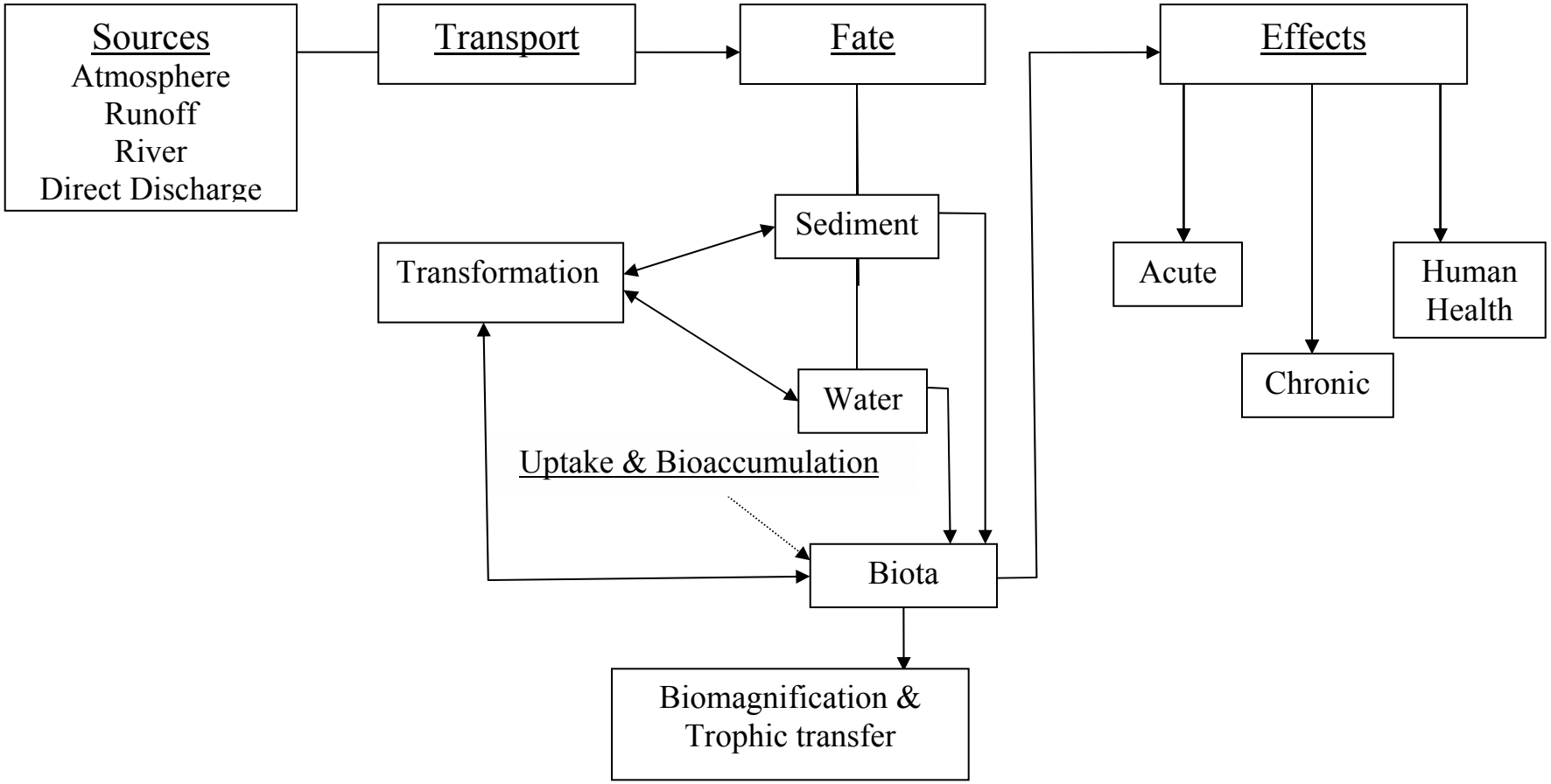
Ways to Engage End Users:

- Series of state of the environment reports

Implementation Approaches:

- Fund coordinating structure to support networking
- Regular workshops and associated reports (state of the environment reports, and summaries useful to educate public and advise managers. Create web site, track # hits)
- Ensure sufficient early warning capacity in the indicators -- what data will we need 10 years out?
- Support/strengthen existing sub-regional coordinating bodies (e.g. GOM Council) and create/fund additional sub-regional coordinating bodies as needed.
- Support a research program to develop new technologies and understanding – e.g. molecular diagnostics, chemical sensors for deployment on OOS buoys
- Develop new, collaborative monitoring programs. Each party can contribute modest funding.

Figure 1 Schematic of processes that occur in coastal systems.



Northeast Coastal Indicators Workshop: Climate Change Session

Co-chairs: Mark Parker, CT DEP, Long Island Sound Study Outreach
Rapporteur: Hal Walker, EPA, National Health & Environmental Effects Research Lab, Atlantic Ecology Division

Breakout Group Participants:
Geno Olmi, NOAA Coastal Services Center
Josie Quintrell, GoMoos
Susan Russell Robinson, USGS
Luc Vescovi, Ouranos - Consortium on Regional Climate Change

Conceptual Model

- Issue and Problem Definition – What are the causes of and inputs to Climate Change?
- Odum quote concerning scale
- The group, in general agreed in the need to revise the Conceptual Model to align with a Pressure, State, Response framework
- Natural & Anthropogenic forcing (pressure).
    - Greenhouse Gasses Emissions
        - Globally (we don't have to measure these)
        - Regionally
    - Emissions affecting Air Quality, NOx – ozone.

1. Examples of Pressure indicators
    - Greenhouse gas emissions
        - Global
        - Regional
    - Emissions affecting Air Quality, NOx - ozone

2. Examples of State indicators: Physical Responses Primary Change
    - Climate – Solar Radiation, Volcanoes, Global Greenhouse Gases
    - Weather (air temp, barometric pressure, atmospheric circulation / NAO, precipitation, soil moisture, wind)
        - Changes in winter, snow trends, ice out, and ice flow change.
    - Ocean & Coastal Circulation, Coastal Water (surface and bottom), Temperature, Salinity, Stratification.
    - Relative Sea Level Rise
    - Storms and Coastal Erosion

3. Examples of State indicators: Secondary Changes Bio-Chemical Responses to Physical Change
    - Acid rain pH trends - The Indicator Statement: Acid Deposition Trends are going down nationally, but not regionally. – PH changes attributable to Sulfur, Reactive Nitrogen, Etc. (sources of S, N, Etc)
    - Contaminants Runoff, contaminant concentrations, bacteria, flux flow relationships
    - Species Composition
        - Phytoplankton (HABs), zooplankton, fish, whales, birds, insects
        - Wetlands (extent, composition, rate of loss / gain)
    - Biogeography of Marine Disease

- MSX, Dermo, etc.

4. Examples of Response indicators - Societal Impacts: Vulnerabilities.
    - Human Health
        - Air pollution: ozone & impact on human health.
        - Vector borne diseases
        - HABs
    - Ecosystem Services
        - Commercial and Recreational Fisheries, Tourism
        - Water supply (consumption and power generation)
    - Coastal Structures / Infrastructure
        - Storm Damage to Structures. Erosion and Beach maintenance
        - RSLR (USGS)
        - Sewage Treatment Plants located very near sea level.

5. Examples of Response indicators – Secondary Societal Responses.
    - Scientific Study (modeling, monitoring)
    - Risk Assessment
    - Management Agreements and Decisions
        - Laws & Regulations, Policies, Coastal Setbacks,
        - Futures markets for temp, emissions trading,
        - Societal Incentives (e.g. Dept of Ag).
        - Voluntary Actions, Mitigation.
    - Adaptation
        - Amount of money available for adaptation
        - Rates of flood insurance, Sales of hybrid cars.
    - Restoration

Making it Happen

Identify actions required over the next 12-18 months to implement the proposed indicators.

- Find an agency or NGO to agree to be the central clearing house and data base coordinator for all the Northeast Coastal region partners to submit their indicator data to.
- Identify a coordinating agency, state, or province to coordinate data indices and organize annual meetings for evaluating the program.
- Apply for state or federal grant money to fund data maintenance and distribution

Conceptual Model for Understanding and Managing Risks (PSR)

A. *(pressure)*
    - Chemical & Physical Changes: Atmospheric Chemistry (greenhouse gases, tropospheric ozone)

B. *(state)*
    - Climate, Weather (temperature, precipitation, extreme events e.g. hurricanes, storms), freshwater input, coastal circulation
    - Biotic Responses to chemical and physical changes
    - Societal Impacts on coastal infrastructure, erosion, sustainability of natural coastal resources (e.g. wetlands)

C. *(response)*
    - Human Actions to mitigate, manage risks, and adapt to change.
    - Regional Actions. Climate Change Action Plan [details]

- Establishment and maintenance of Greenhouse Gas Emission Inventories.

Climate Change – Top Web-Survey Issues

- Effect of Climate Change and Weather Patterns on hydrology and freshwater inputs.
- Climate-Related Regime Shifts in Biota, including temperature effects on biodiversity.
- Effects of Relative Sea Level Rise and Changing Weather Patterns on Coastal Infrastructure and Erosion.
- Societal Responses: What is being done to mitigate, or minimize risks?

Straw Regional Indicators

- Climate Change
  - Annual [seasonal] water temperature by water body (state?)
  - Annual [seasonal] air temperature by watershed [state]?
  - Annual rate [height] of sea level rise by state [harbor]
  - Annual number and frequency of extreme storm events [define extreme]
  - Annual Carbon dioxide emissions [change in CO2 in atmosphere]
- Levels of unhealthy ozone (metric: number of days annually by state [watershed] of ozone levels above state standards [area of unhealthy levels?]
- Biodiversity
  - Changes in biodiversity by habitat and water body type [link to climate change metric]
  - Number of at risk species per watershed [habitat] [state] per year
  - Changes in species range expansions or declines

Top Questions

1) How are atmospheric conditions in the Northwest Atlantic Region changing in response to global climate change?
2) What are the impacts of climate change and weather patterns on hydrology and fresh water inputs to the Northwest Atlantic region? How vulnerable are we?
3) What are the impacts of climate related regime shifts in biota and biodiversity related to water temperatures?
   - Air shed, Ocean, Biological Communities (land and sea), Hazards
4) What are the effects of relative sea level rise (RSLR) and changing weather patterns on coastal infrastructure.
5) What are the socioeconomic responses to climate change impacts? What is the human response to mitigate risks and take advantage of changing resources?

Recognizing the Odum quote to "Always select the scale one size larger than your problem because it is half driven from the large scale, that is the first principle of the system approach." The Climate Change breakout group agreed it was important to monitor some parameters at the regional level that could be compared to measurements at the global level (such as CO_2 measurement at Mauna Laua, Hawaii).

Q1. How are atmospheric conditions in the Northwest Atlantic Region changing in response to global climate change? (pressure indicators)

Indicator(s):

1. Identify Global and Regional components.

- Global Component – Regional Contribution to Greenhouse Gases
- What are the global and regional contributions to Climate Change?

- Do we have a good set of indicators of emissions relevant for decision making?
    - Monitor carbon dioxide levels at coastal and off shore stations.
    - Monitor ozone at coastal and off shore stations. Days of unhealthy ozone levels in coastal areas.
    - Monitor NO_x and SO_x at coastal and off shore stations.
    - Monitor cloud cover/solar reflection trends in the Northeast Coastal and Northwest Atlantic region.
    - Monitor methane and /or carbon monoxide in the Northeast Coastal region.

Q2. What are the impacts of climate change to: weather, atmospheric & ocean circulation, and ecosystems. How vulnerable are we?

Indicator(s):

1. Identify what weather and ocean circulation patterns change one way or another. (state indicators)

- Precipitation trends of the Northeast Coastal watersheds. (Is it getting wetter?)
- Length of Winter (Lake Ice in and Ice Out, Duration of Snow pack). Trends of seasonal air temperatures in the Northeast Coastal region.
- Salinity trends and patterns in estuarine coastal embayment and water bodies of the Northeast Coastal region.
- Surface and bottom water temperatures – trends in nearshore and offshore areas. Tracking the North Atlantic oscillation pattern over time and correlation to precipitation regimes over the Northwest Atlantic and Northeast Coastal regions.
- Trends in frequency and intensity of coastal storm events.
- Acid rain trends, pH monitoring.

Q3. What are the impacts of climate related regime shifts in biota and biodiversity related to water temperatures?

Indicator(s):

1. What are the shifts in biological communities (plankton, fish, whales, birds, insects, amphibians)? (state and natural response indicators)

- Monitor biodiversity of finfish, including the index of cold water vs. warm water species.
- Monitor range shifts and migratory patterns of marine finfish. Extension of warm water species to the north along with marine diseases.
- Monitor diversity of planktonic community (phyto- and zooplankton), index of warm vs. cold water species.
- Monitor frequency and intensity of harmful algal blooms (HABs).
- Monitor trends of marine diseases and parasites related to water temperatures in shellfish, finfish, and marine mammals in the Northeast Coastal region.
- Track wetland plant range shifts and composition due to seasonal temperature regime shifts.

Spatial Aggregation: Northwest Atlantic Coast

Temporal Aggregation: Annual to decadal

Audience: Managers, Scientists, Fishermen, Aquaculture, and the Public

Q4. What are the effects of relative sea level rise (RSLR) and changing weather patterns on coastal infrastructure? (state and natural response indicators)

Indicator(s):

1. Identify the natural resources response to and adaptation to increased RSLR and coastal storm events.

- Rate of sea level rise in Northeast Coastal embayments and estuaries.
- Rate of coastal headland erosion.
- Rate of sedimentation of embayment and boating channels (frequency of dredging projects).
- Rate of loss or gain of public access to coastal resources due to RSLR or coastal erosion. (i.e. Number of boat launch, dock, and board walk areas lost or relocated due to being submerged or washed away by storms.)
- Rate of loss/gain of tidal wetlands due to RSLR.

Q5. What are the socioeconomic responses to climate change impacts? What is the human response to mitigate risks and take advantage of changing resources? (anthropogenic response indicators)

Indicator(s):

1. Identify the societal responses (positive or negative) to climate change induced altered coastal landscape and resources. (response indicators)

- Are action plan(s) being developed for different scales of governance? Are the actions plans being implemented?
- Mitigation & Adaptation, Management Actions.
    - Number of coastal action plans being developed and implemented at all government levels.
    - Number of mitigation/action measures being taken per year and per coastal watershed. (i.e.
    - Number of permits for bulkhead construction or dikes and structures to protect existing development in low lying areas.)
- Trends of regional maritime businesses moving or closing due to sea level rise.
- Trends of regional consumer demand for new or depleted marine fish species impacted by water temperature.
- Trends of relocation of sewage treatment facilities and industries located in coastal areas.
- Trends of insurance claims in the Northeast Coastal region due to coastal flooding and coastal storm damage.

For all Questions/Indicators Listed:

Information Conveyed: To document the nature of past change & to develop model forecasts.

Indicator Audience: Managers, Scientists, and the Public

Spatial and Temporal Scales: (e.g. North Atlantic Oscillation – NAO),

- Annual in length of season depicted decadal, and longer
    - Freshwater discharges increasing into the arctic and moving south into coastal waters
- Spatial Scale & Aggregation (Tundra – Arctic and NW Atlantic Continental Shelf)
- Temporal Scale & Aggregation (past 100 yrs, with 50 yr forecast)

Making it Happen

Key partners needed:

- Climate Change Action Plan (Management)

- NOAA – NOS & NMFS, USGS, EPA, USF&WS, States, NGOs, Environment Canada, OURANOS, DFO

End Users: Coastal Managers, Other End Users, Public
- American Association of Land Planners, Etc, Etc.
- Science Museums
- Boston Aquarium
- Mystic Aquarium

Ways to engage end users: (e.g. OURANOS consortium to engage end users).
- Agreements (Climate Change Action Plan, NEG-ECP Agreements)
- Predictive Modeling (Canadian, US, and other Climate Change Model, Downscaling, etc.
- Global and Regional Models
    - Education – Outreach
- Ways to collect data
    - Existing: Federal, State, Provinces, and Volunteer
    - Who is collecting it:
- Federal Agencies
    - NOAA: National Weather Services, NOS, NMFS, NESDIS, OAR
    - Environment Canada: Metero. Service of Canada
    - Ocean Observing is evolving (e.g. GCOS, GOOS, GoMOOS),
    - EPA NCA,
    - USGS Water and Biology Disciplines
    - Other Organizations
    - GoMOOS
- Adequacy and Shortcomings of existing data:
- Modeling and Data gaps:
    - New Data Needed to Fill Gaps and Improve Coastal Models
    - Ocean Atmospheric Coupling
    - Missing Data Up North (physical, biological)
    - Missing Data on Ocean Boundary Conditions
    - Missing Data on Species Composition
- Data Distribution Systems

Implementation approaches:
- Utilize existing agreement tools such as the Northeast Governors and Eastern Canadian Premiers.
- Utilize existing interstate and interagency agreements and Memorandums of Understanding (MOUs)
- Encourage and create new MOUs between coastal states and provinces.
- Find an agency or non profit group willing to take on data coordination and compile a data library for the region. Provide Grant money and assistance to that coordinating entity.
- Coordinators:
    - USEPA
    - NOAA
    - State of Maine DEP
    - A regional non-governmental organization (NGO)
- Potential funding sources and urgency of the need:
    - Known appropriations $s
    - Appropriations in jeopardy $s

- Appropriations needed to fill gaps.

E.g. Climate Change Action Plan, 2001

1. Establish Regional Emission Inventory
2. Establish Plan for Reducing GHG emissions and conserving energy
3. Promotion of Public Awareness
4. State and Provincial Governments to Lead by Example
5. Reduction of Greenhouse Gases from the Electric Sector
6. Reduction of Energy Demand Through Conservation
7. Reduction and/or Adaptation of Negative Impacts
8. Decrease in Transportation Sector's Growth in GHG emissions
9. Creation of Regional Emissions Registry and Trading Mechanism

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