Large Marine Ecosystem Assessment and Management

Bay of Bengal LME
Inception Workshop
3-5 November 2009

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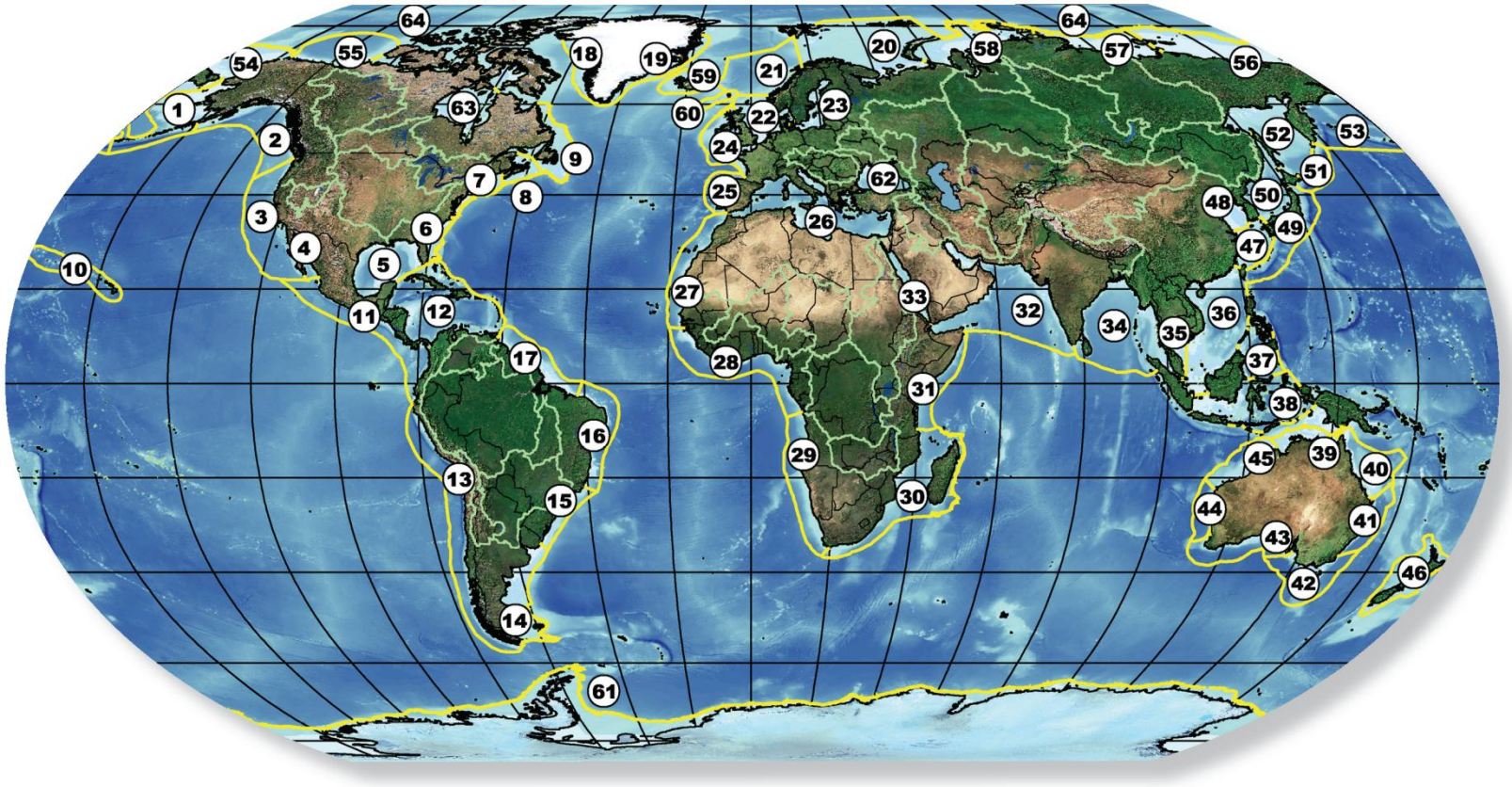
NOAA Fisheries Service
Silver Spring, MD, USA

ECOLOGICAL CRITERIA USED TO DETERMINE AREAL EXTENT OF LMES:

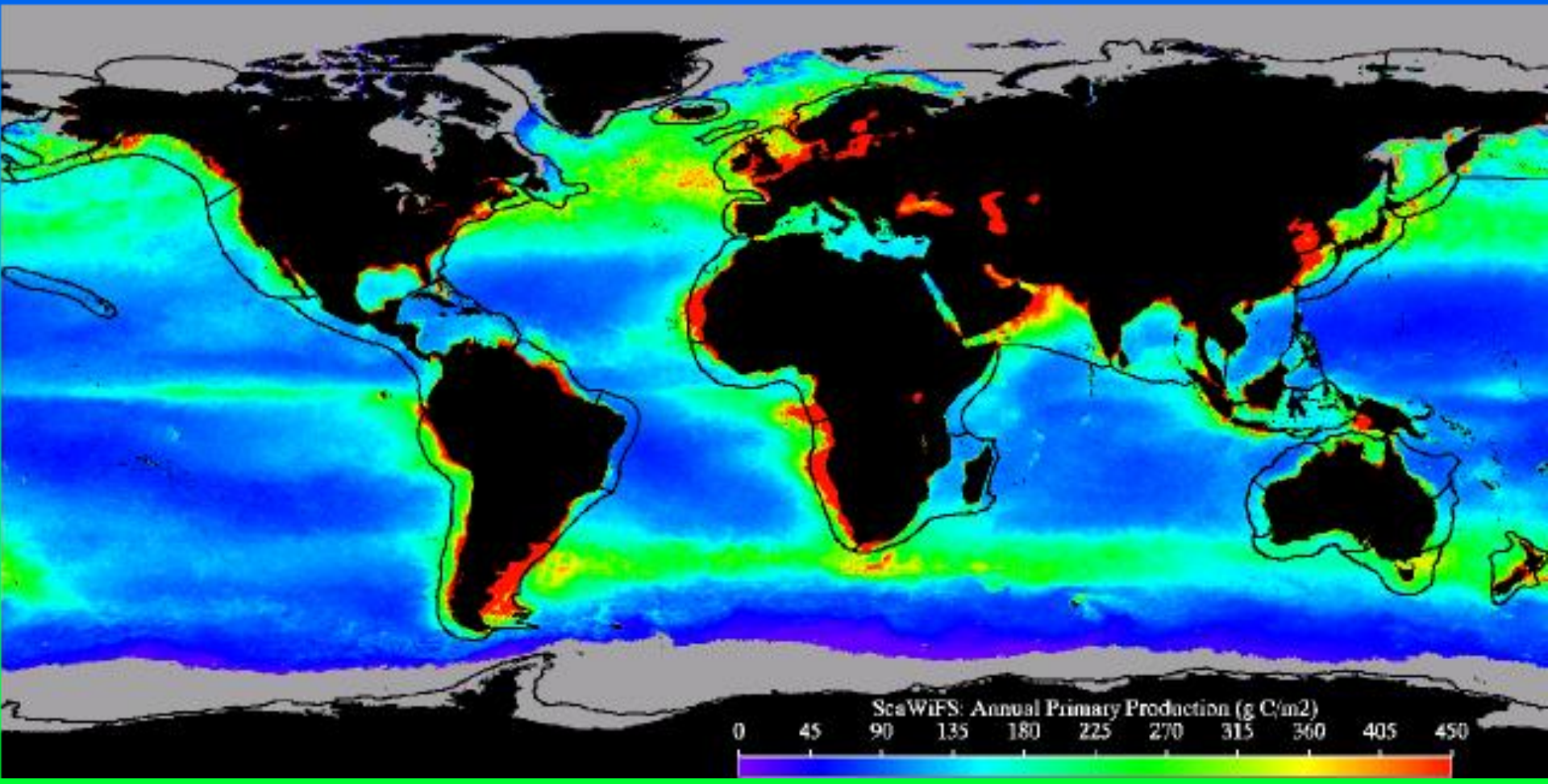
- Bathymetry
- Hydrography
- Productivity
- Trophodynamics

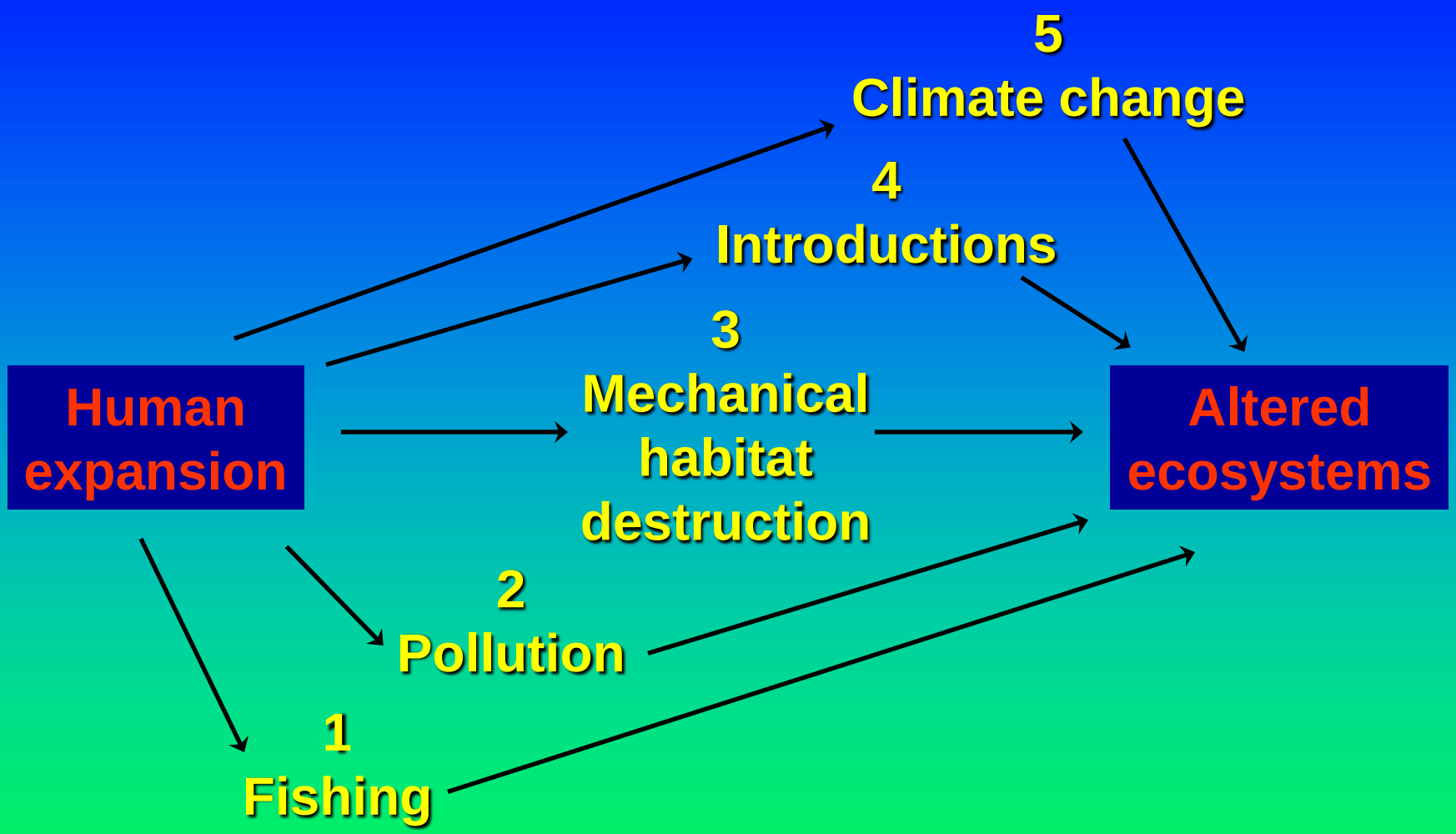
Large Marine Ecosystems of the World and Linked Watersheds



1 East Bering Sea
2 Gulf of Alaska
3 California Current
4 Gulf of California
5 Gulf of Mexico
6 Southeast U.S. Continental Shelf
7 Northeast U.S. Continental Shelf
8 Scotian Shelf
9 Newfoundland-Labrador Shelf
10 Insular Pacific-Hawaiian
11 Pacific Central-American Coastal
12 Caribbean Sea
13 Humboldt Current
14 Patagonian Shelf
15 South Brazil Shelf
16 East Brazil Shelf
17 North Brazil Shelf
18 West Greenland Shelf
19 East Greenland Shelf
20 Barents Sea
21 Norwegian Shelf
22 North Sea
23 Baltic Sea
24 Celtic-Biscay Shelf
25 Iberian Coastal
26 Mediterranean Sea
27 Canary Current
28 Guinea Current
29 Benguela Current
30 Agulhas Current
31 Somali Coastal Current
32 Arabian Sea
33 Red Sea
34 Bay of Bengal
35 Gulf of Thailand
36 South China Sea
37 Sulu-Celebes Sea
38 Indonesian Sea
39 North Australian Shelf
40 Northeast Australian Shelf-Great Barrier Reef
41 East-Central Australian Shelf
42 Southeast Australian Shelf
43 Southwest Australian Shelf
44 West-Central Australian Shelf
45 Northwest Australian Shelf
46 New Zealand Shelf
47 East China Sea
48 Yellow Sea
49 Kuroshio Current
50 Sea of Japan
51 Oyashio Current
52 Okhotsk Sea
53 West Bering Sea
54 Chukchi Sea
55 Beaufort Sea
56 East Siberian Sea
57 Laptev Sea
58 Kara Sea
59 Iceland Shelf
60 Faroe Plateau
61 Antarctic
62 Black Sea
63 Hudson Bay
64 Arctic Ocean

80% of the World's Fisheries Catches are produced in 64 Large Marine Ecosystems





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

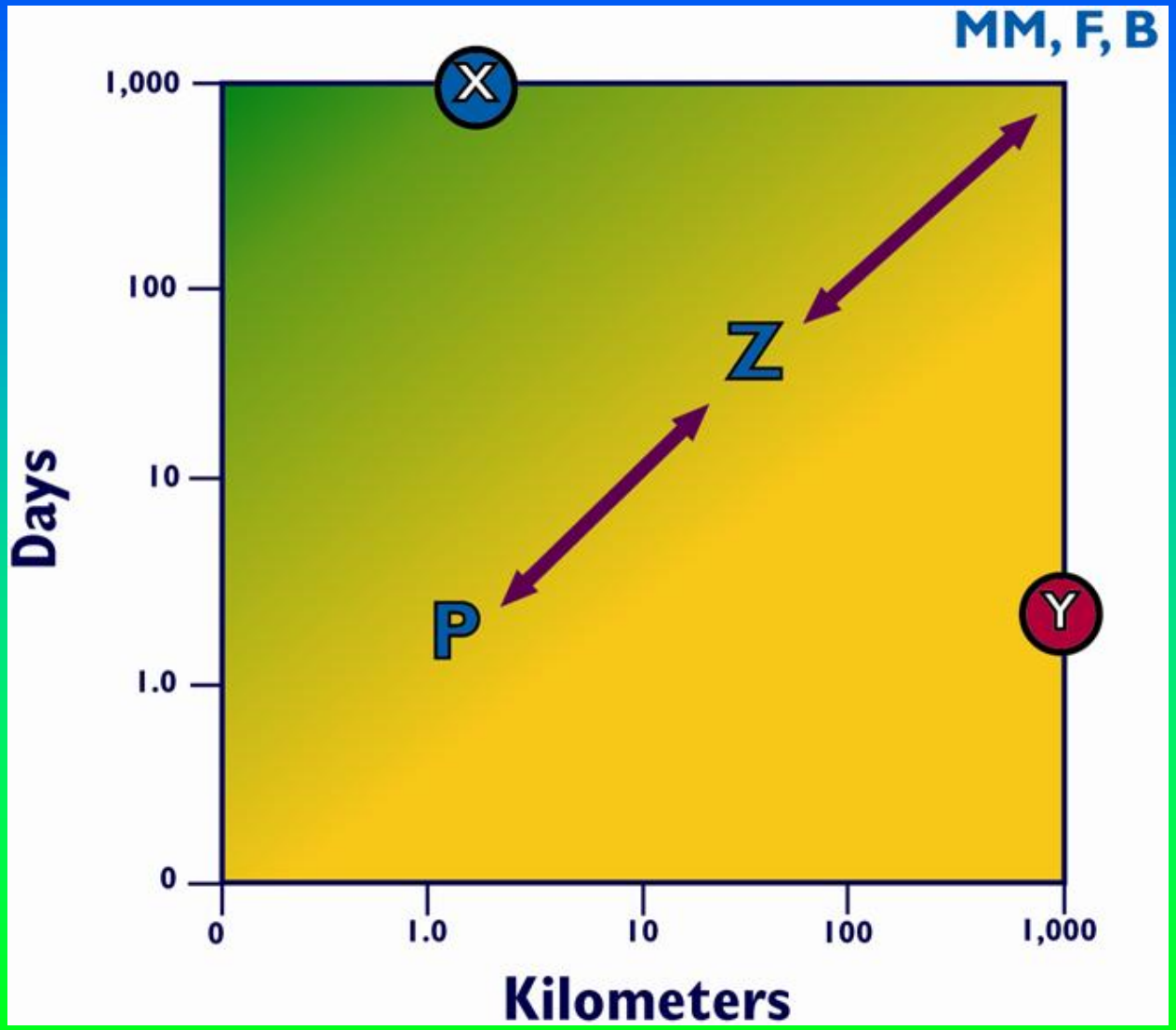
LMEs ARE GLOBAL CENTERS OF EFFORTS TO:

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

SELECTED ECOSYSTEM-RELATED WSSD TARGETS AND PROGRAMS OF IMPLEMENTATION (POI), Johannesburg, August 2002

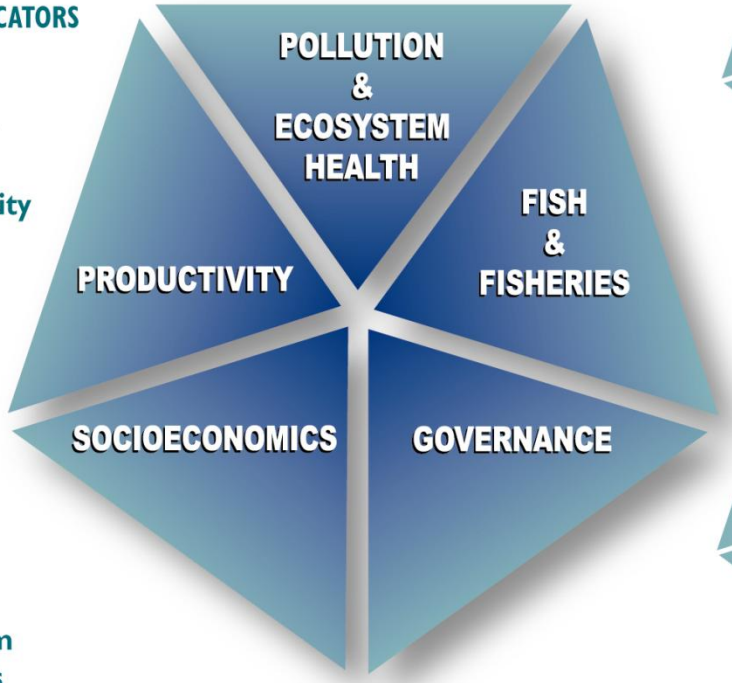
- Land-based Sources of Pollution
  POI – Substantially reduce by 2006
- Ecosystem-based Approach
  POI – Introduce by 2010
- Marine Protected Areas
  POI - Designated Network by 2012
- Restoration and Sustainability of Fisheries
  POI – On an urgent basis and where possible to MSY by 2015

TEMPORAL AND SPATIAL SCALE RELATIONS FOR THE PELAGIC FOOD WEB



5 MODULES WITH INDICATORS

Modular Assessments for Sustainable Development



PRODUCTIVITY MODULE INDICATORS
- Photosynthetic activity
- Zooplankton biodiversity
- Oceanographic variability
- Zooplankton biomass
- Ichthyoplankton biodiversity

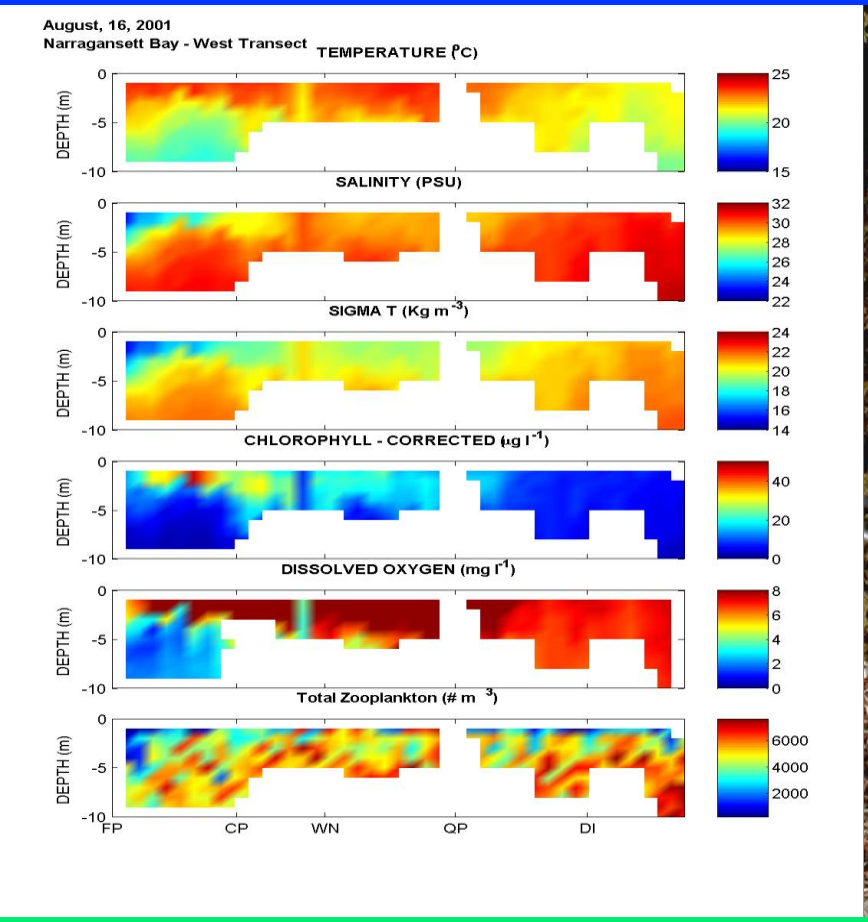
POLLUTION & ECOSYSTEM HEALTH MODULE INDICATORS
- Eutrophication
- Biotoxins
- Pathology
- Emerging disease
- Health indices
- Multiple marine ecological disturbances

SOCIOECONOMIC MODULE INDICATORS
- Integrated assessments
- Human forcing
- Sustainability of long-term socioeconomic benefits

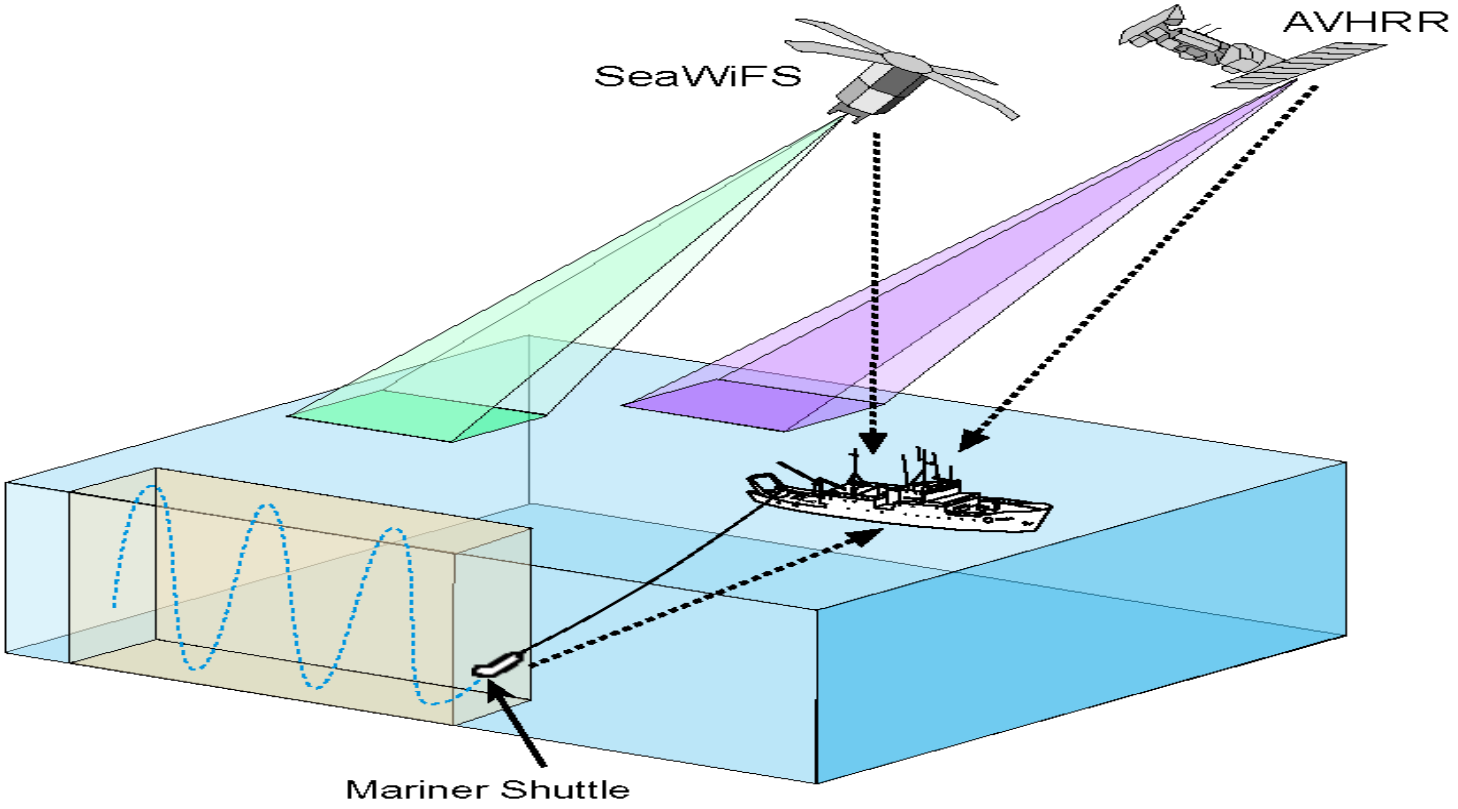
FISH & FISHERIES MODULE INDICATORS
- Biodiversity
- Finfish
- Shellfish
- Demersal species
- Pelagic species

GOVERNANCE MODULE INDICATORS
- Stakeholder participation
- Adaptive management

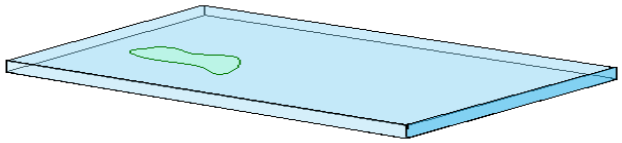
PRODUCTIVITY INDICATORS



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).

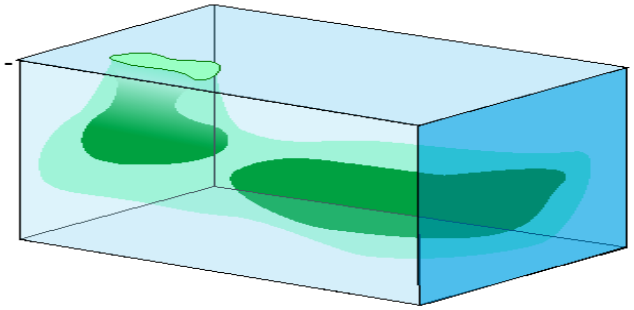


Satellite and in-situ information collected and integrated at sea



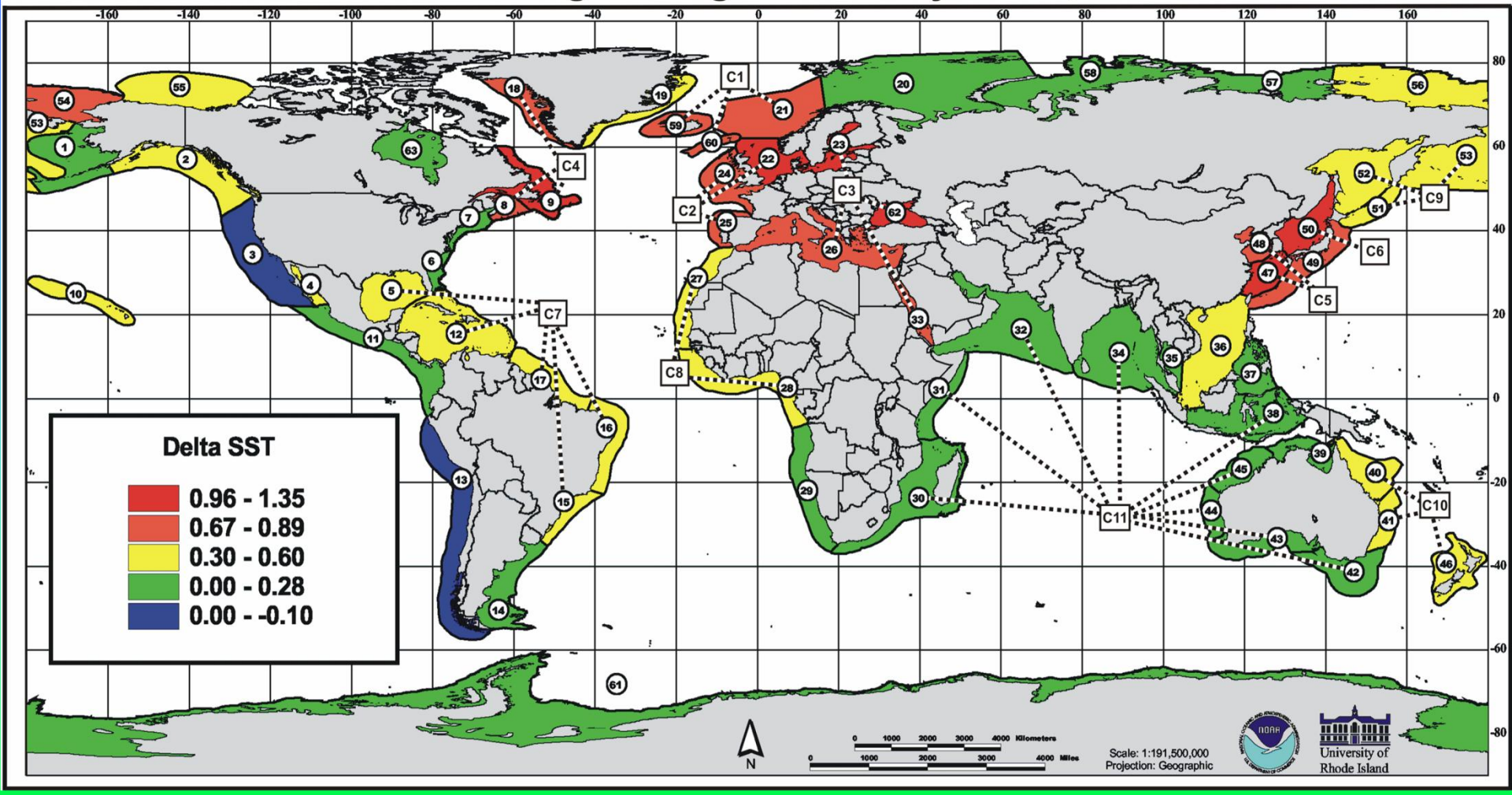
Satellite interpretation alone
(section of sea surface)

VS.



3-D Visualization of Primary Productivity
produced from satellite and in-situ sensors

SST Warming in Large Marine Systems, 1982-2006



FISH AND FISHERIES DATA COLLECTIONS/INDICATORS

- Demersal species surveys
- Pelagic species surveys
- Ichthyoplankton surveys
- Invertebrate surveys (molluscs, crustaceans, cephalopods)
- Essential fish habitat

POLLUTION AND ECOSYSTEM HEALTH INDICATORS

Indicators:

- *Water Clarity*
- *Dissolved Oxygen*
- *Coastal Wetland Loss*
- *Eutrophic Condition*
- *Sediment Contamination*
- *Fish Tissue Contaminants*

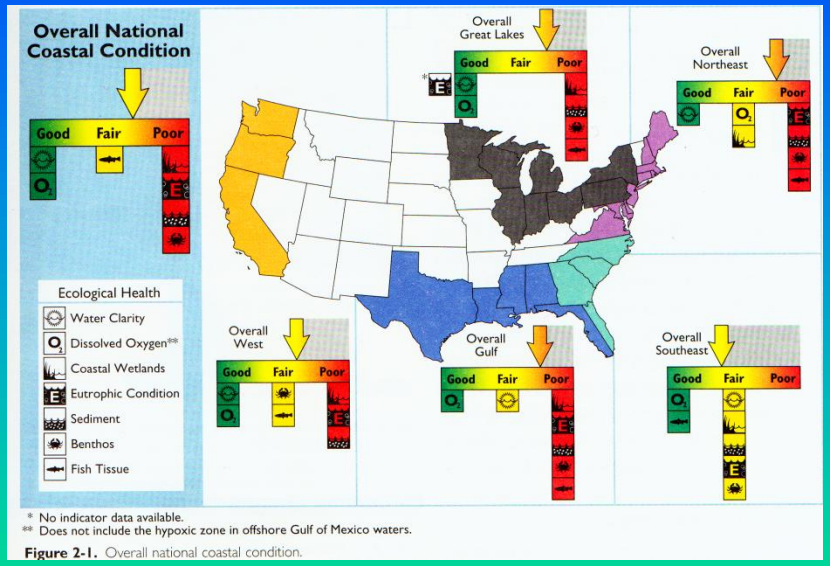
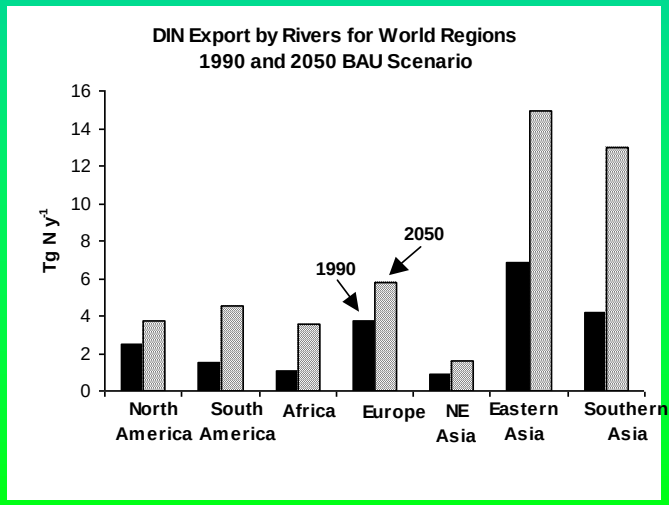
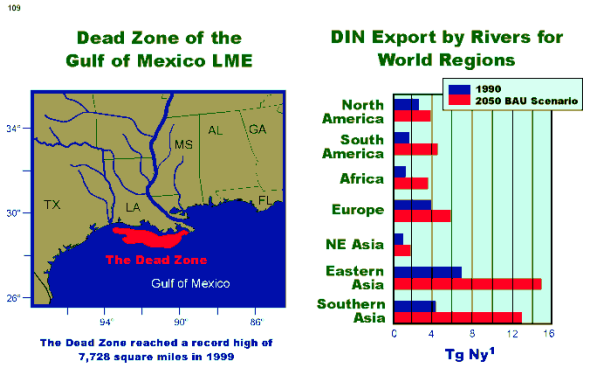


Figure 2-1. Overall national coastal condition.





Nitrogen inputs and transport by rivers to coastal systems

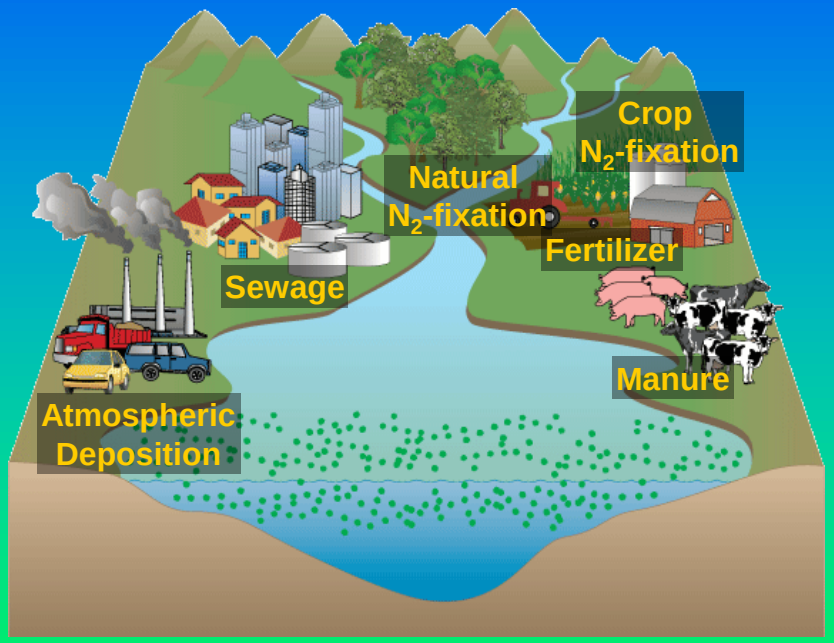
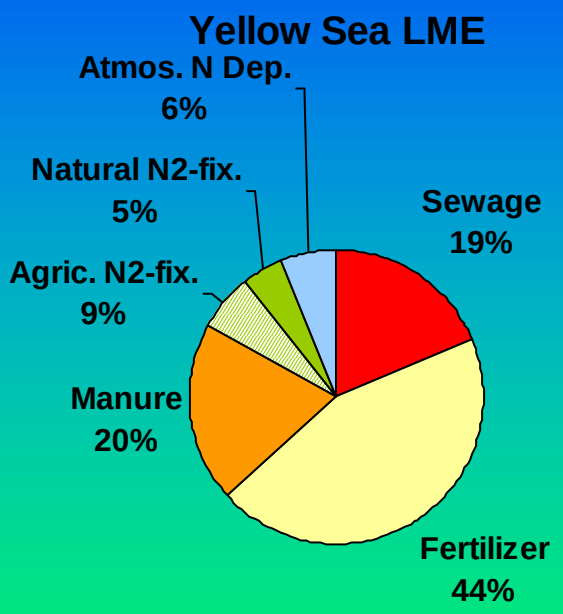
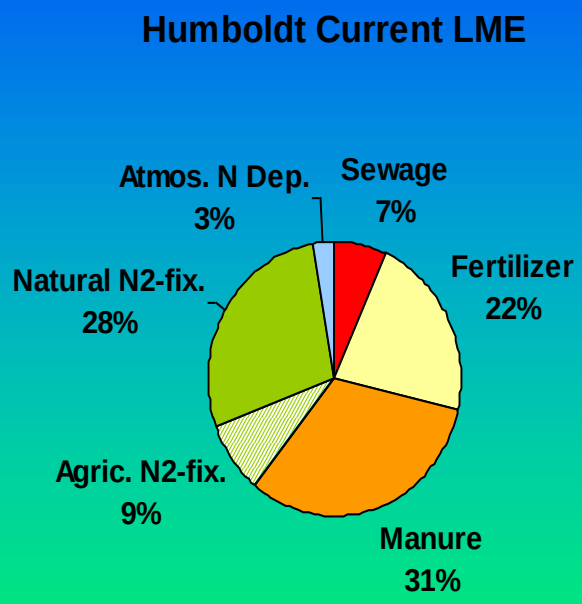
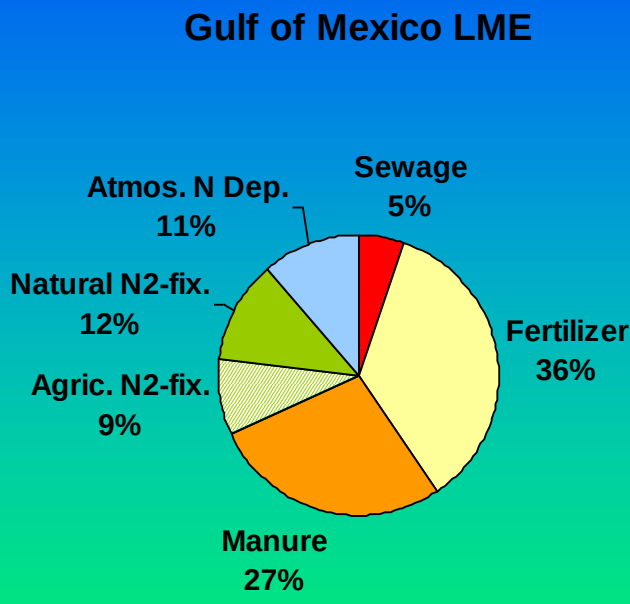


Figure courtesy of University of Maryland Center for Environmental Science

Source attribution of DIN export predicted by the NEWS DIN model to the Yellow Sea, Humboldt Current and Gulf of Mexico LMEs.







DIN inputs (tons N/y) to LMEs from land-based sources predicted by the NEWS DIN model

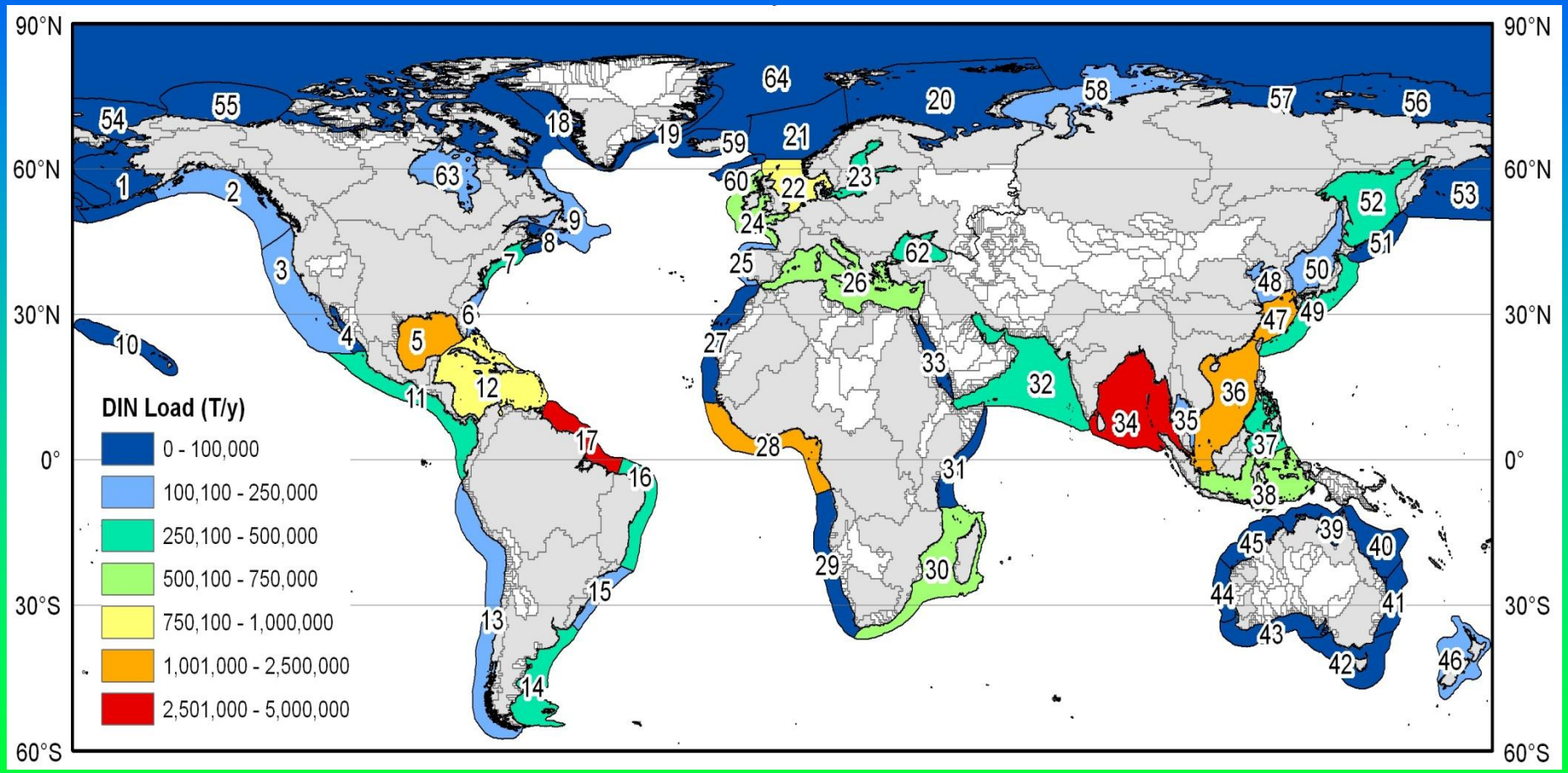
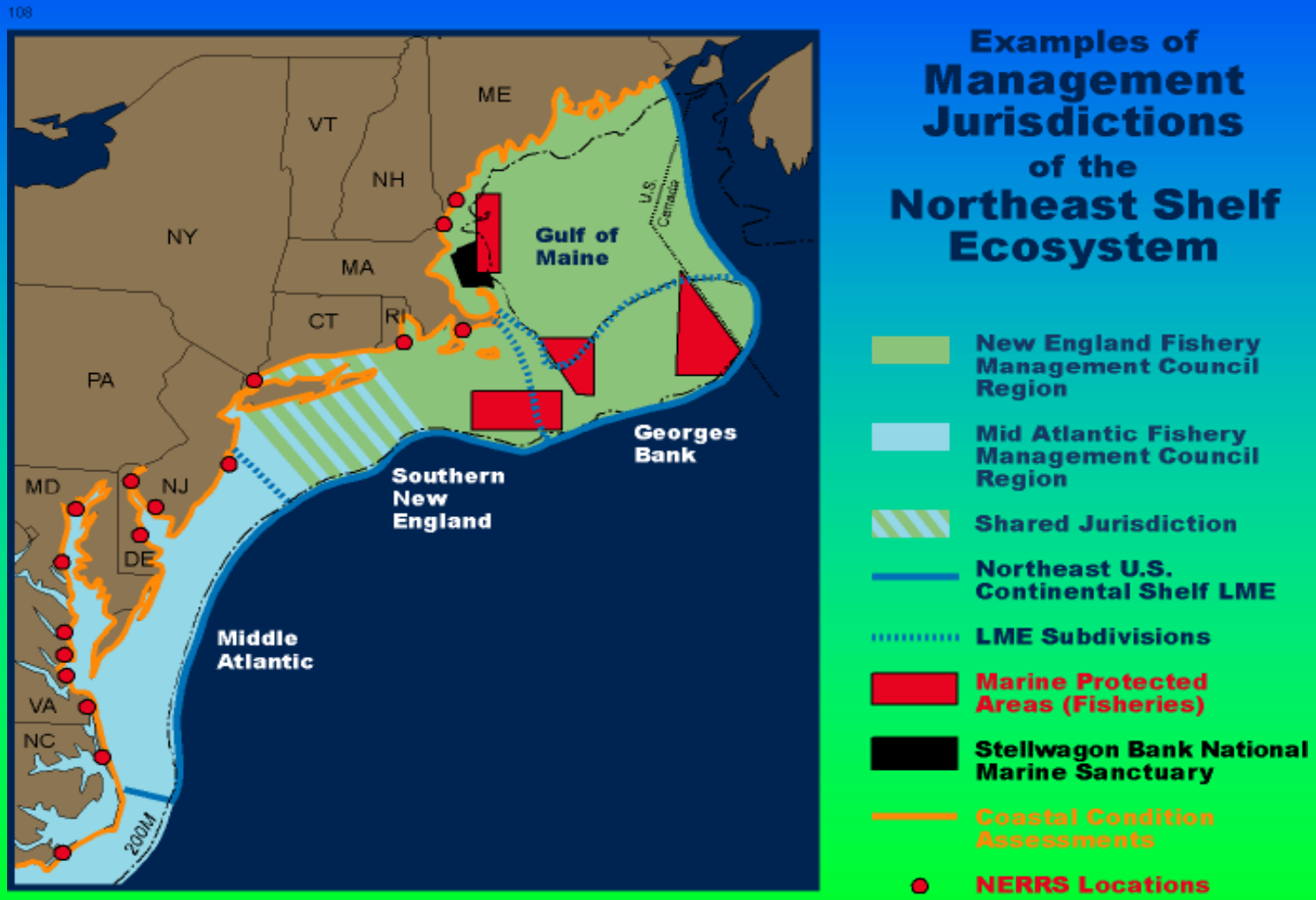


Figure Seitzinger and Lee, 2008.

SOCIOECONOMICS AND GOVERNANCE

NORTHEAST SHELF MANAGEMENT JURISDICTIONS



GEF-Supported LME Projects

NOAA Fisheries' Science & Technical Expertise

Available for Support of Large Marine Ecosystem Projects

NOAA Fisheries' Expertise Available for Science and Technical Support of LMEs

- Living Marine Resources:
  - **Stock Assessments (pelagics, demersal)**
    - **Fishery Independent**
      - **Survey Design**
      - **Assessment models**
    - **Fishery Dependent**
      - **Observer Programs (design, training, implementation)**
      - **Catch Statistics**
      - **Port Sampling**
  - **Life History Studies**
    - **Age and Growth (otoliths, spines, vertebrae)**
    - **Population Structure**
      - **Genetics**
      - **Tagging**
    - **Reproduction and Early Life History**
  - **Protected Resources Monitoring and Assessment**
    - **Marine Mammals, Turtles, Seabirds**
      - **Bycatch monitoring**
      - **Bycatch mitigation**
      - **Survey design**
      - **Life history research**
      - **Population modeling**
      - **Stranding Network**

NOAA Fisheries' Expertise Available for Science and Technical Support of LMEs

- Living Marine Resources (continued):
  - Enforcement and Compliance
    - Vessel Monitoring Systems (VMS), Monitoring and Control Systems, Illegal Unregulated and Unreported catch
  - Economics and Social Science Assessments and Surveys
    - Spatial modeling
    - Bioeconomic and ecological-economic models
    - Cost-benefit / cost effectiveness of fisheries rebuilding programs, protected species recovery programs, and habitat restoration and protection programs
    - Regional economic impact models
  - Management and Governance approaches
    - Fishery management plans for single-species and species complexes
    - Recovery planning for endangered species
    - Management in an ecosystem context (Fishery Ecosystem Plans, Integrated Ecosystem Assessments)

NOAA Fisheries' Expertise Available for Science and Technical Support of LMEs

- Ecosystem Studies
  - Habitat Characterization and Assessment
    - Estuaries, Coral Reef, other benthos, pelagic environment
  - Comparative Ecosystem Research and Analysis
  - Climate Effects on Ecosystems
    - Productivity and lower trophic level monitoring (*in situ* and remotely sensed)
    - Oceanographic observations and models (*in situ* and remotely sensed)
    - Process research
  - Water Quality and Contaminant Monitoring
    - Contaminant monitoring and analysis (in animals and the environment)
    - Nutrient monitoring
    - Harmful Algal Blooms monitoring and prediction

NOAA Fisheries' Expertise Available for Science and Technical Support of LMEs

- Modeling:
  - Assessment Models
  - Ecosystem Models
  - Hydrographic Models
  - Coupled Bio-Physical Models
  - Statistical Modeling
- Data Management:
  - Regional ecosystem data management
  - Access to Data from Distributed Systems
  - Visualization and Analysis of Marine Data
- Oceanographic and climate observations

How NOAA Fisheries Can Share Expertise

- Conduct training courses and workshops in-country
- Rotational Programs of scientists to NOAA Fisheries Science Centers, Labs, and Headquarters for specific training opportunities:
  - Longer duration training courses (1+ months)
  - Short term rotations (~1-2 weeks)
- Placement of expert(s) at LME Project Offices for defined periods to provide training and assistance on specific topics

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.

Questions?