

Assessment and Management of Large Marine Ecosystems

Merida, Mexico

Kenneth Sherman

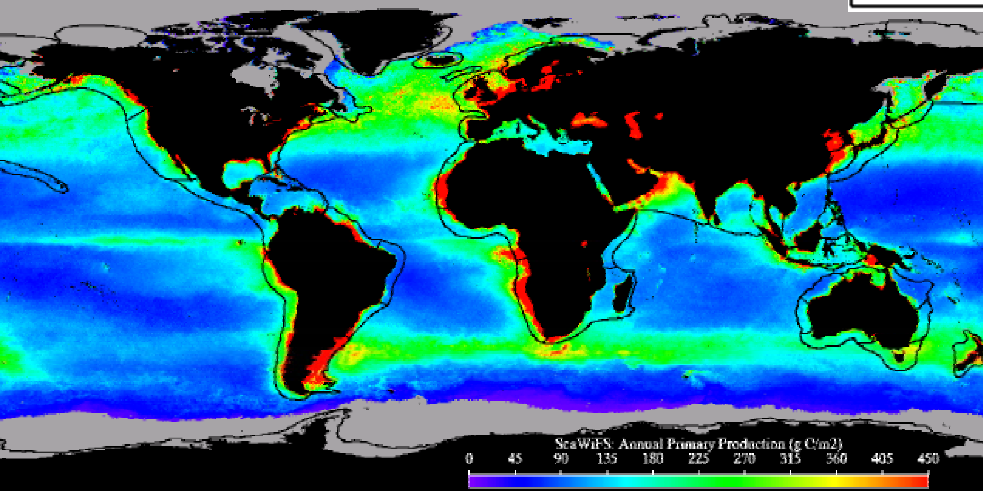
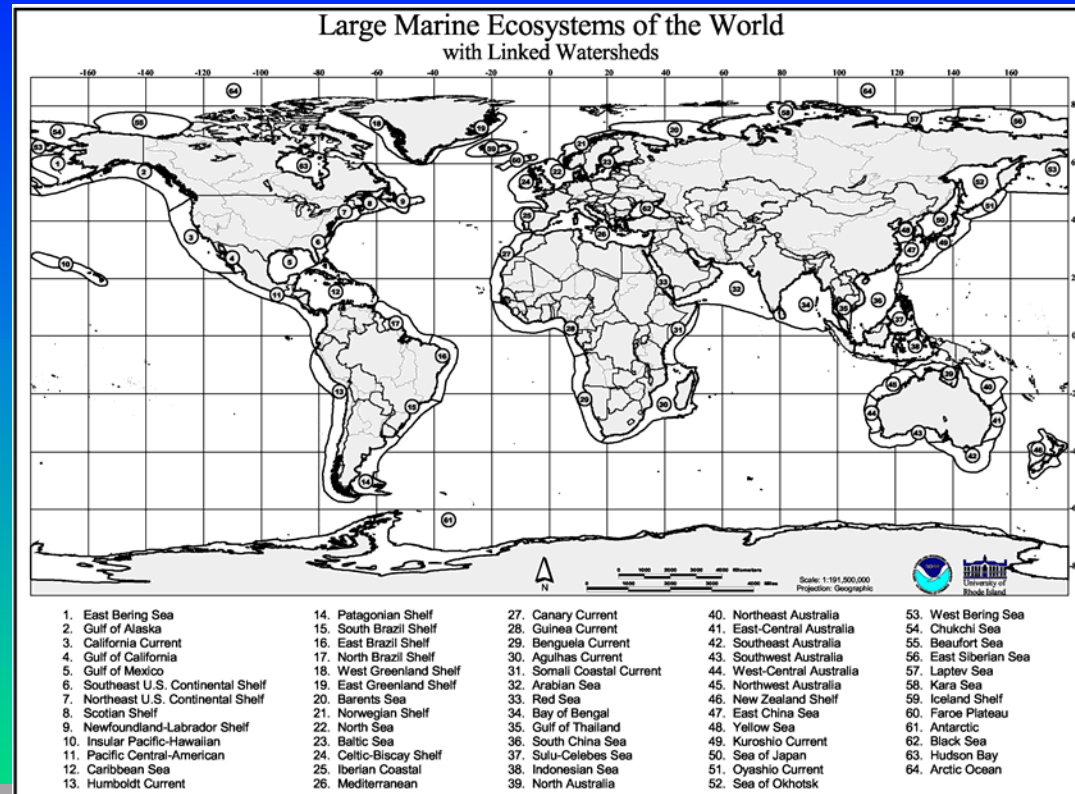
17 January 2006

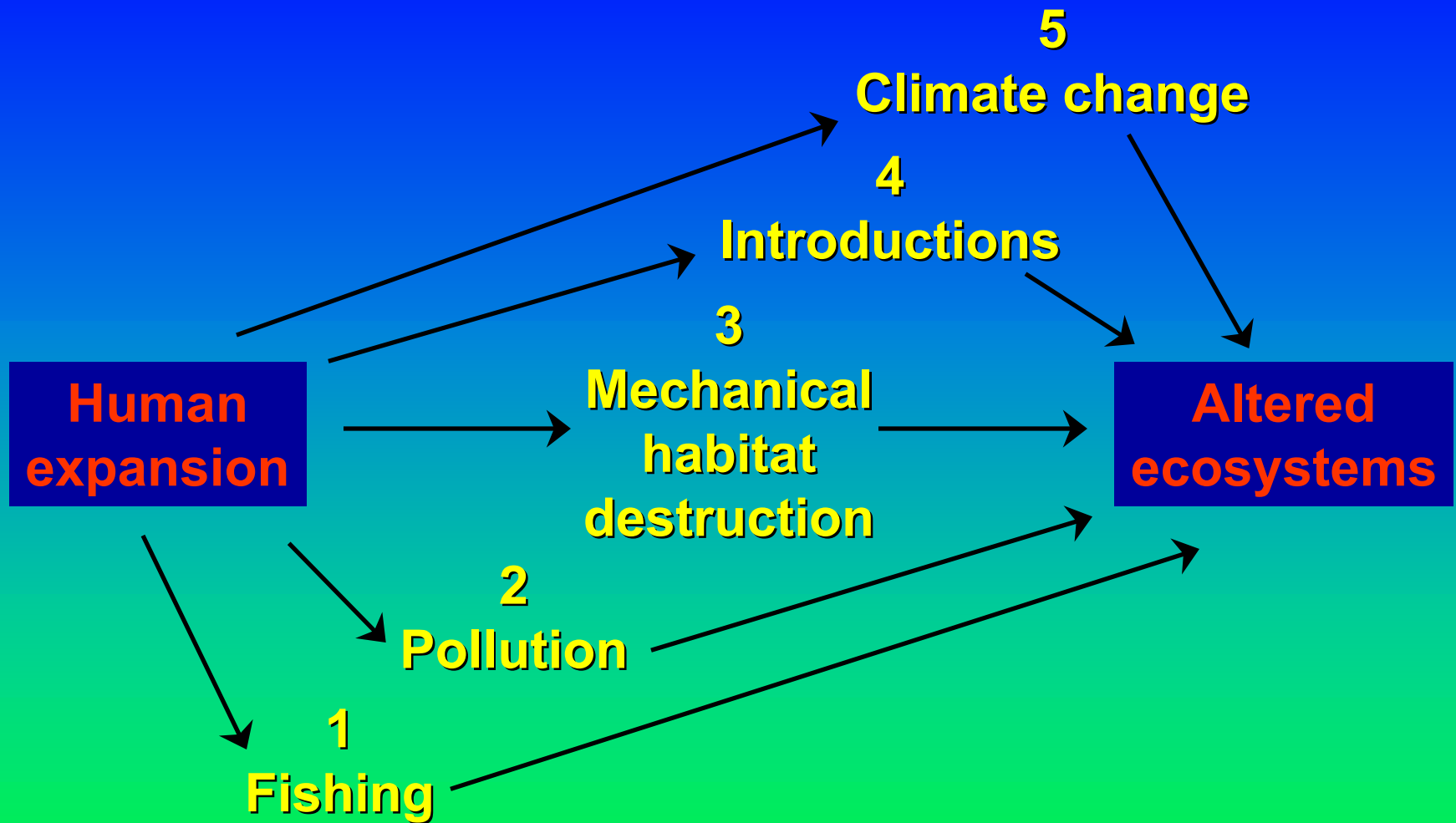
ECOLOGICAL CRITERIA USED TO DETERMINE AREAL EXTENT OF LMES:

- **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

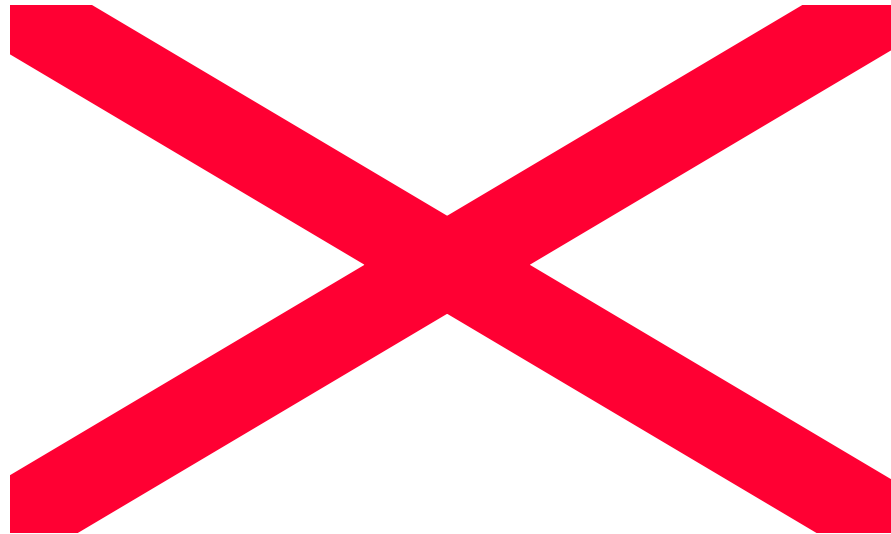
Fish and Fisheries

Pollution

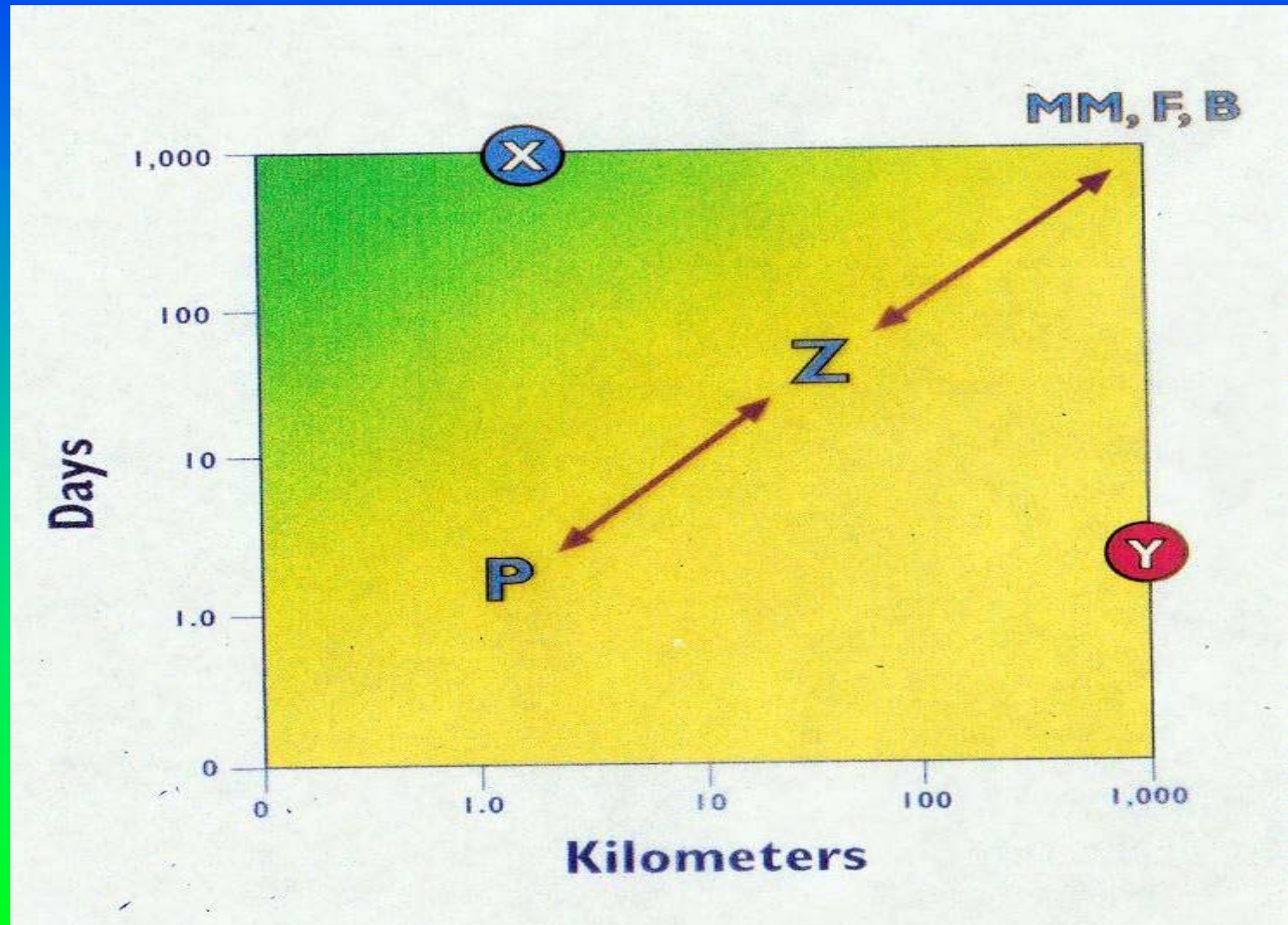
Socioeconomic

Governance

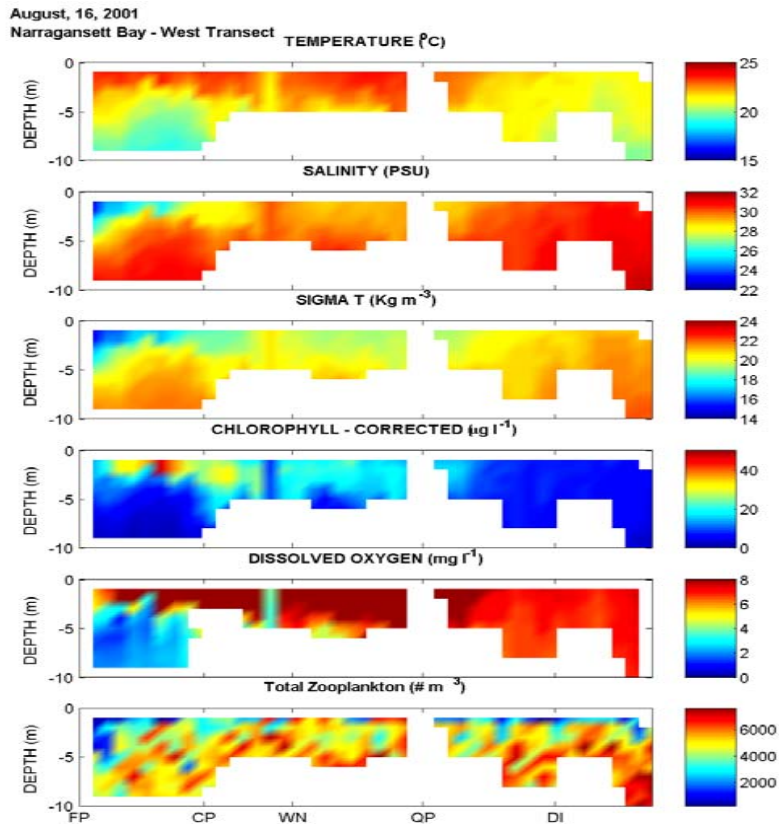
5 MODULES WITH INDICATORS



TEMPORAL AND SPATIAL SCALE RELATIONS FOR THE PELAGIC FOOD WEB



PRODUCTIVITY INDICATORS

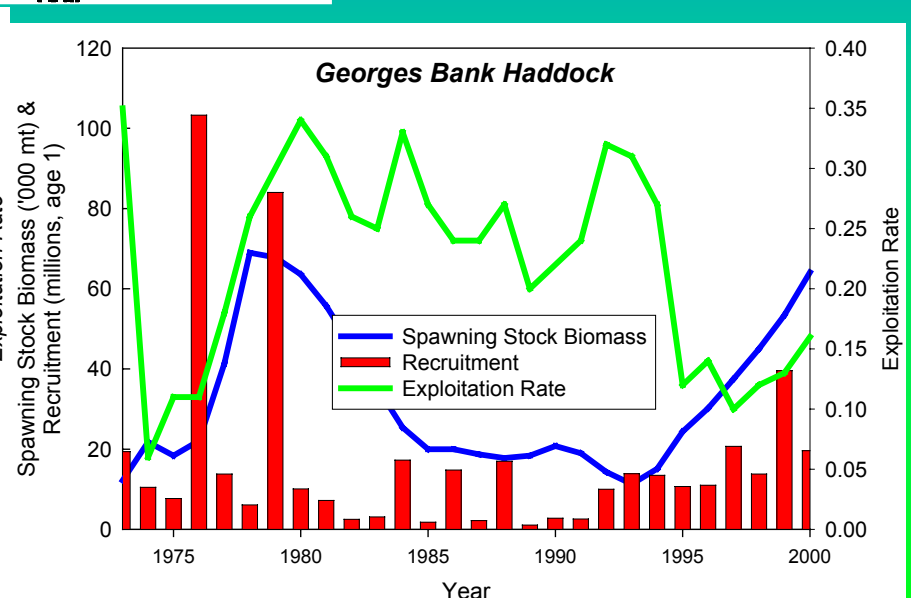
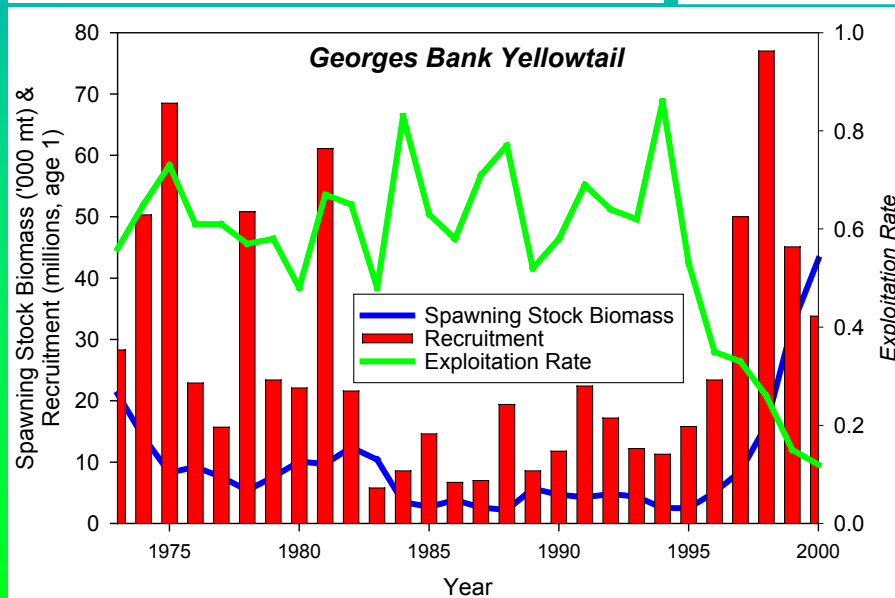
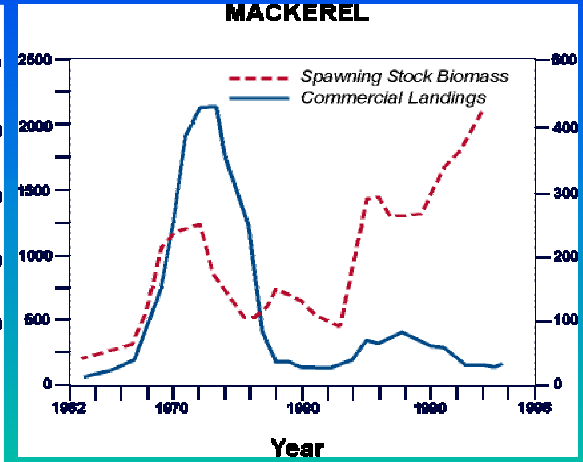
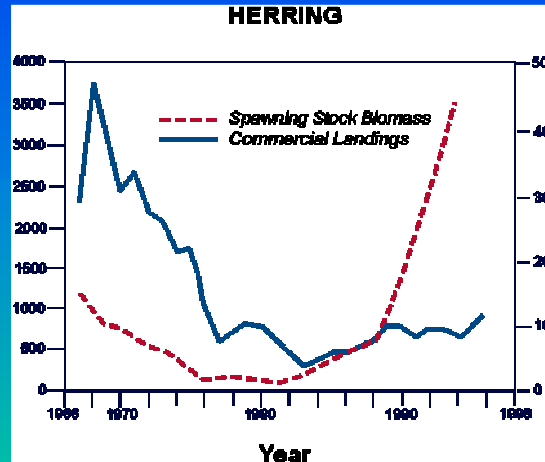
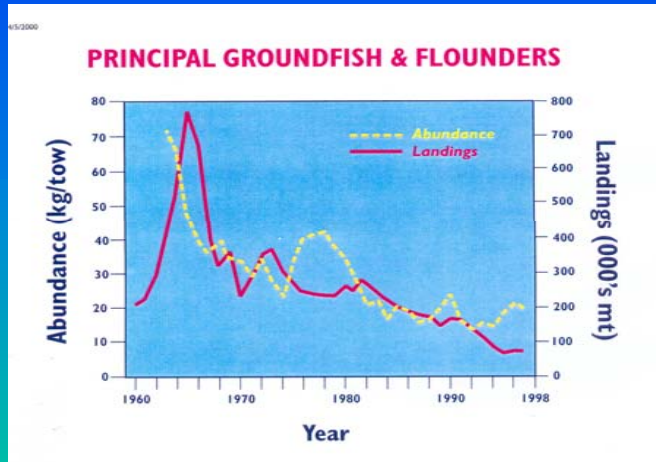


An undulating oceanographic recorder (above), towed behind a ship, is used to collect ecological parameters needed to assess the state of the marine ecosystem (left).

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**

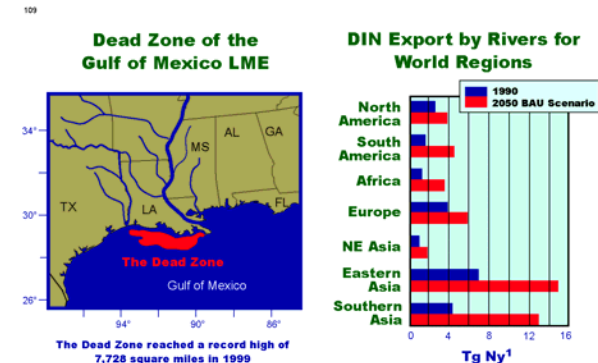
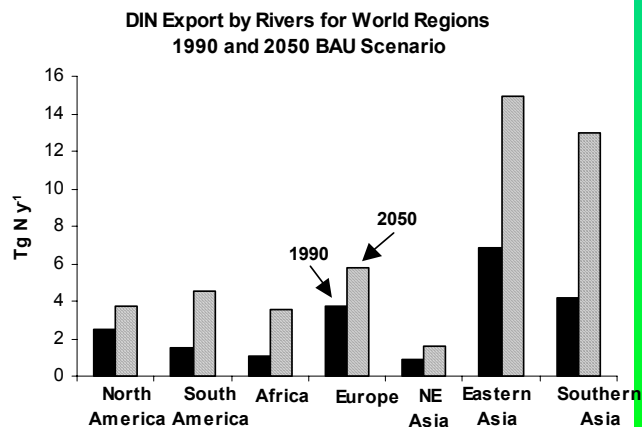
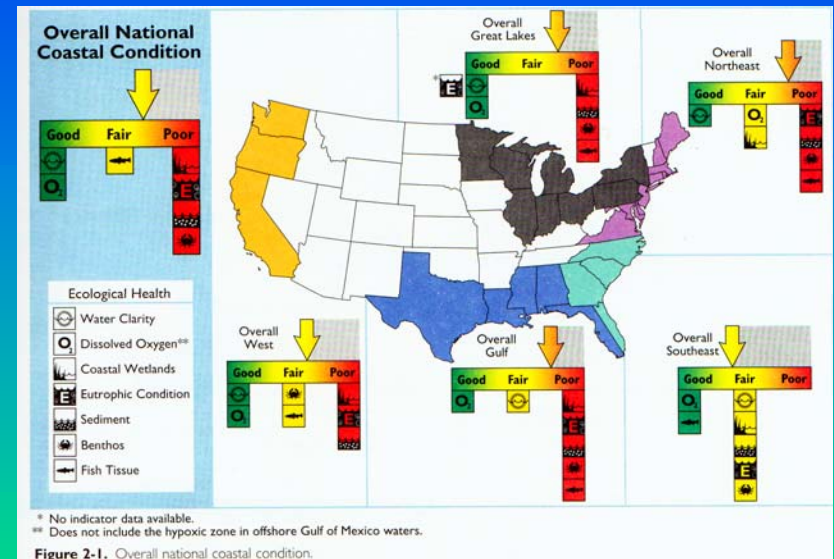
FISH AND FISHERIES INDICATORS



POLLUTION AND ECOSYSTEM HEALTH INDICATORS

Indicators:

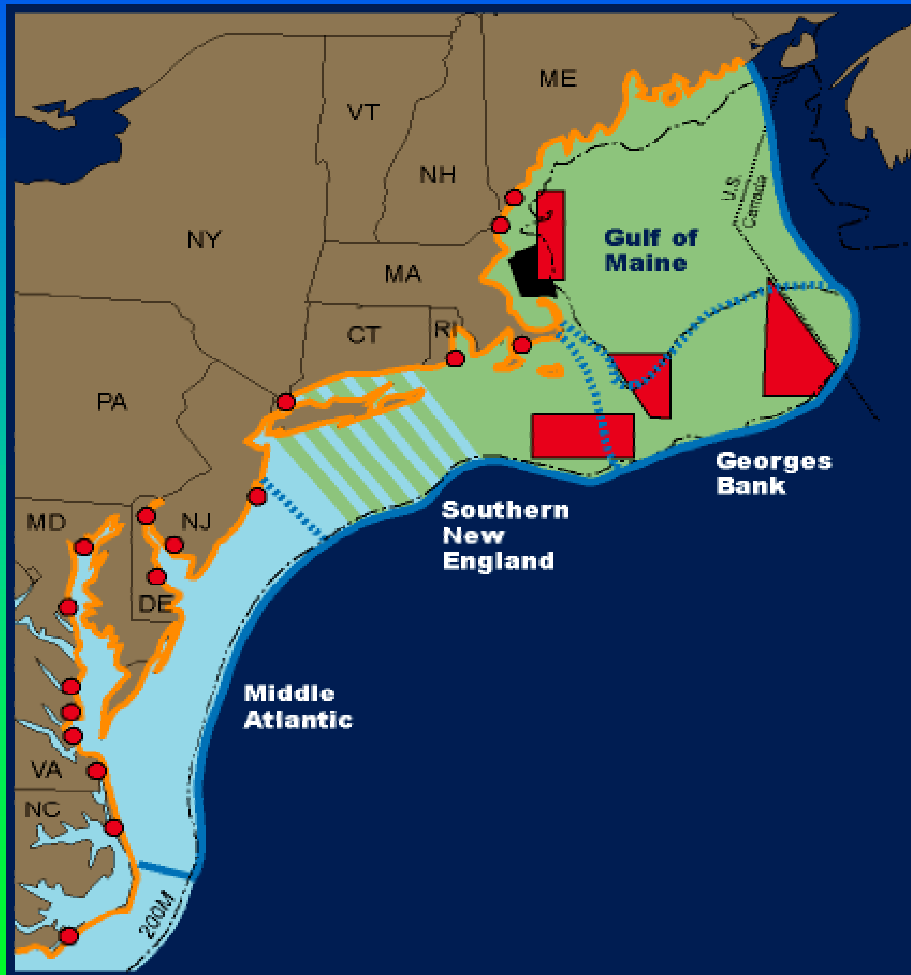
Water Clarity
Dissolved Oxygen
Coastal Wetland Loss
Eutrophic Condition
Sediment Contamination
Benthic Index
Fish Tissue Contaminants
Multiple Marine Ecological Disturbances



SOCIOECONOMICS AND GOVERNANCE

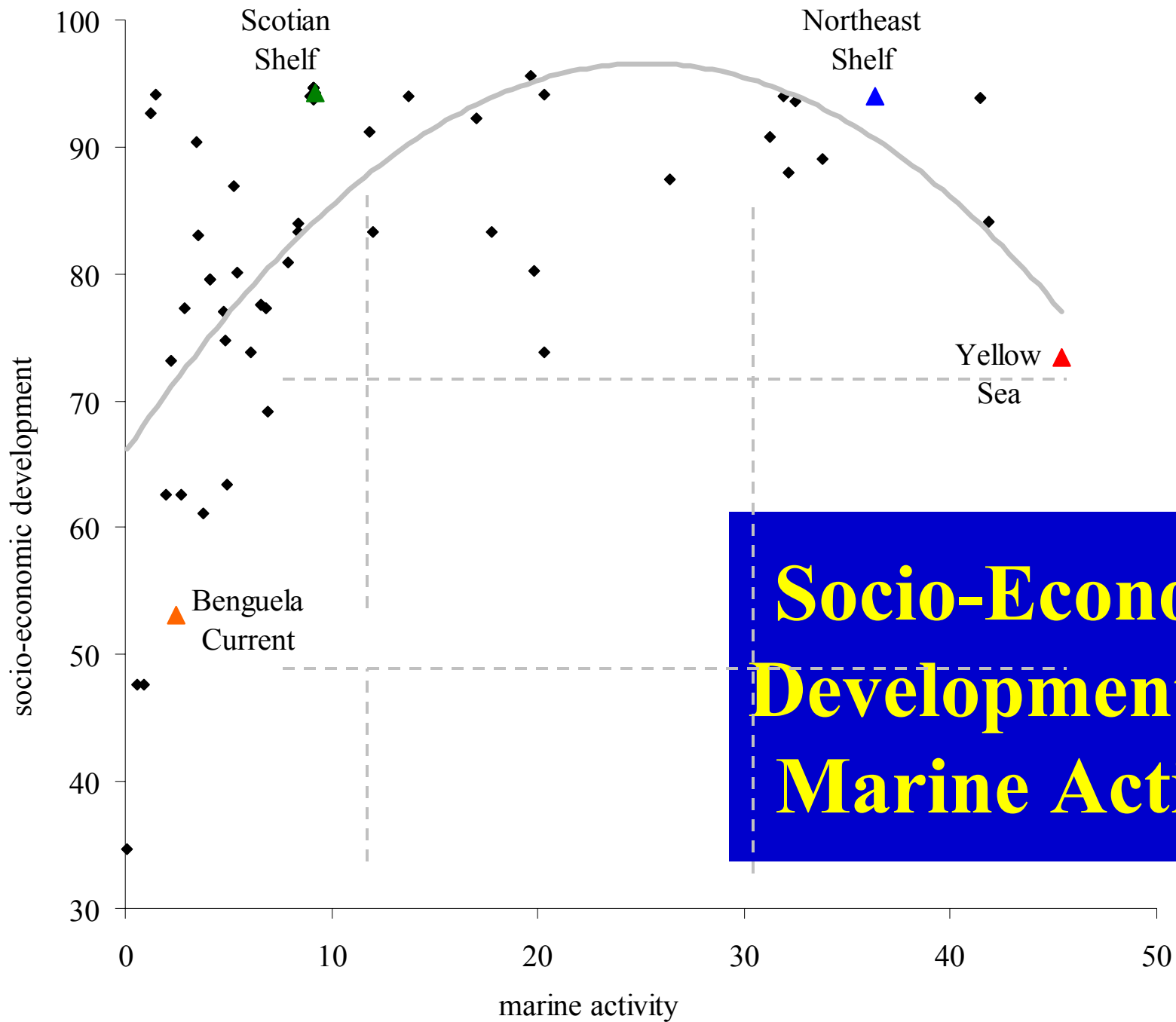
NORTHEAST SHELF MANAGEMENT JURISDICTIONS

109



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

WSSD 17



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

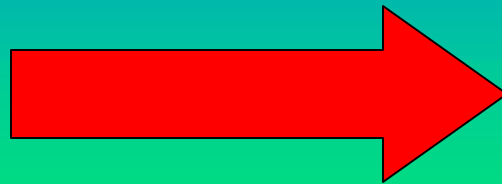
121 countries currently involved in 17 GEF-LME projects

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.

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

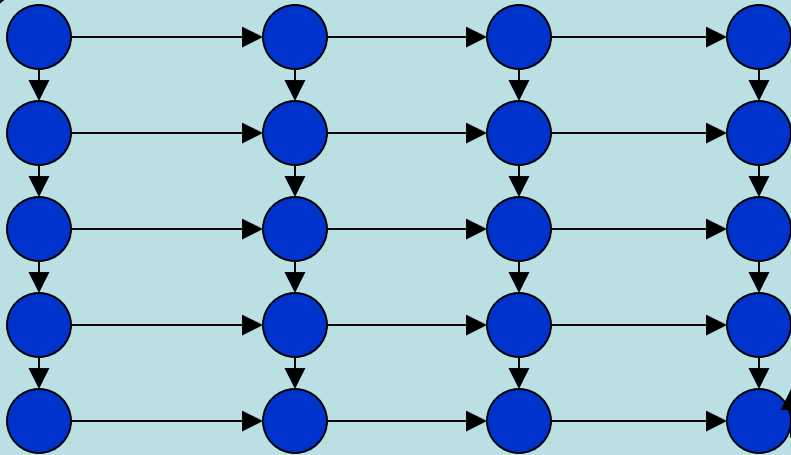
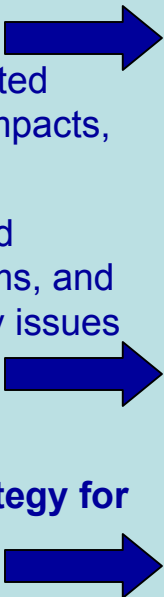
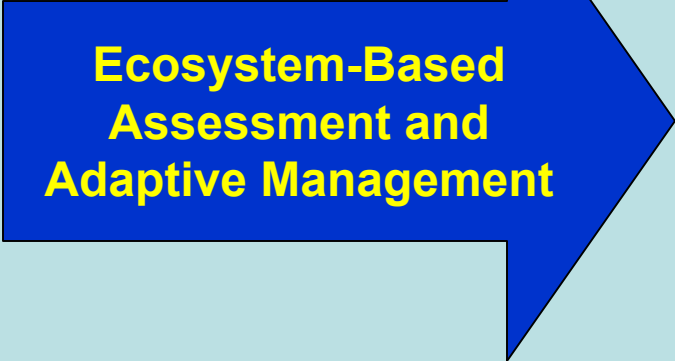
3.1 Productivity indicators and assessments

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

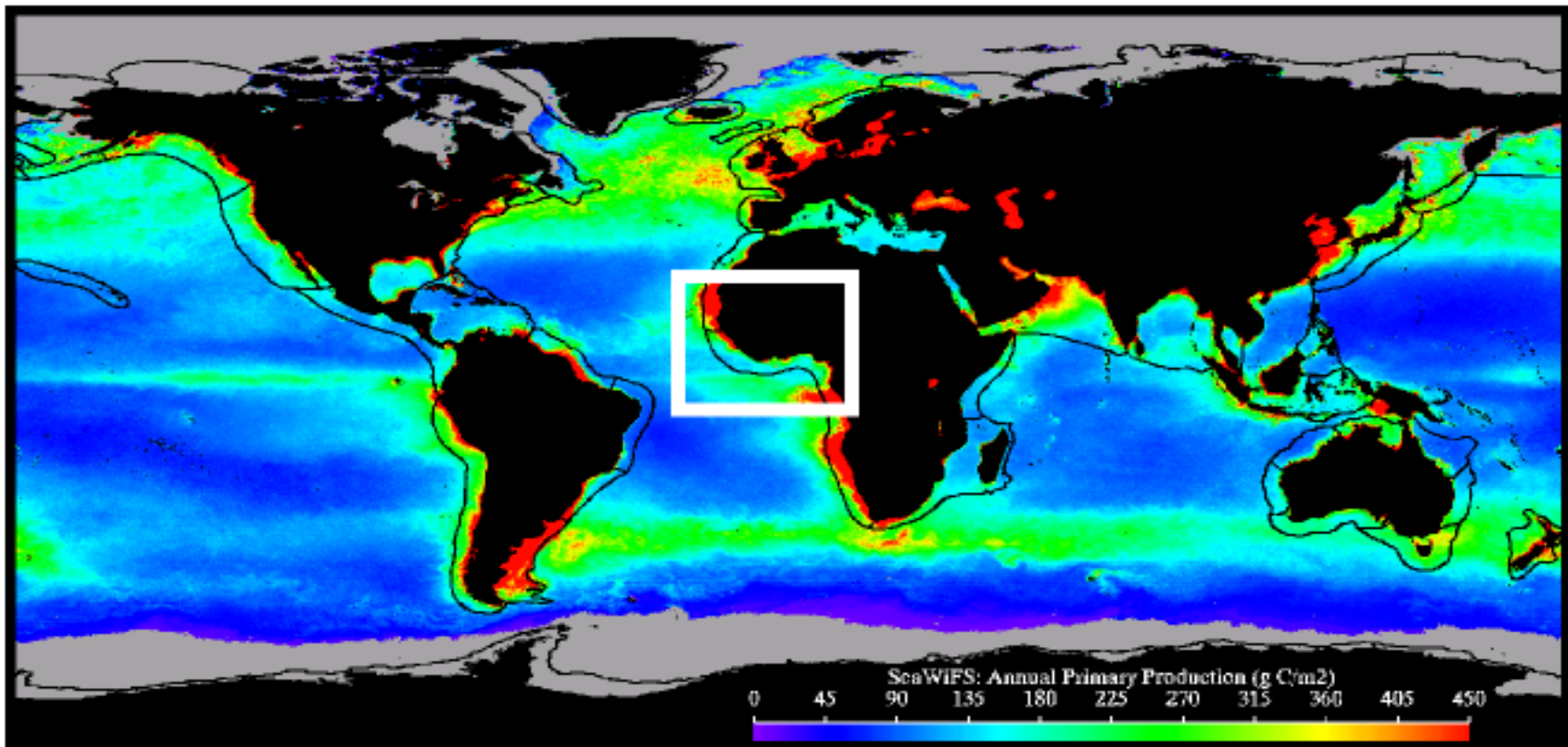


Year 1	Year 2	Year 3	Year 4	Years 5-10
	Assessments & Management Actions	Assessments & Management Actions	Assessments & Management Actions	Toward Self-financing Assessments and adaptive management

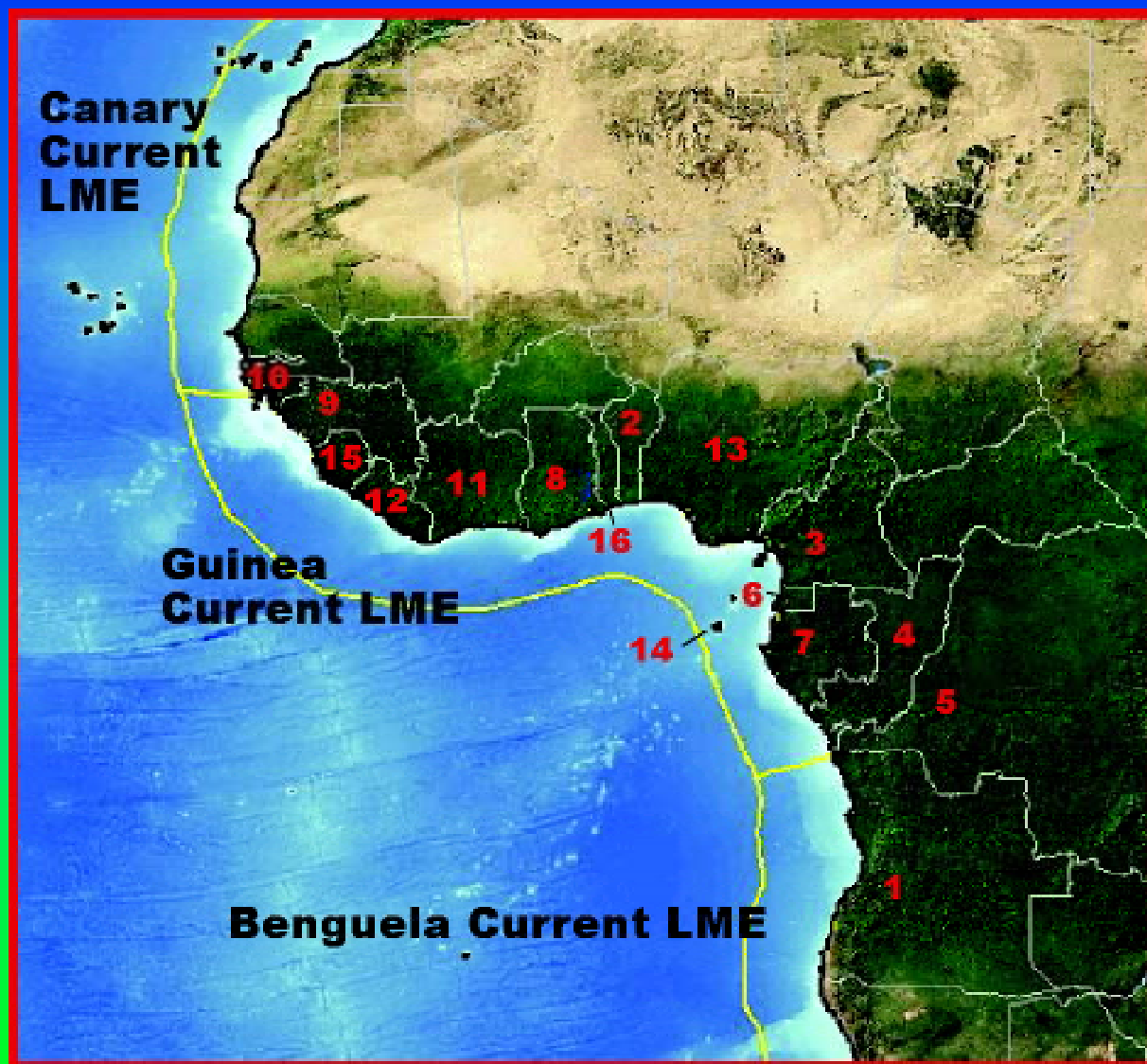
Collaborating International Partners

- **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)

Restoration of the Guinea Current Large Marine Ecosystem



The Guinea Current Large Marine Ecosystem

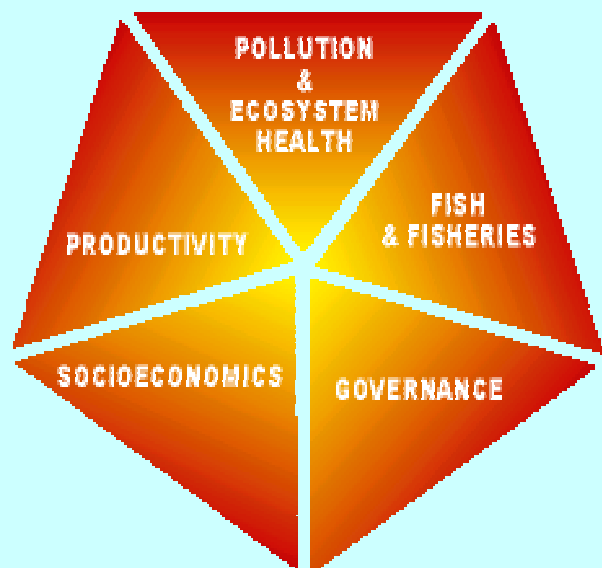


- 1 Angola
- 2 Benin
- 3 Cameroon
- 4 Congo-Brazzaville
- 5 Congo-Kinshasa
- 6 Equatorial Guinea
- 7 Gabon
- 8 Ghana
- 9 Guinea
- 10 Guinea-Bissau
- 11 Ivory Coast
- 12 Liberia
- 13 Nigeria
- 14 Sao Tome & Principe
- 15 Sierra Leone
- 16 Togo

SPECIFIC PROJECT OBJECTIVES

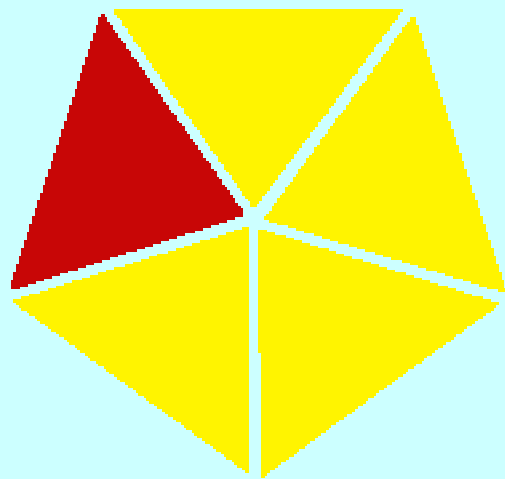
Among the specific project objectives are:

- Recovery of depleted fish biomass and fisheries to promote greater food security, sustainable productivity, and socioeconomic benefits
- Reduction in pollution and eutrophication levels of coastal waters
- Restoration of degraded habitats
- Including coral reefs, mangroves, and wetlands



Modular Assessments

**Support LME Restoration
and
Sustainable Development**



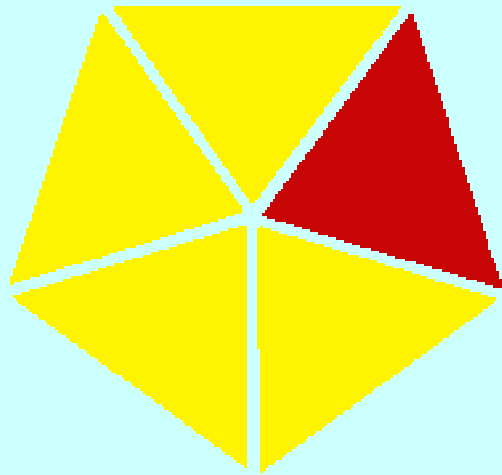
Productivity Module Indicator

The first ever African-planned and implemented productivity surveys cooperatively carried out

Ships tow Continuous Plankton Recorders (CPR) to assess the LME's physical and biological characteristics



**Dr. George Wiafe, scientist and Professor at
University of Ghana.
His Ph.D research analyzed samples
collected from GCLME.**



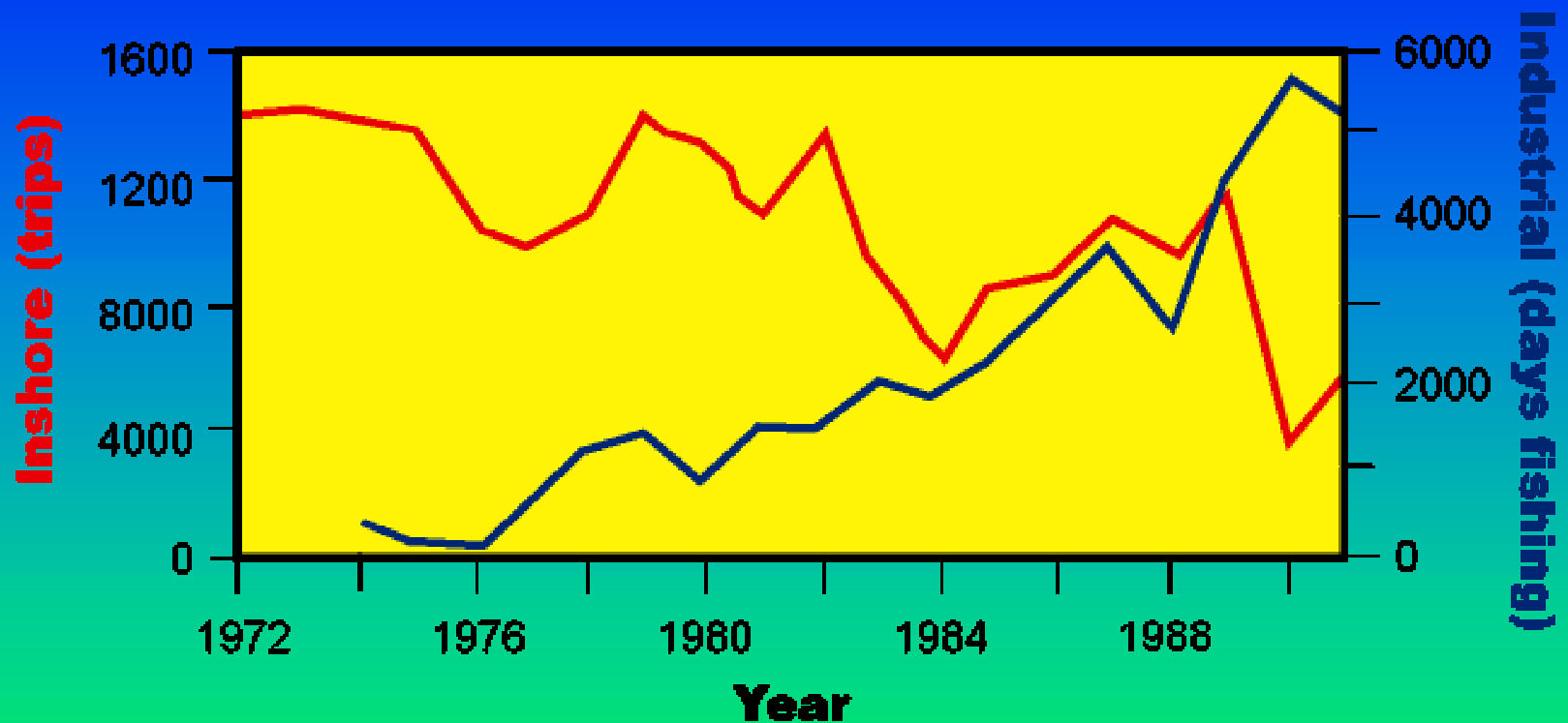
Fish & Fisheries Module Indicator

Bottom-trawl surveys of demersal fish populations successfully conducted by African scientists

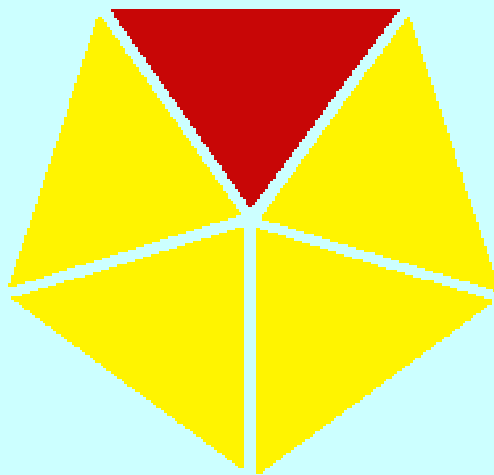
Transboundary actions developed to achieve sustainable management of the fisheries resource

Efforts to find the appropriate balance between artisanal and industrial fisheries





Evolution of trawling effort in the Ghanaian demersal fisheries, by K.A. Koranteng, 2002. Status of Demersal Fishery Resources on the Inner Continental Shelf off Ghana. In: J. McGlade, P. Cury, and K. Koranteng, "Gulf of Guinea Fishery Resources: Ecosystem Forcing and Sustainable Development". Elsevier.

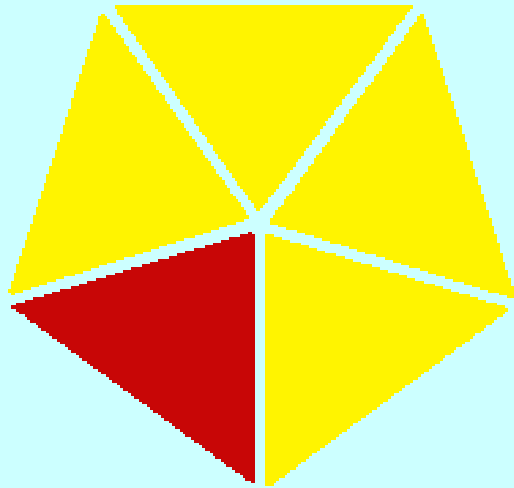


Pollution & Habitat Restoration Module Indicator

Mangrove restoration project initiated to help restore fish stocks and reduce pollution

Recommendations to reduce industrial pollution

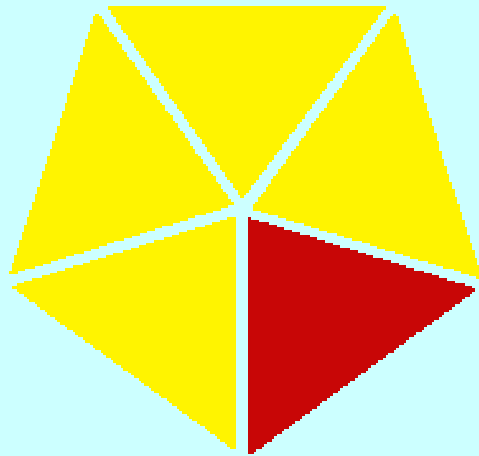
Successful campaign for the reduction, recovery, recycling and reuse of industrial wastes



Socio-economic Module Indicator

Making more fish available to the 300 million coastal peoples of the region

Restoration of lagoons, mangroves, estuaries and deltas will help restore and sustain living resources



Governance Module Indicator

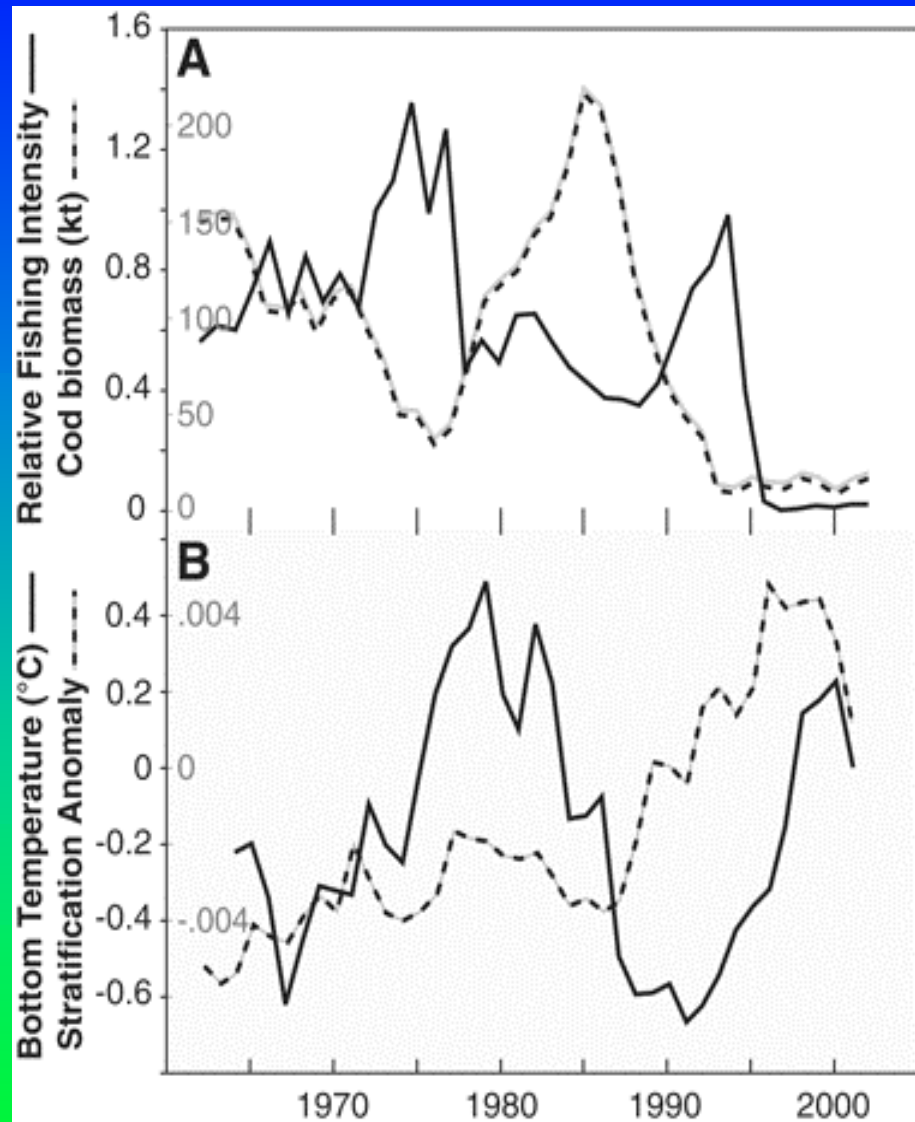
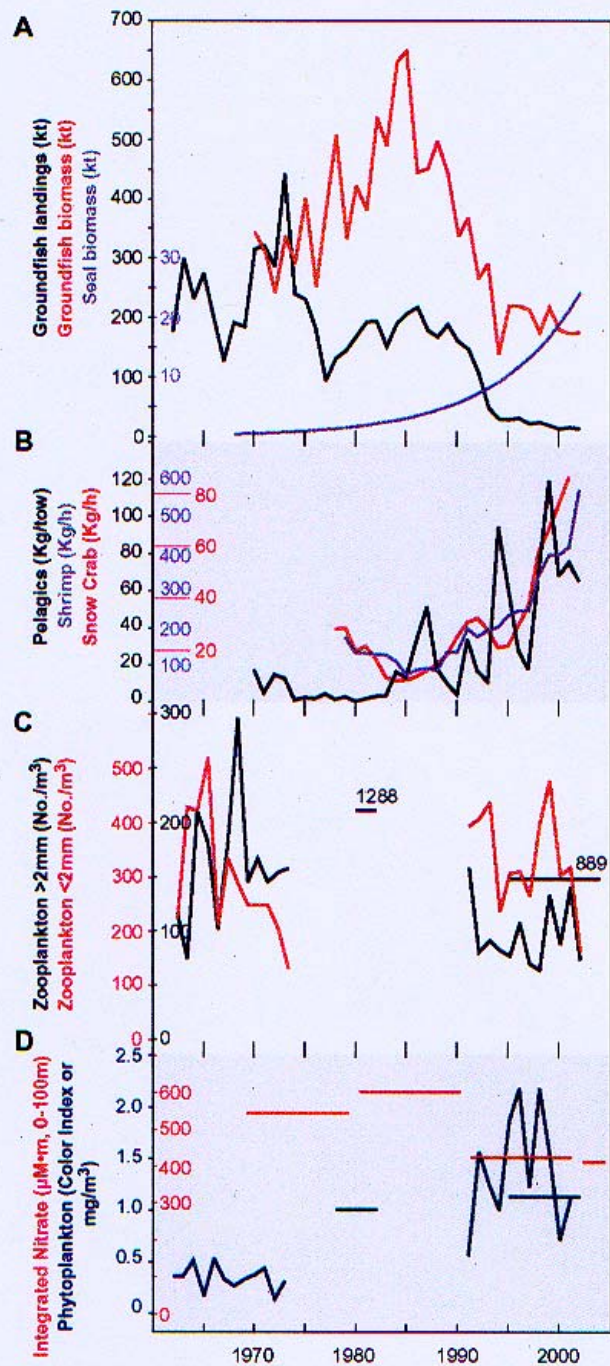
The Accra Declaration (1998) expresses a common political will for the sustainable development of the marine and coastal areas and a better livelihood for the coastal communities

All 16 countries bordering the LME contributing to the preparation and implementation of a Strategic Action Program (SAP)

Compact to ensure the long-term sustainable development of fisheries



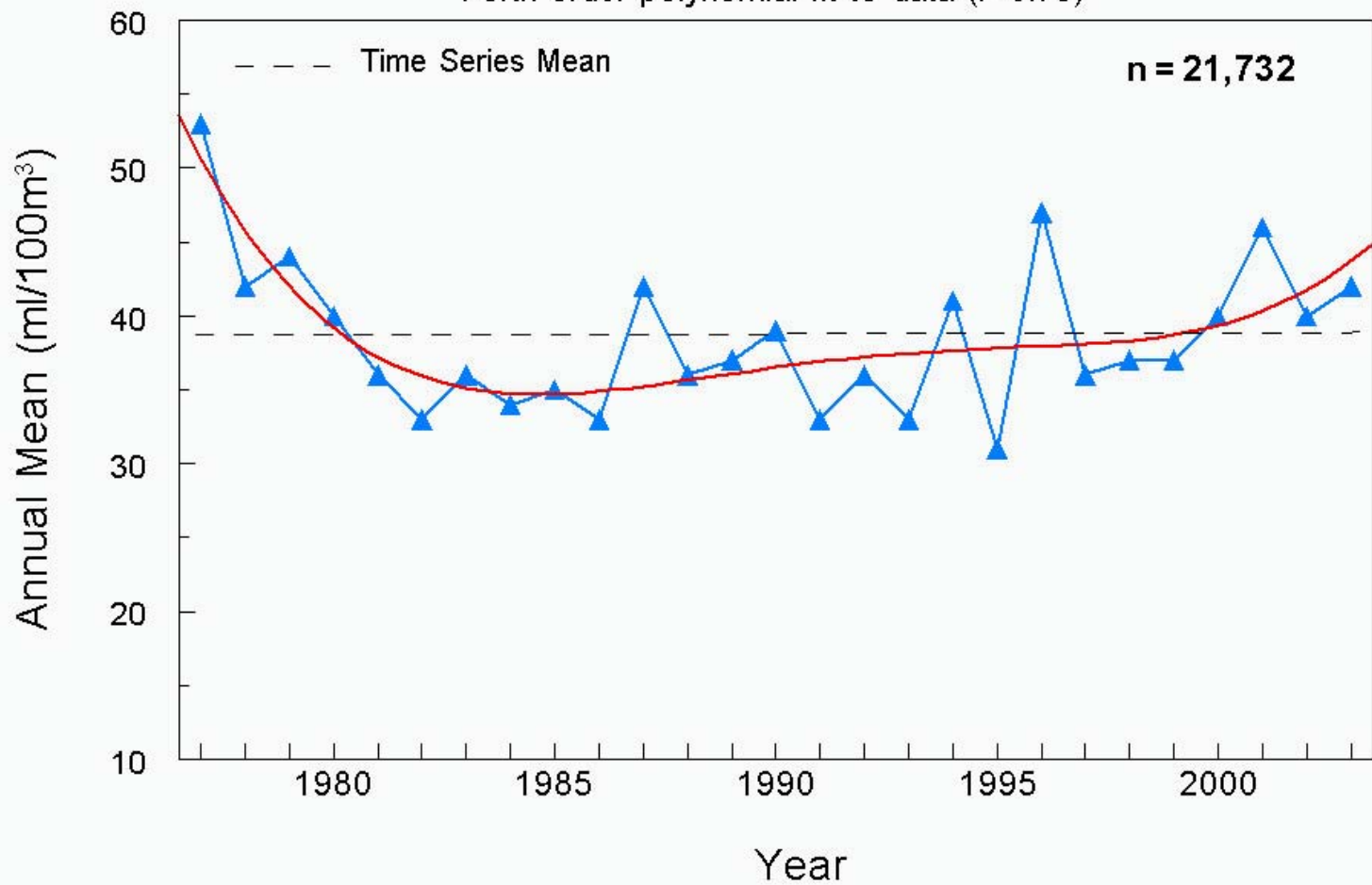
Management plans and strategies should balance economic development with environmental protection and conservation concerns" (Accra Declaration, 1998).



From: Frank, Petrie, Choi, and Leggett. 2005. Trophic cascades in a formerly cod-dominated ecosystem. Science 308:1621.

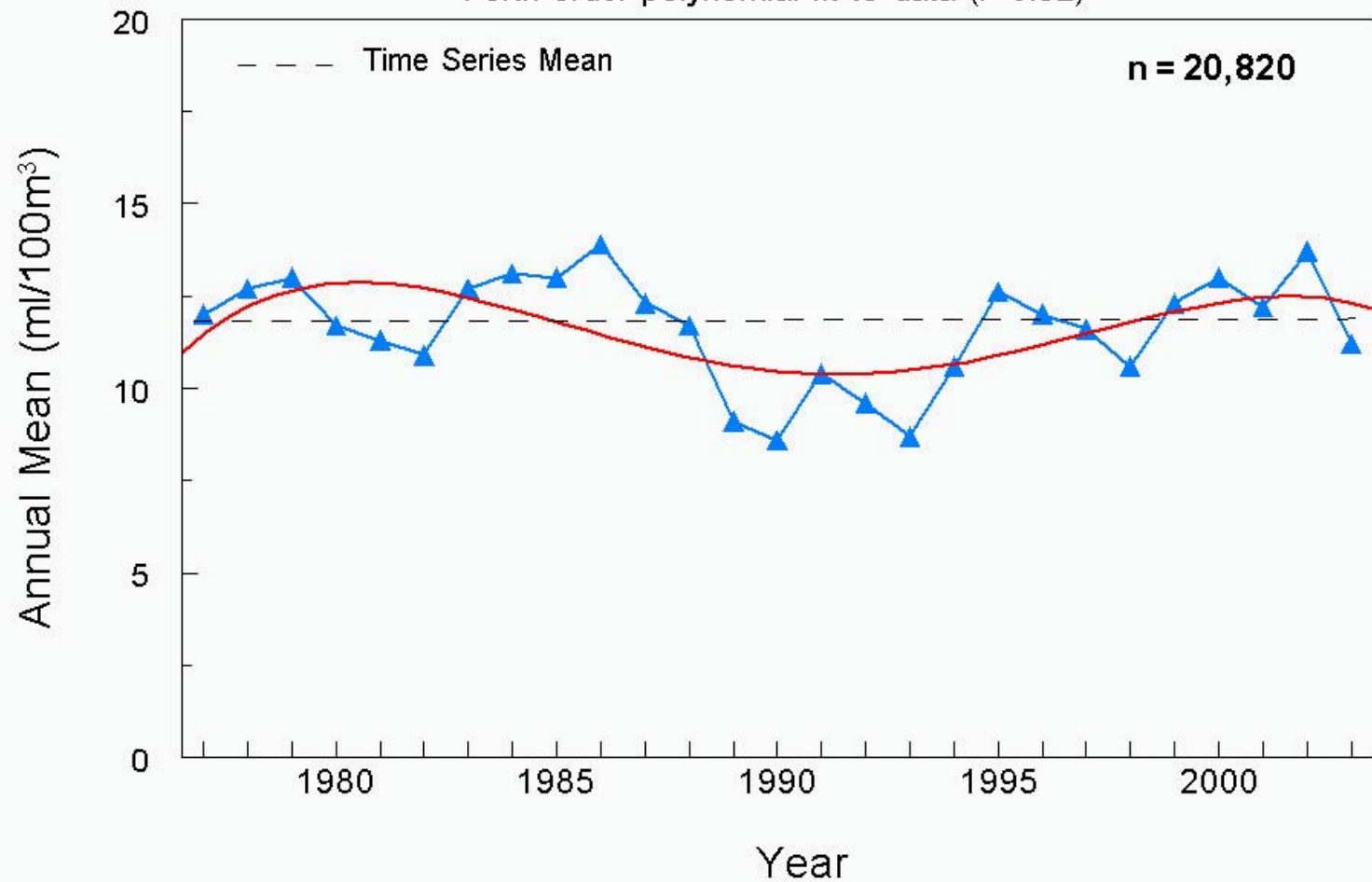
Zooplankton Biomass 1977 - 2003

Fourth order polynomial fit to data ($r=0.73$)



Surface Temperature 1977 - 2003

Forth order polynomial fit to data ($r=0.52$)



FISH AND FISHERIES INDICATORS

