

Assessment and Management of Large Marine Ecosystems

**IOC 8th Consultative Meeting
Paris, France**

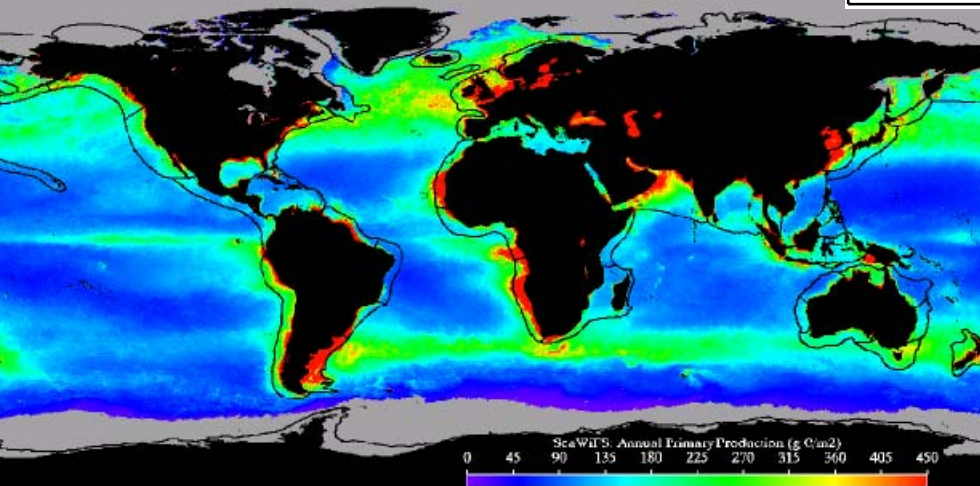
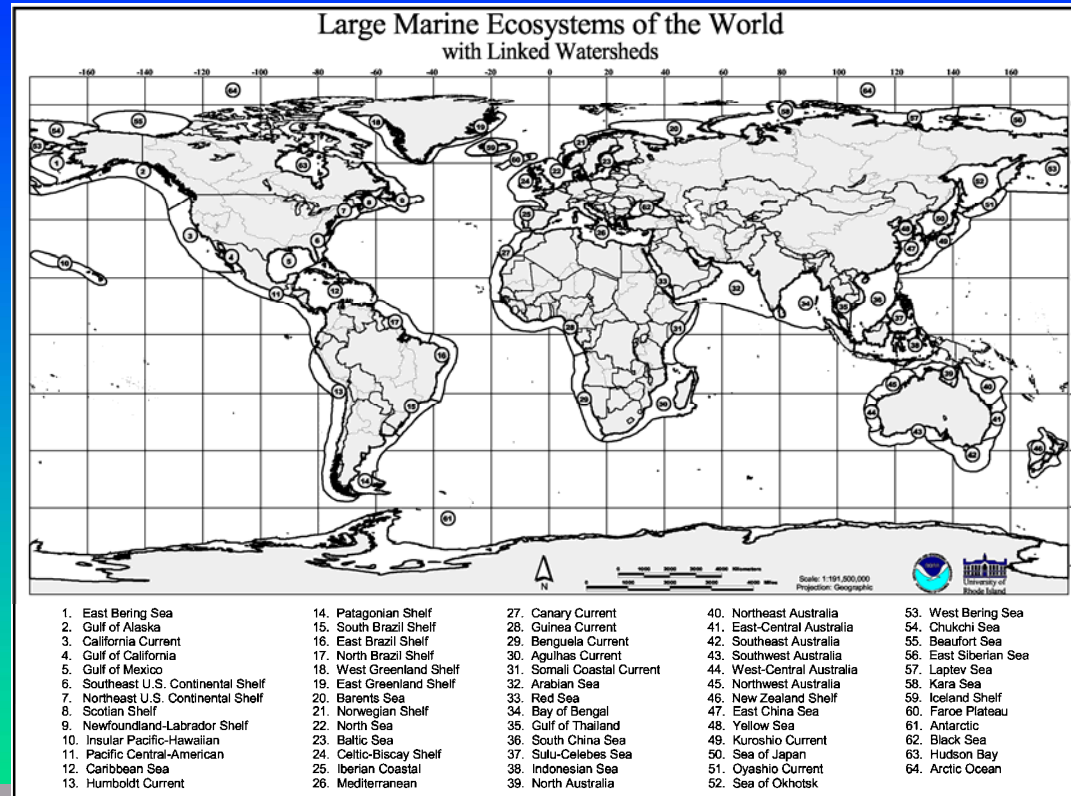
3-4 July 2006

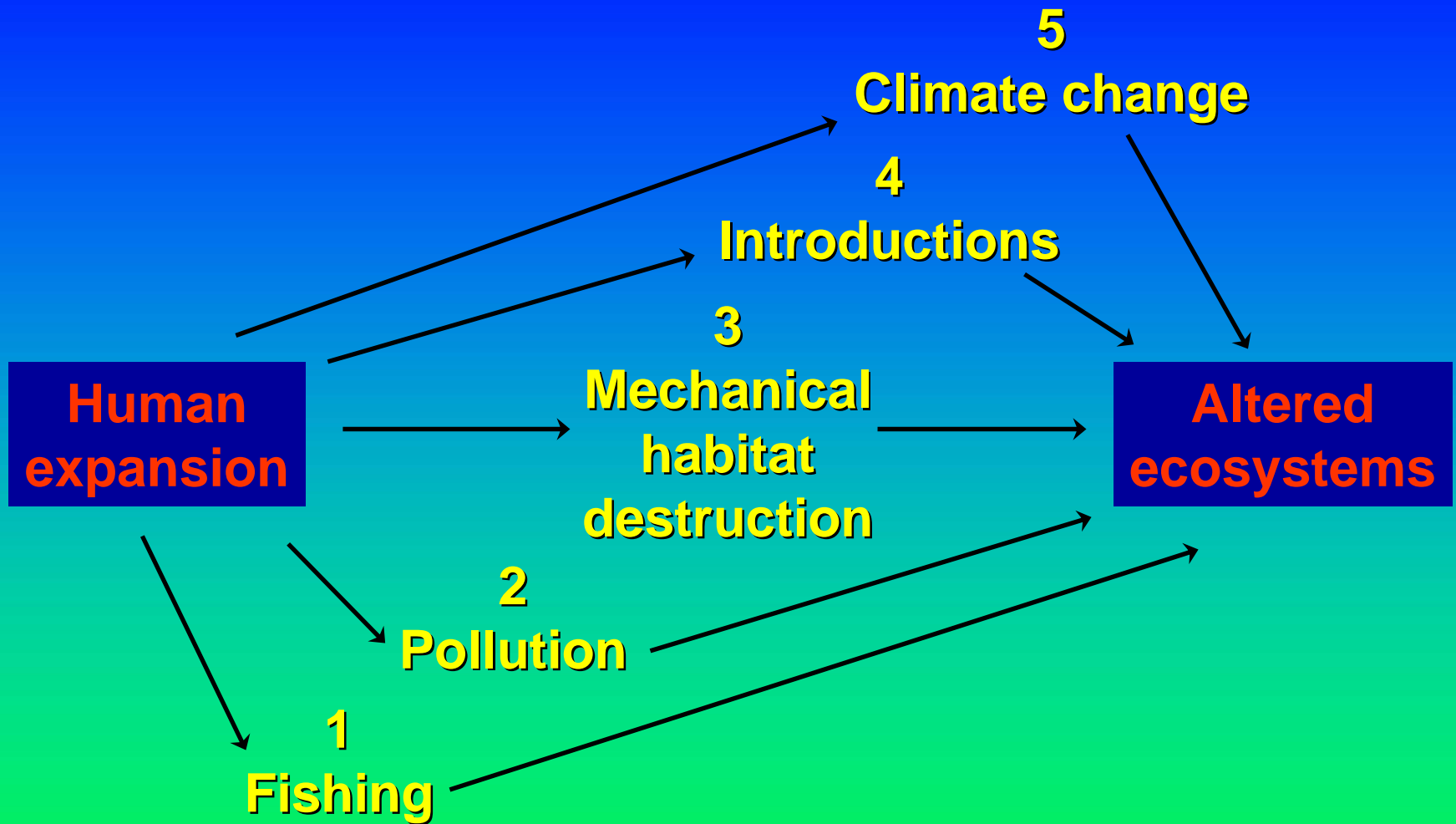
ECOLOGICAL CRITERIA USED TO DETERMINE AREAL EXTENT OF LMES:

- **Bathymetry**
- **Hydrography**
- **Productivity**
- **Trophodynamics**

THE WORLD'S 64 LMES

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





“Then” **“Now”**

PRINCIPAL CAUSES OF LME DEGRADATION

LMEs ARE GLOBAL CENTERS OF EFFORTS TO:

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

INDICATORS OF CHANGING ECOSYSTEM STATES:

Productivity

Fish and Fisheries

Pollution

Socioeconomic

Governance

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



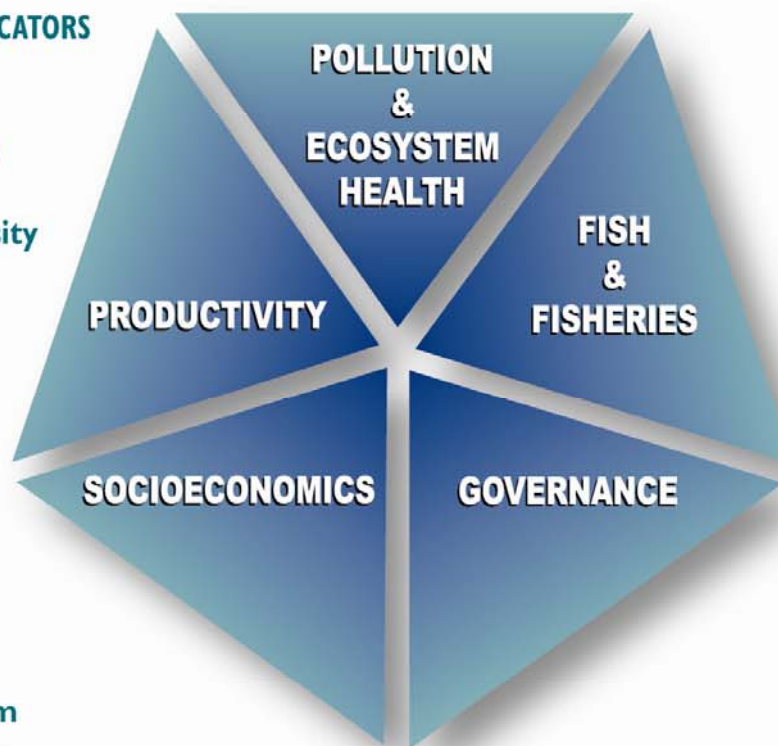
FISH & FISHERIES MODULE INDICATORS

Biodiversity
Finfish
Shellfish
Demersal species
Pelagic species

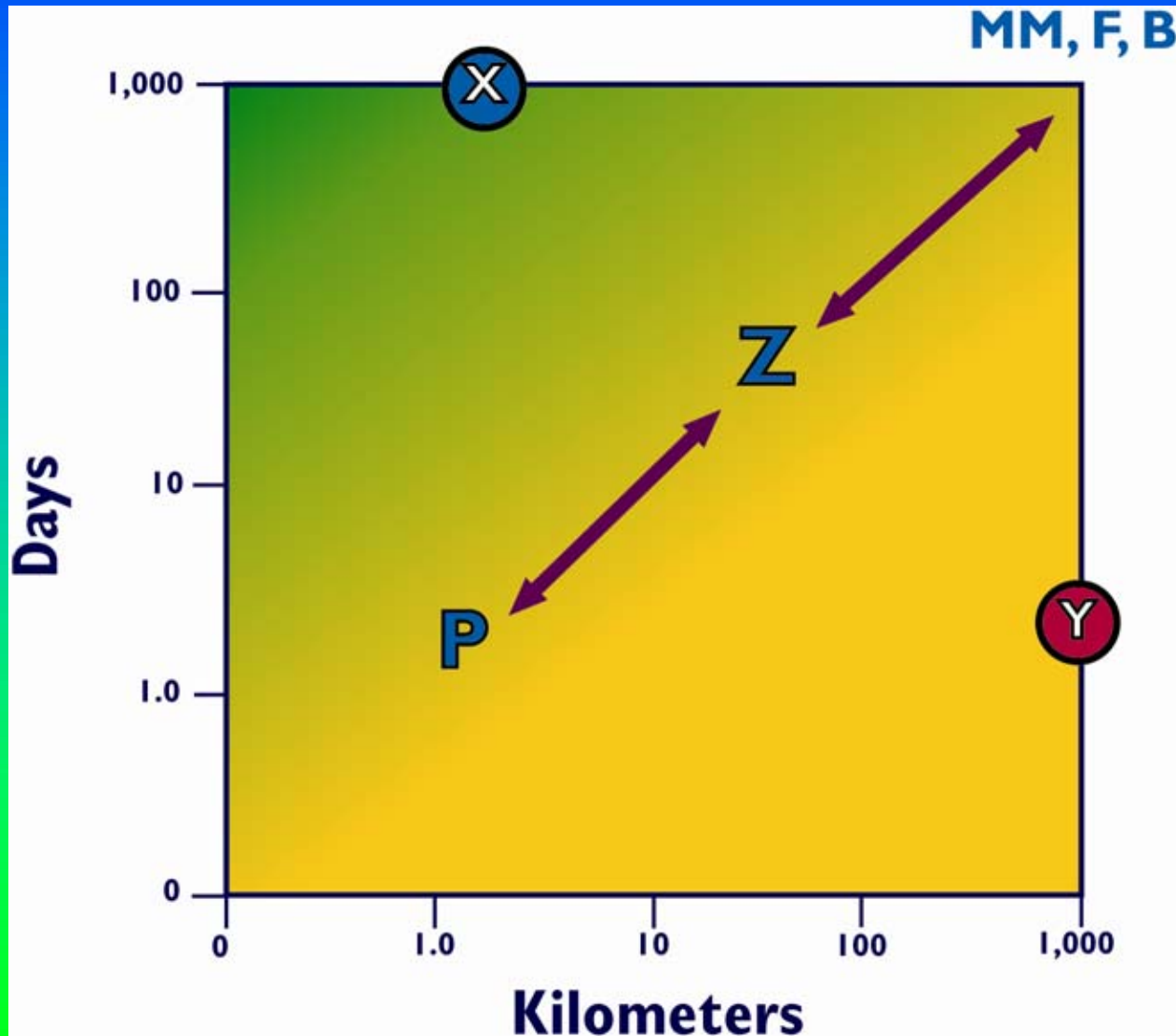


GOVERNANCE MODULE INDICATORS

Stakeholder participation
Adaptive management



TEMPORAL AND SPATIAL SCALE RELATIONS FOR THE PELAGIC FOOD WEB

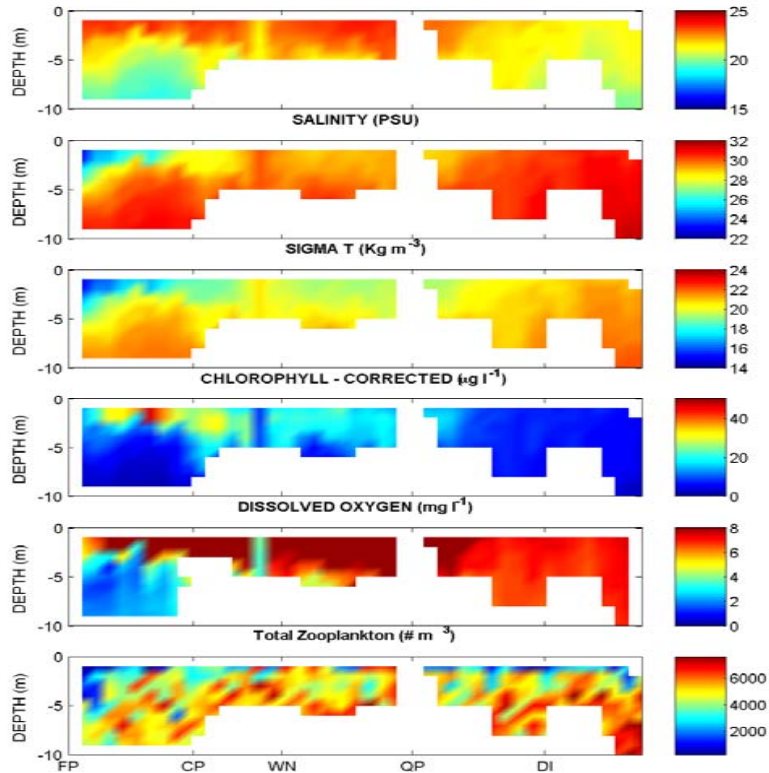


PRODUCTIVITY INDICATORS

August, 16, 2001

Narragansett Bay - West Transect

TEMPERATURE (°C)



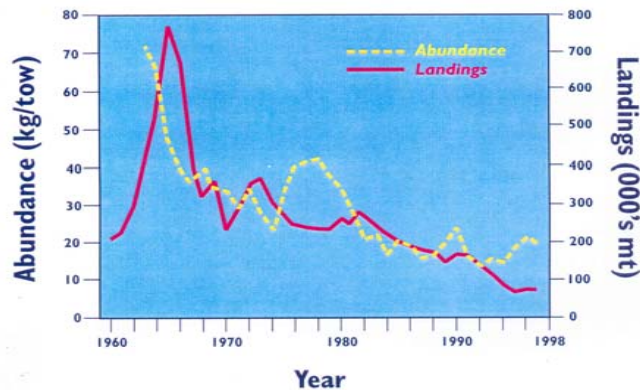
An undulating oceanographic recorder (above), towed behind a ship, is used to collect ecological parameters needed to assess the state of the marine ecosystem (left).

FISH AND FISHERIES INDICATORS

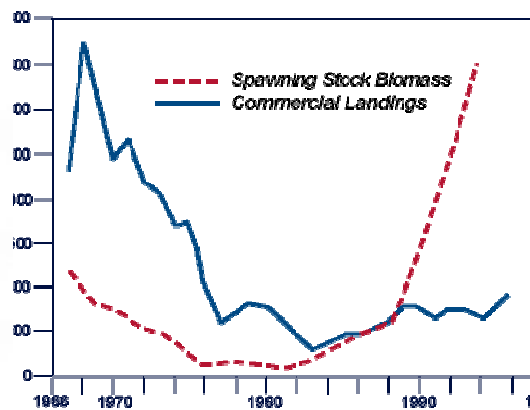
- **Demersal species surveys**
- **Pelagic species surveys**
- **Ichthyoplankton surveys**
- **Invertebrate surveys (clams, scallops, shrimp, lobster, squid)**
- **Essential fish habitat**
- **Marine protected areas**

FISH AND FISHERIES INDICATORS

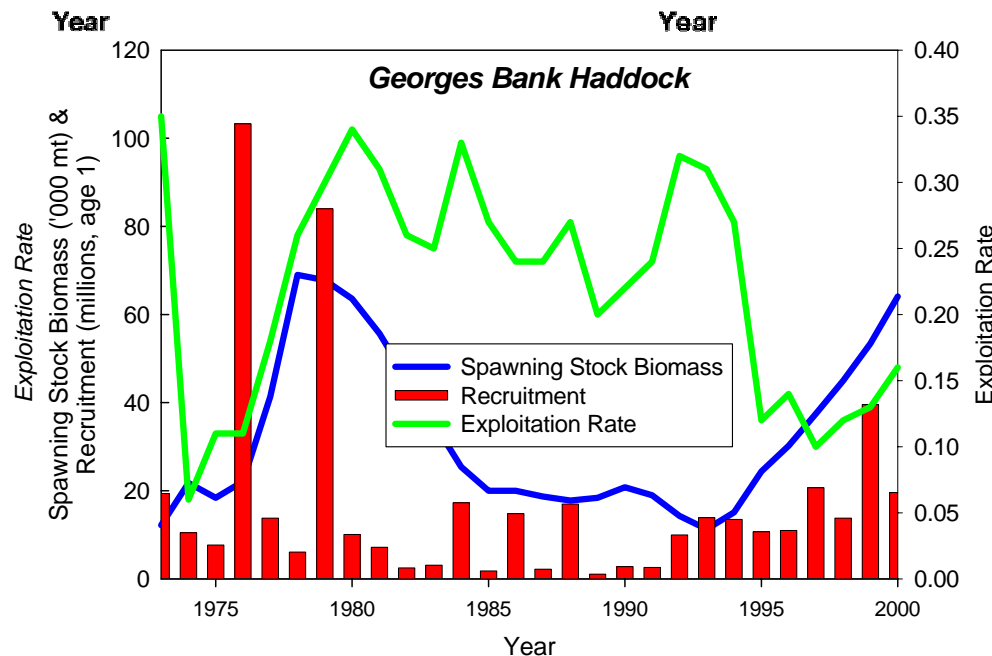
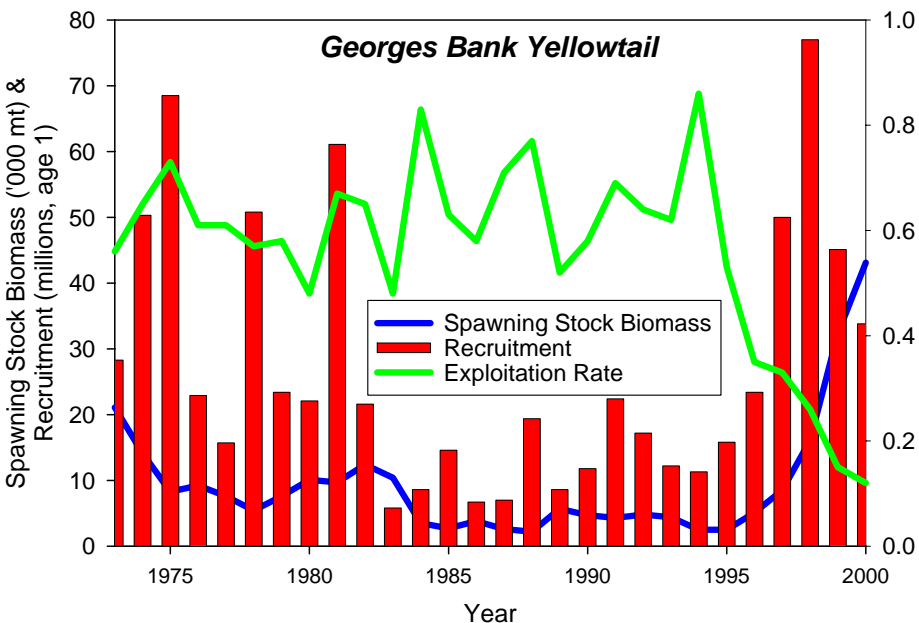
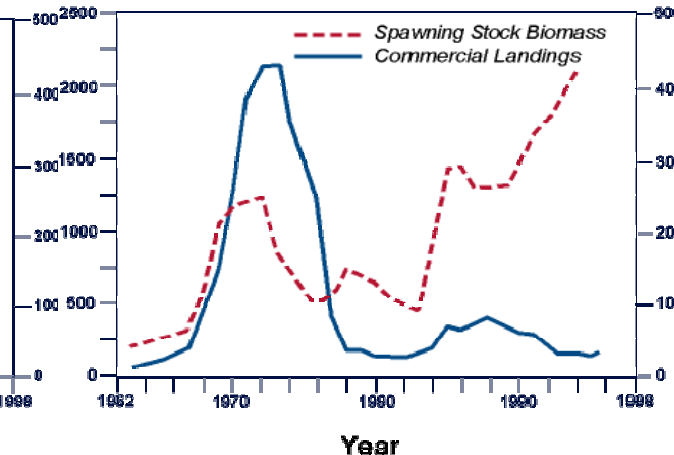
PRINCIPAL GROUNDFISH & FLOUNDERS



HERRING



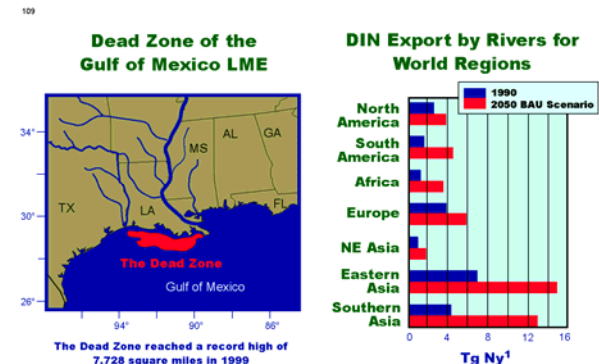
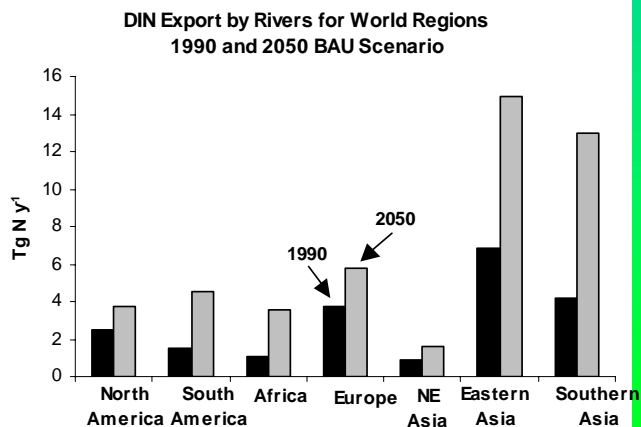
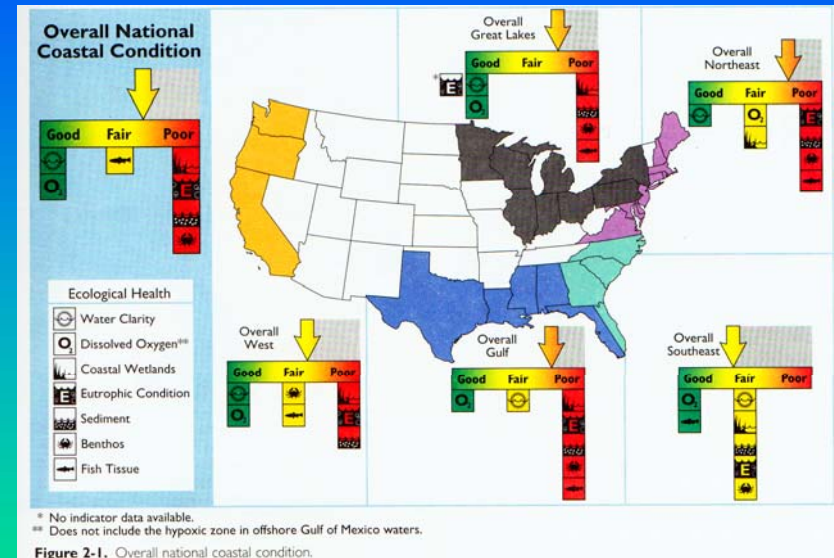
MACKEREL



POLLUTION AND ECOSYSTEM HEALTH INDICATORS

Indicators:

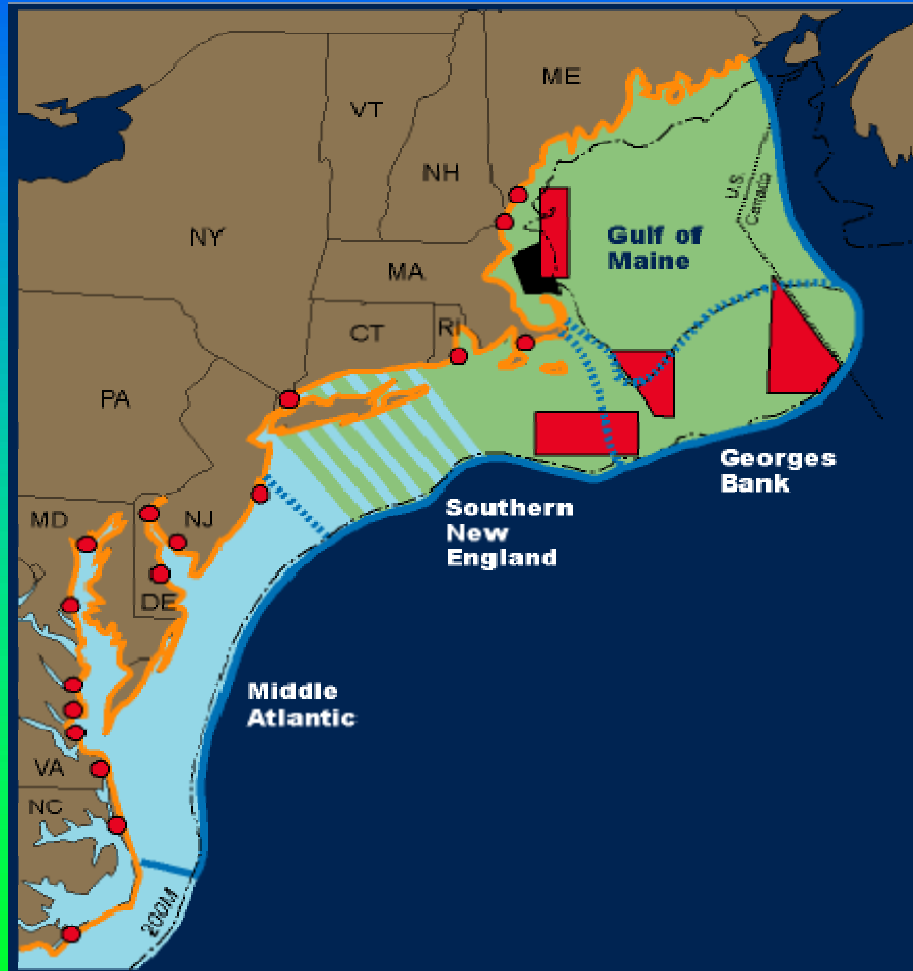
Water Clarity
Dissolved Oxygen
Coastal Wetland Loss
Eutrophic Condition
Sediment Contamination
Benthic Index
Fish Tissue Contaminants
Multiple Marine Ecological Disturbances



SOCIOECONOMICS AND GOVERNANCE

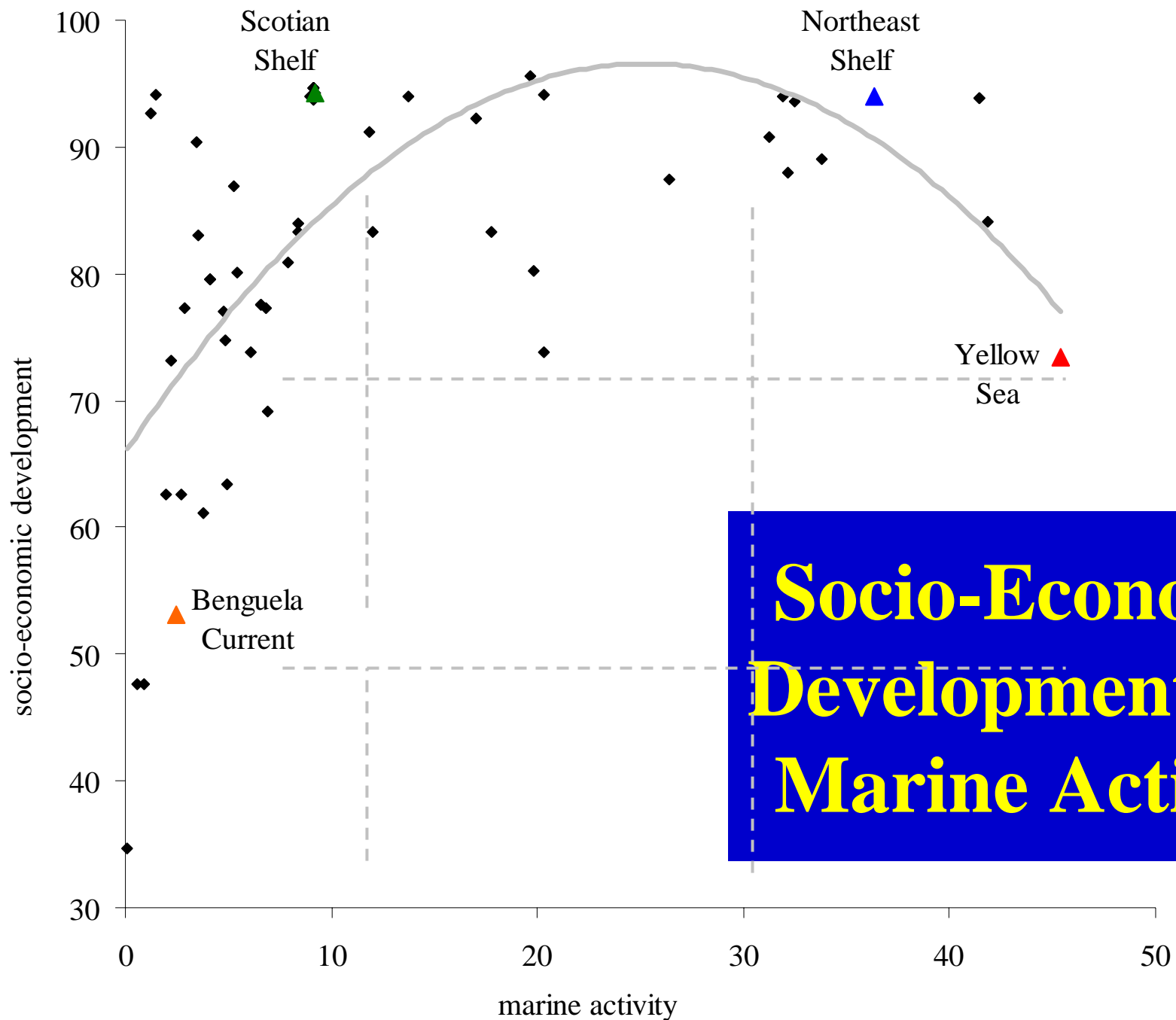
NORTHEAST SHELF MANAGEMENT JURISDICTIONS

169




Examples of Management Jurisdictions of the Northeast Shelf Ecosystem

- New England Fishery Management Council Region
- Mid Atlantic Fishery Management Council Region
- Shared Jurisdiction
- Northeast U.S. Continental Shelf LME
- LME Subdivisions
- Marine Protected Areas (Fisheries)
- Stellwagen Bank National Marine Sanctuary
- Coastal Condition Assessments
- NERRS Locations



Socio-Economic Development and Marine Activity

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.

LME / GEF PROJECTS IN SUPPORT OF UNEP REGIONAL SEAS PROGRAMME

- **Integrate land-based sources of pollution Project activities with LME modular assessment strategy**
- **From \$650 million to \$1.8 billion**
- **+ \$200 million (Sub-Sahara World Bank Fisheries Grants and Loans)**
- **TOTAL: \$2 billion**

GEF – LME Programs Partner with UNEP Regional Seas Programme



More than 140 countries participate in 13 regional programmes in the Black Sea, Caribbean, East Africa, East Asia, the Kuwait Convention Region, Mediterranean, North-East Pacific, North-West Pacific, Red Sea and Gulf of Aden, South Asia, South-East Pacific, South Pacific, and West and Central Africa—all under UNEP's auspices. There are also 5 partner programmes for the Antarctic, Arctic, Baltic Sea, Caspian Sea and North-East Atlantic.

121 countries currently involved in 17 GEF-LME projects

- | | | | | |
|---|--------------------------|----------------------------|-----------------------------------|------------------------|
| 1. East African Sea | 16. Patagonian Shelf | 31. Canary Current | 46. Northwest Atlantic Shelf (New | 61. Central Sea |
| 2. Gulf of Alaska | 17. South China Sea | 32. Benguela Current | 47. Barents Sea | 62. North Atlantic Sea |
| 3. California Current | 18. East China Sea | 33. Benguela Current | 48. East-Central Atlantic Shelf | 63. Central Sea |
| 4. Gulf of California | 19. North Atlantic Shelf | 34. Agulhas Current | 49. Southwest Atlantic Shelf | 64. Indian Ocean |
| 5. Gulf of Mexico | 20. West Greenland Shelf | 35. Somali Coastal Current | 50. Southwest Atlantic Shelf | 65. West Indian Sea |
| 6. Southwest Atlantic Continental Shelf | 21. East Greenland Shelf | 36. Western Sea | 51. West-Central Atlantic Shelf | 66. Indian Sea |
| 7. Southwest Atlantic Continental Shelf | 22. Canada Sea | 37. Red Sea | 52. Southwest Atlantic Shelf | 67. Indian Sea |
| 8. Ross Sea | 23. Norwegian Shelf | 38. Bay of Bengal | 53. West Indian Sea | 68. Indian Sea |
| 9. Newfoundland Labrador Shelf | 24. North Sea | 39. Gulf of Thailand | 54. East China Sea | 69. Indian Sea |
| 10. Indian Pacific Margin | 25. Baltic Sea | 40. South China Sea | 55. Yellow Sea | 70. Indian Sea |
| 11. Pacific Central American Coastal | 26. Costa Rican Shelf | 41. South China Sea | 56. Japanese Current | 71. Indian Sea |
| 12. Caribbean Sea | 27. West African Shelf | 42. Indonesian Sea | 57. Bay of Japan | 72. Indian Sea |
| 13. Venezuela Current | 28. Mediterranean Sea | 43. North Atlantic Shelf | 58. Chinese Current | 73. Indian Sea |

GEF International Waters Operational Strategy

Supports
New

- Ecosystem-based
LME Restoration
Actions



Paradigm

- TDA/SAP
Priority Actions

SELECTED ECOSYSTEM-RELATED WSSD TARGETS AND PROGRAM OF ACTION (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

PLANNING ACTIONS

1. Transboundary Diagnostic Analysis (TDA) – provides consensus priorities from analysis and ranking of water-related resources issues, their environmental and socioeconomic impacts, immediate and root causes and possible remedies

2. Strategic Action Program (SAP) – provides national and regional commitments to policy, legal and institutional reforms, and investments to remedy root causes of priority transboundary issues identified in TDA

IMPLEMENTATION ACTIONS

3. Ecosystem-based assessment and management strategy for TDA and SAP

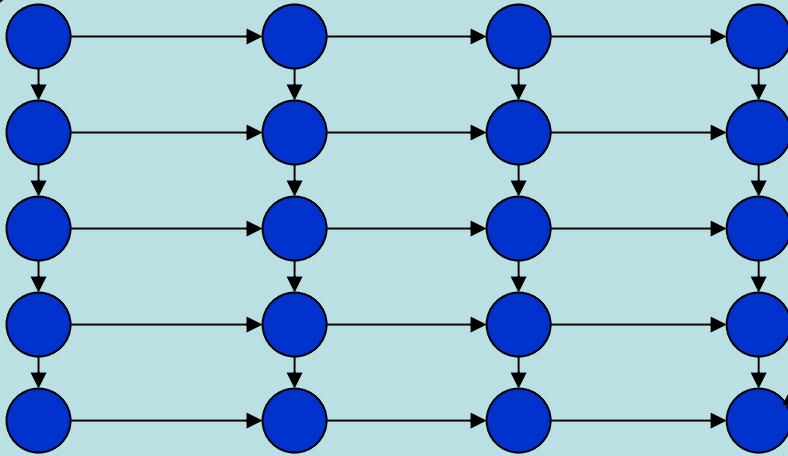
3.1 Productivity indicators and assessments

3.2 Fish and fisheries indicators and assessments

3.3 Pollution and ecosystem health indicators and assessments

3.4 Socioeconomic indicators and assessments

3.5 Governance indicators and assessments



Year 1	Year 2	Year 3	Year 4	Years 5-10
	Assessments & Management Actions	Assessments & Management Actions	Assessments & Management Actions	Toward Self-financing Assessments and adaptive management

Collaborating International Partners

- **IOC** (Intergovernmental Oceanographic Commission)
- **UNDP** (United Nations Development Programme)
- **UNEP** (United Nations Environmental Programme)
- Global International Waters Assessment (GIWA)
- Global Programme of Action for the Protection of the Marine Environment from Land-Based Activities (GPA)
- **UNIDO** (United Nations Industrial Development Organization)
- **FAO** (Food and Agriculture Organization, Fisheries Division)
- **GEF** (The Global Environmental Facility)
- **The World Bank**
- **Non-Governmental Organizations (NGOs)**
- **IUCN** (International Union for the Conservation of nature, GEF-LME Projects)
- **WWF** (World Wildlife Fund)

GEF-LME MSP

Land-based Sources of Nutrients to LME Coastal Systems

A Watershed Model Approach: Amount and Sources



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*IOC-IUCN-NOAA-UNEP Large Marine Ecosystem, 8th Consultative Committee Meeting
3-4 July 2006, Paris, France*

Introduction

- A watershed nutrient export model (DIN-model) relating land-based activities to coastal nutrient enrichment - application to LMEs
- 2 training workshops
- **7 LME regions:**
Baltic Sea, Bay of Bengal, Benguela Current, Guinea Current, Gulf of Mexico, Humboldt Current, Yellow Sea

Training Workshop 1

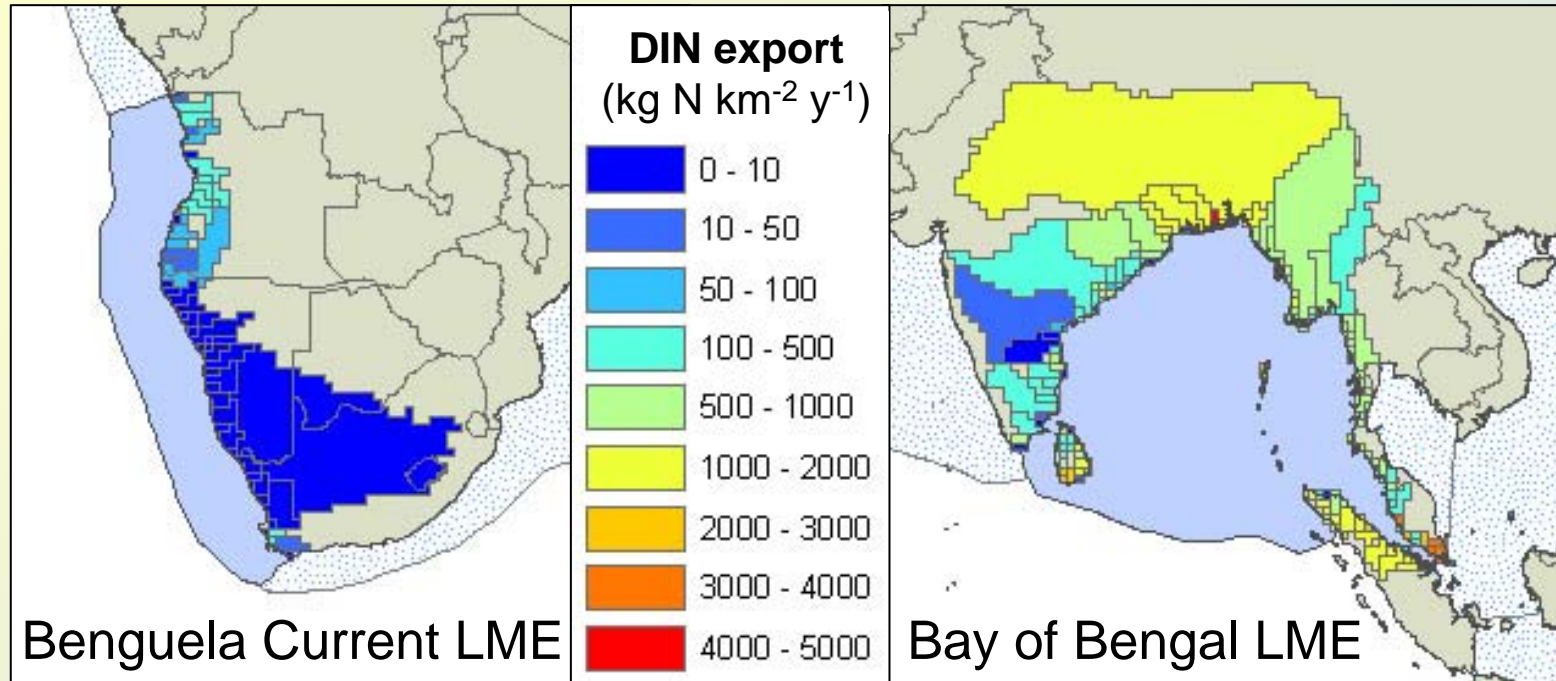
23-27 January 2006, UNESCO-IOC Paris



- Networked among different LMEs
- Learned to use ArcGIS mapping software
- Explored model structure, nutrient inputs and exports from watersheds within their LMEs
- Summarized results in a draft document to LME Directors
- Interacted with other international groups – INI, Global NEWS

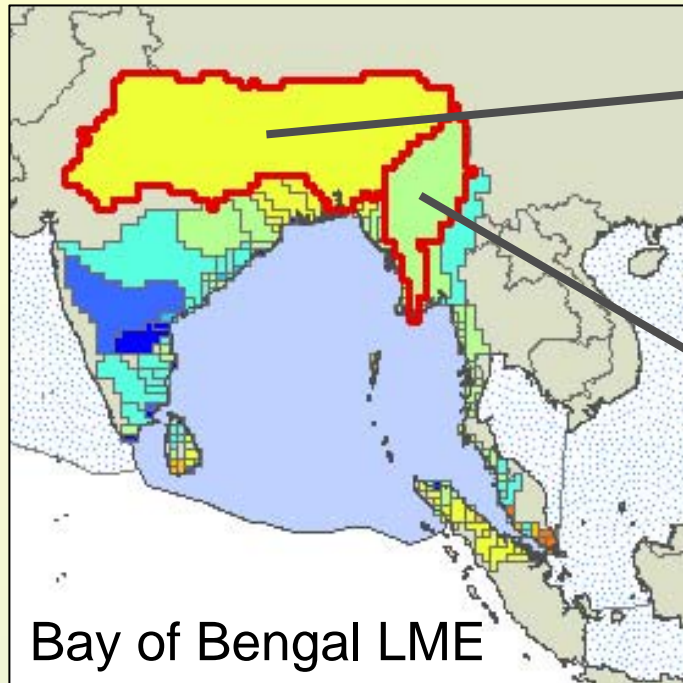
Example DIN-Model Output

By watershed within each LME

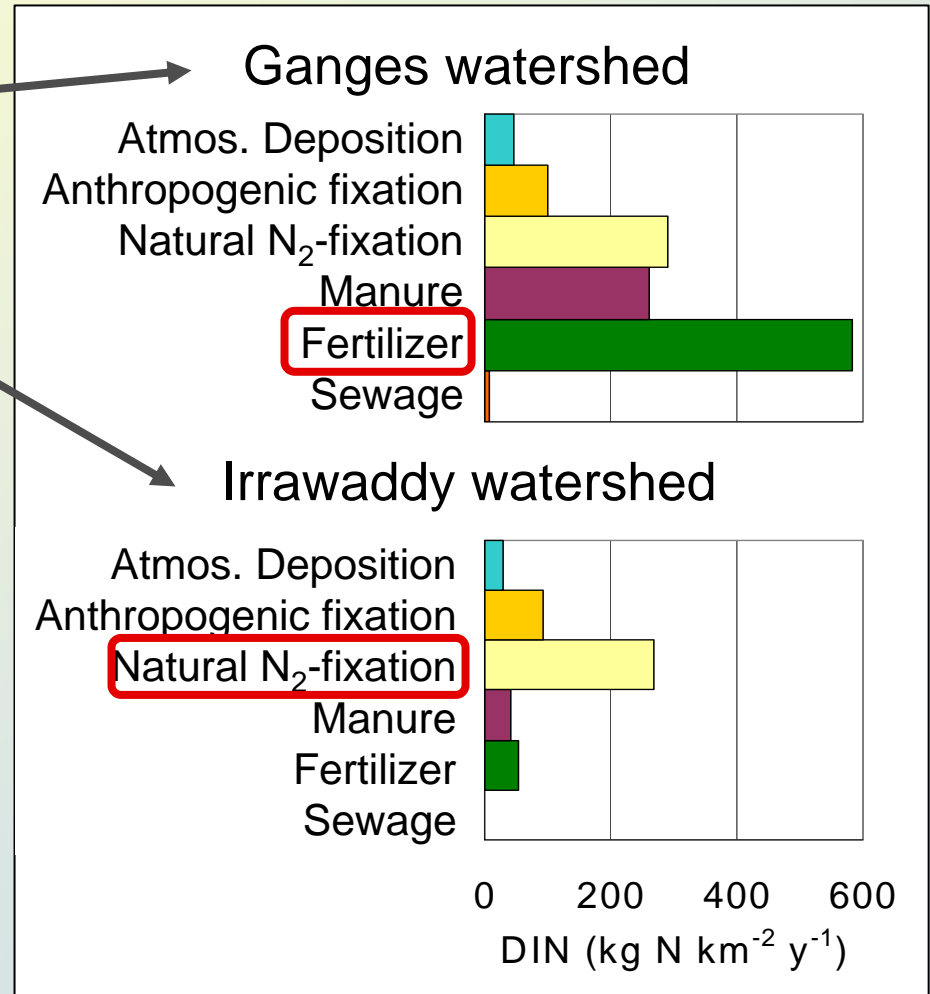


- Amount of DIN export varies among watersheds within LME
- Can be used to compare DIN export from watersheds among different LMEs

Contribution of Land-based Nutrient Sources to DIN Export



- Relative magnitude of different source contributions to export varies in watersheds



Continuing Activities

- Training Workshop 2
18-20 September 2006, IOC
Scenario runs (future conditions) year 2030
- Finalize summary documents
Report to LME Directors
- Continue to develop network and interaction
- *LME Directors are encouraged to purchase ArcGIS license for continued use after January 2007 in their region*

***If you want to know more about the workshops or
application to your LME region contact***



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**The UNEP
Large Marine Ecosystems
Report:
A Perspective on Changing
Conditions in LMEs of the
World's Regional Seas**



Collaborating Groups

- URI – Fronts
- UBC – Trophodynamics
 - Fish and Fisheries
- Rutgers – Nutrients
- NOAA/Narrag. – Primary Productivity
- UNEP – Regional Seas Offices
 - The Hague, Netherlands

LME #29: Benguela Current

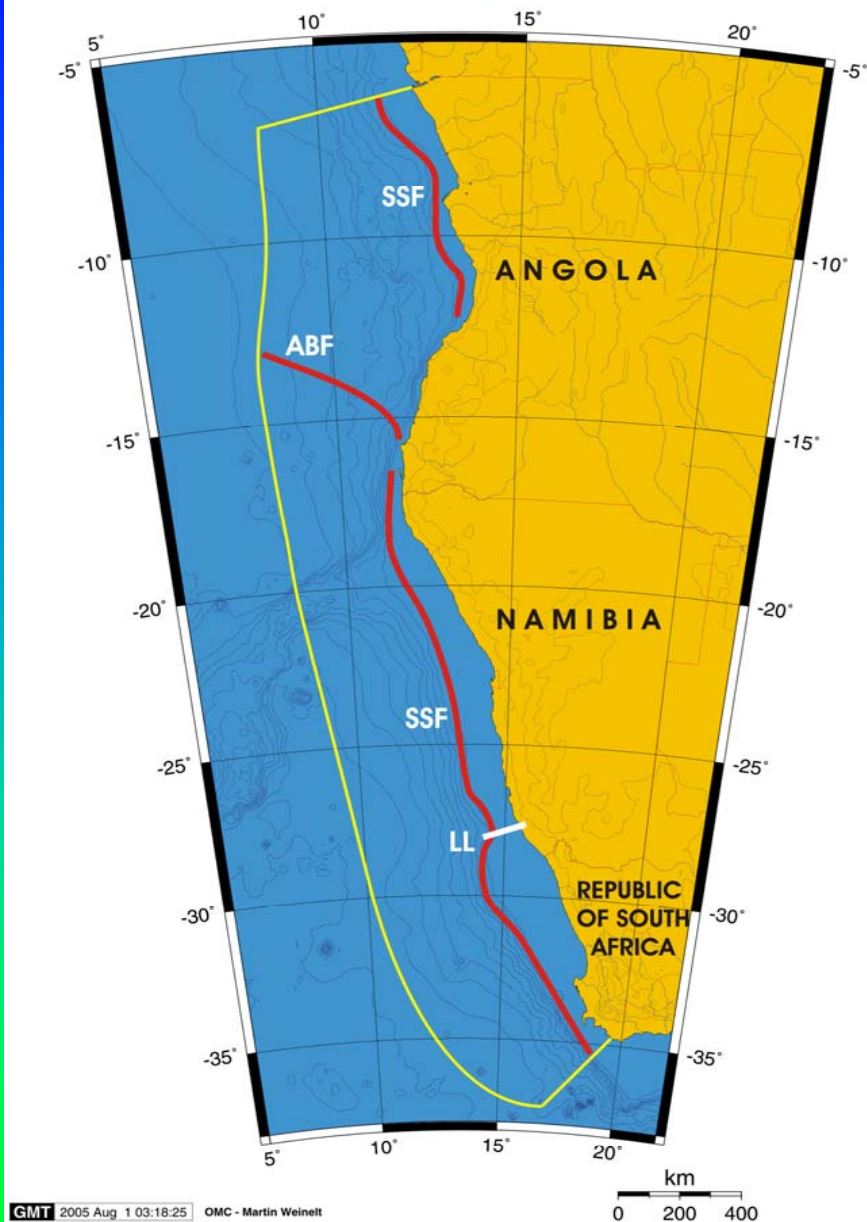
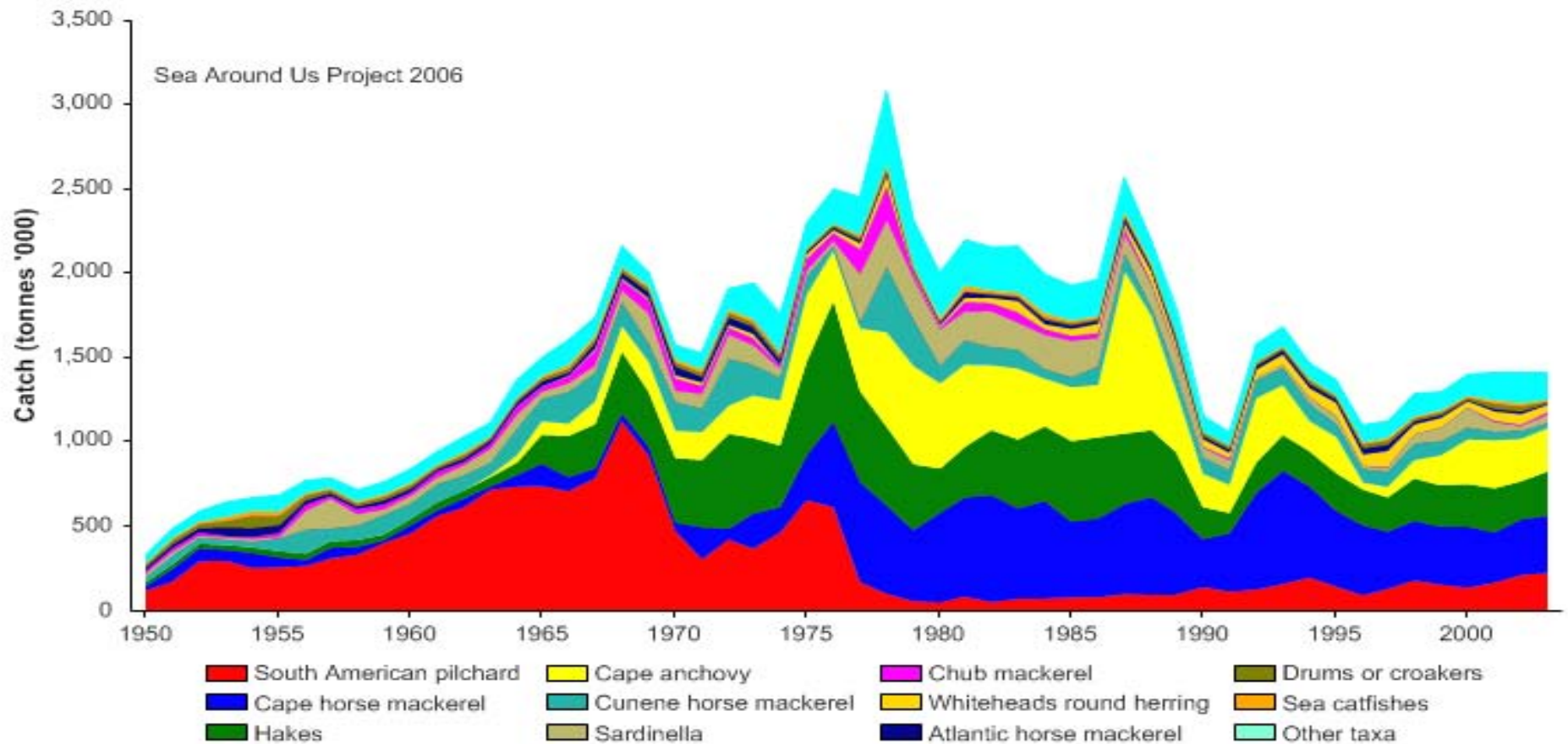


Figure 29. Fronts of LME #29 (Benguela Current). Acronyms: **ABF**, Angola-Benguela Front; **LL**, Lüderitz line; **SSF**, Shelf-Slope Front. Yellow line, LME boundary.

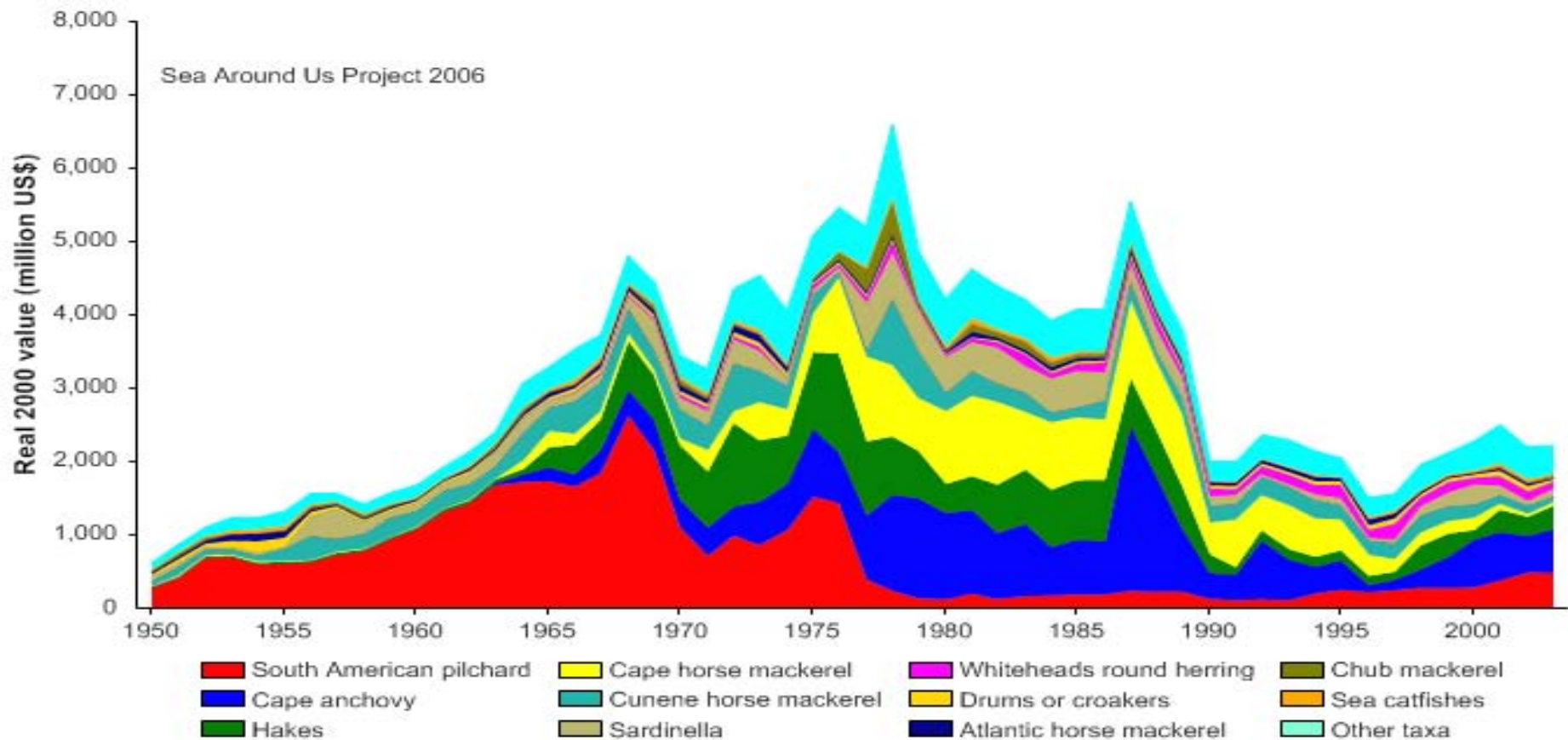
Benguela Current LME fish catch (Sea Around Us Project 2006)



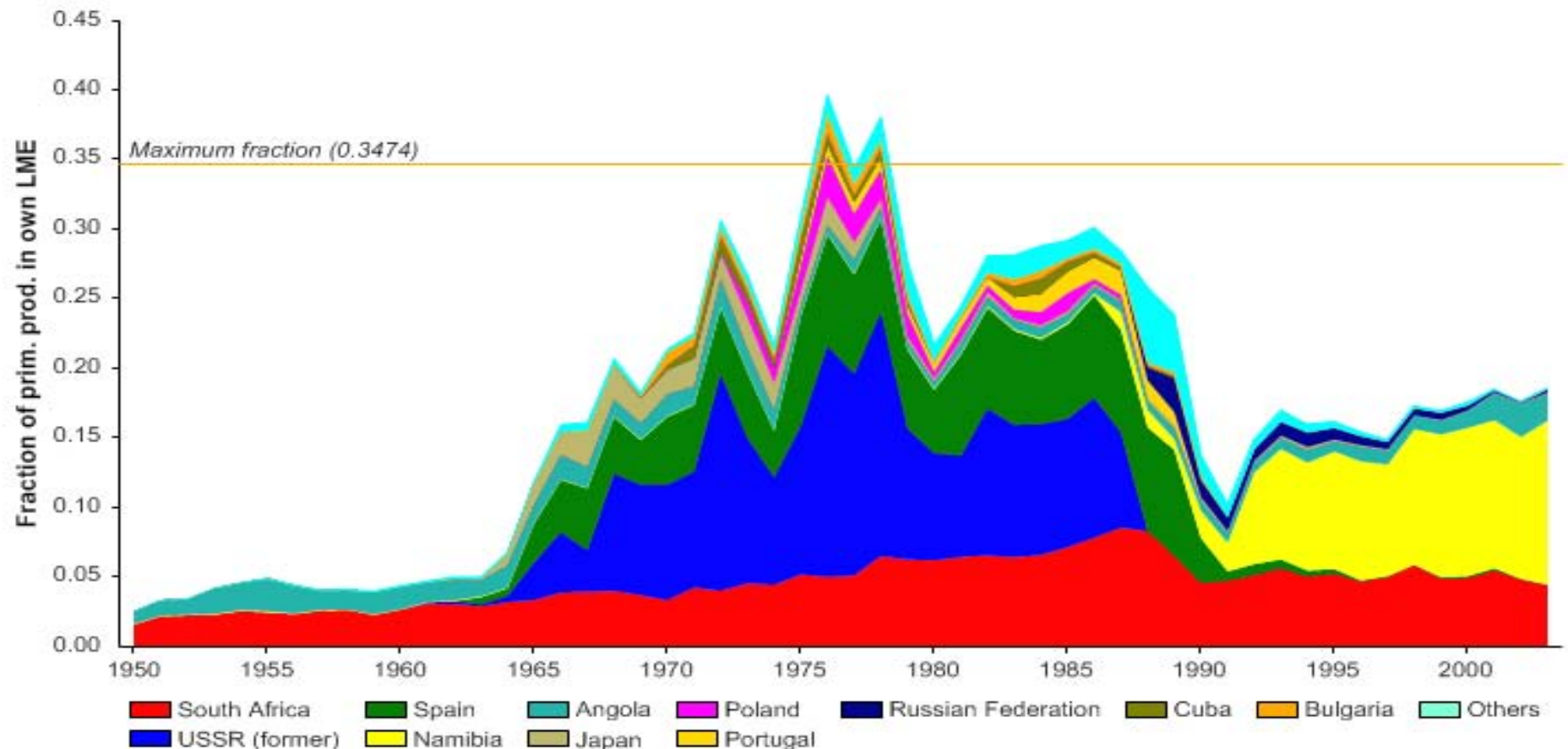
Value of landings

Benguela Current LME

(Sea Around Us Project 2006)



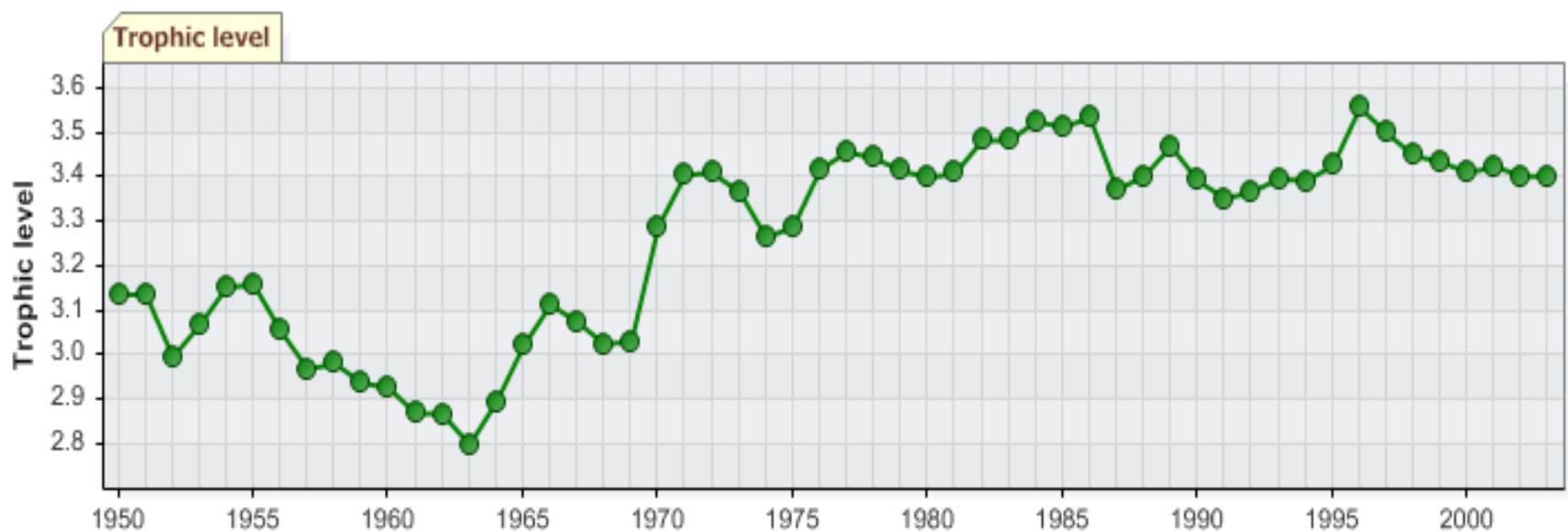
Primary Production required by the catches (1950 – 2003) in the Benguela Current LME (Sea Around Us Project 2006)



Marine trophic index

Benguela Current LME 1950-2003

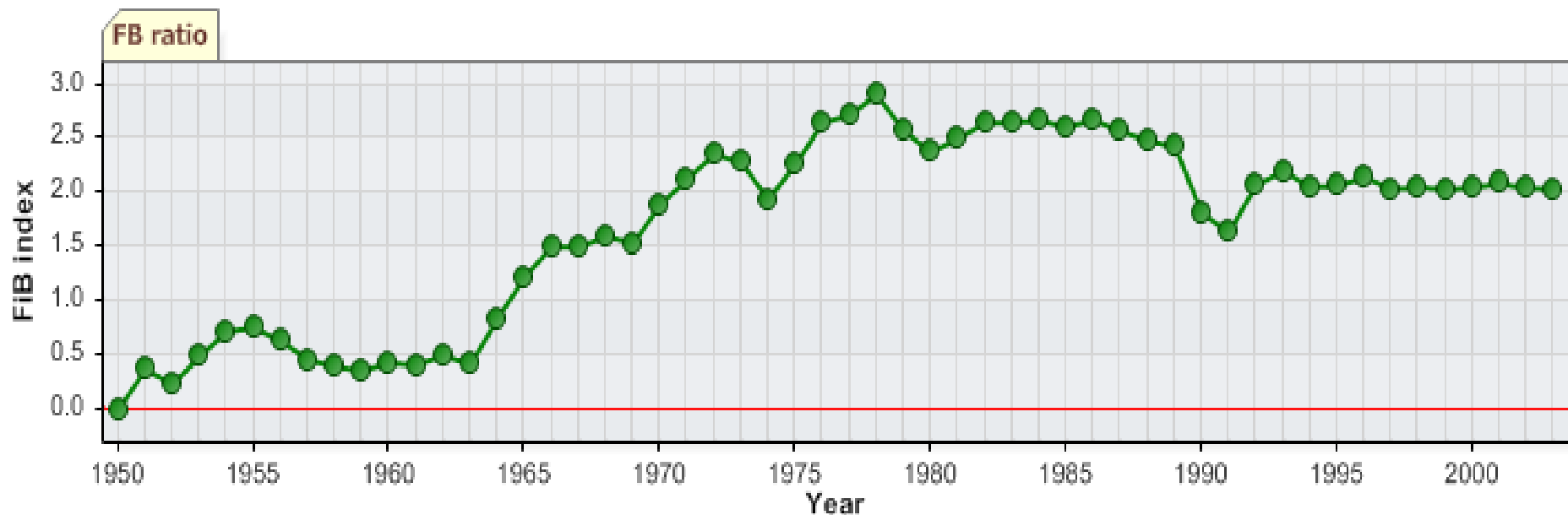
(Sea Around Us Project 2006)



Fishing in Balance (FiB) Index

Benguela Current LME catch 1950-2003

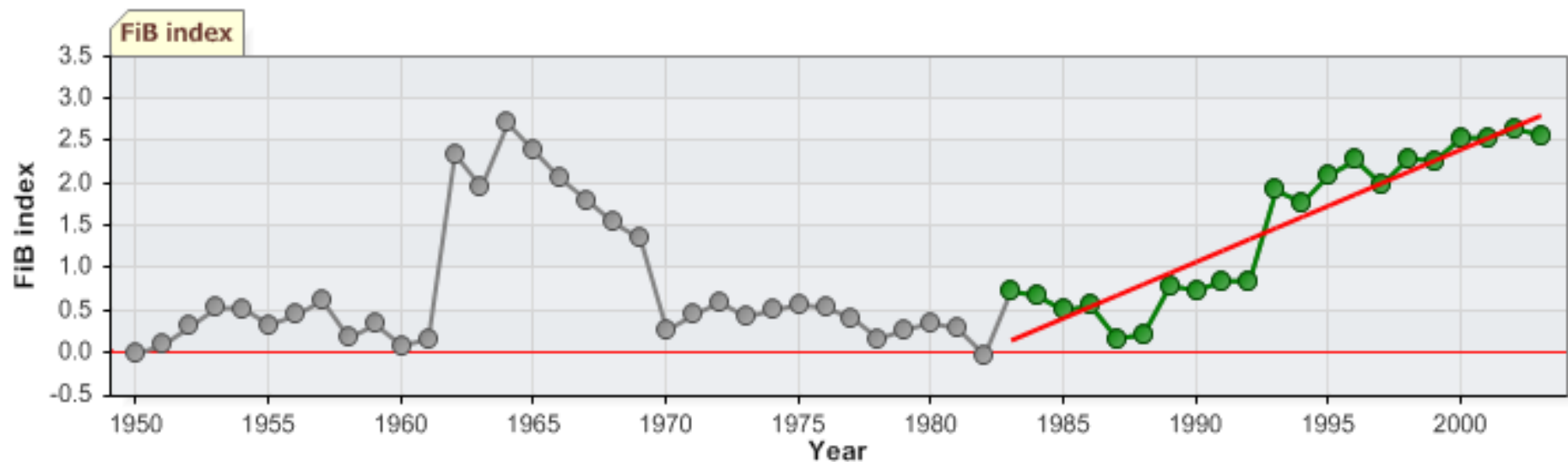
Sea Around Us Project 2006



Trophic Index with Regression- Southeast Australia Shelf LME



Fishing in Balance (FiB) Index – Southeast Australia Shelf LME



Trends in Primary Productivity of Large Marine Ecosystems

North America

September 1997 - August 1999

