METHODS AND INDICATORS FOR THE ASSESSMENT AND MANAGEMENT OF LARGE MARINE ECOSYSTEMS

Canary Current LME Project

CCLME Inception Workshop

Dakar, Senegal

Brad Brown

Nov. 2010

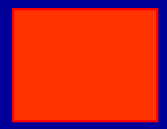
The Downward Spiral

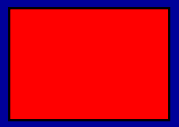
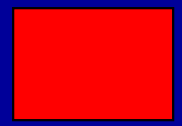
Human activities are cumulatively driving the health of the world's oceans down a rapid spiral, and only prompt and wholesale changes will slow or perhaps ultimately reverse the catastrophic problems they are facing.

Jeremy Jackson, Scripps Institution of Oceanography / University of California, San Diego – Scripps News of 13 August 2008

SELECTED ECOSYSTEM-RELATED WSSD TARGETS AND PROGRAM OF ACTION (POI), Johannesburg, August 2002
- color blocks indicate 2008 status -

- 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



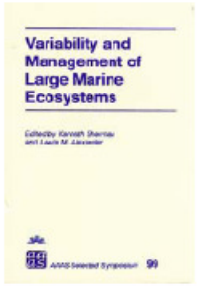
Global Movement Toward LME Recovery and Sustainability

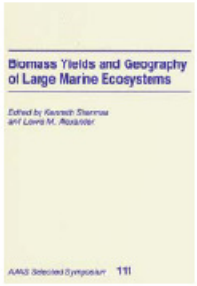
- 5 UN Agencies
  - UNEP
  - UNDP
  - UNIDO
  - FAO
  - IOC – UNESCO
- 2 Major Financial Institutions
  - GEF
  - World Bank
- 2 Non-Governmental Partners
  - IUCN
  - WWF

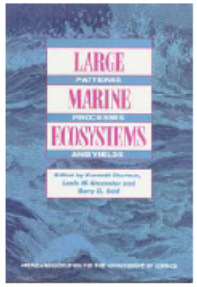
ECOLOGICAL CRITERIA USED TO DETERMINE AREAL EXTENT OF LMES:

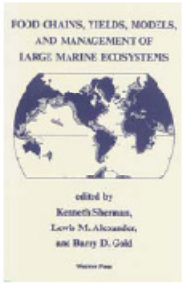
- Bathymetry
- Hydrography
- Productivity
- Trophodynamics

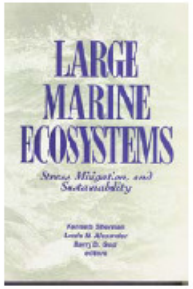
SEMINAL LME VOLUMES, REPORTS AND SELECTED PAPERS

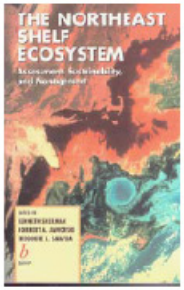


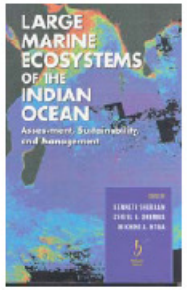


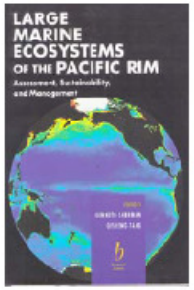


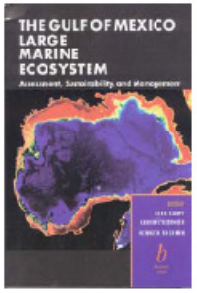


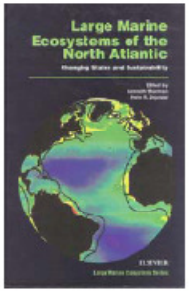


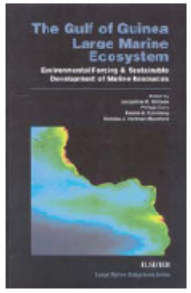


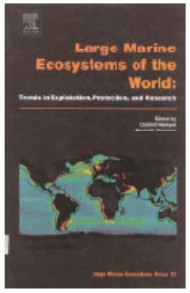


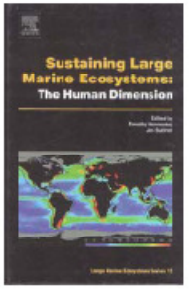


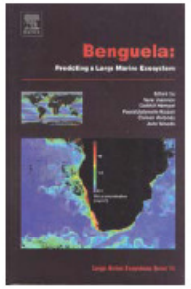


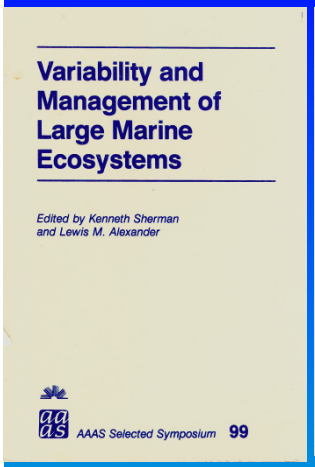


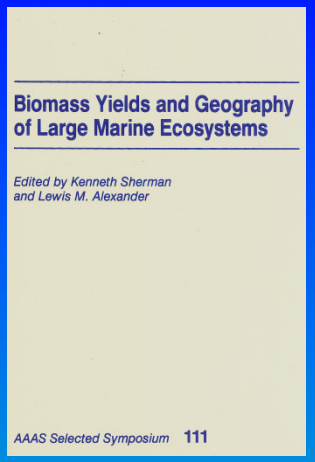


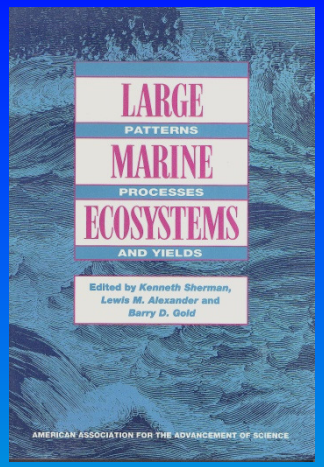


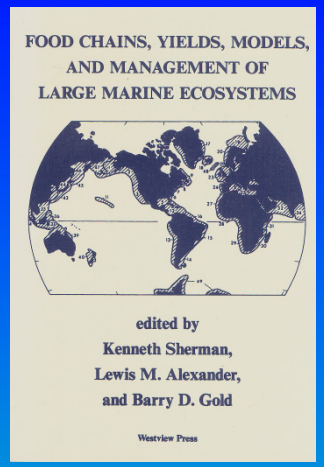


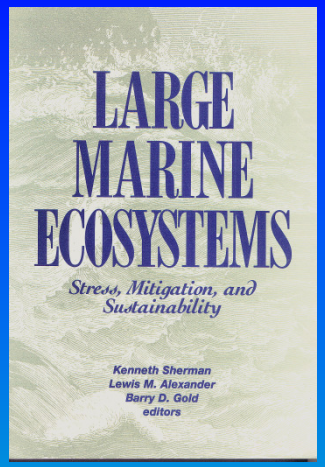


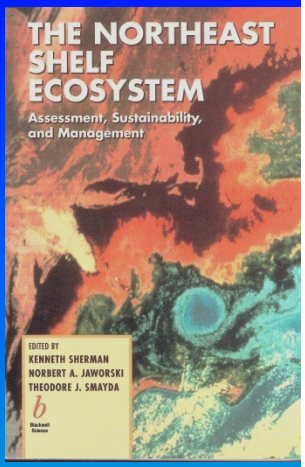


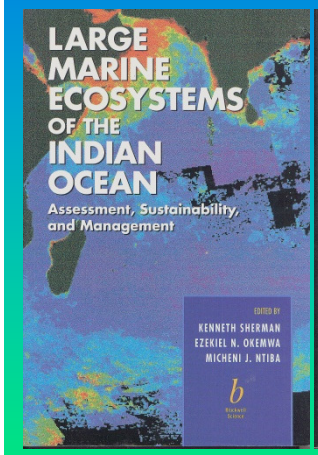


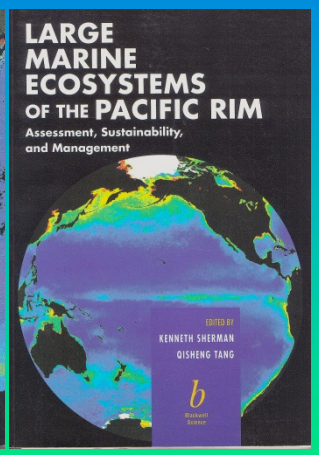


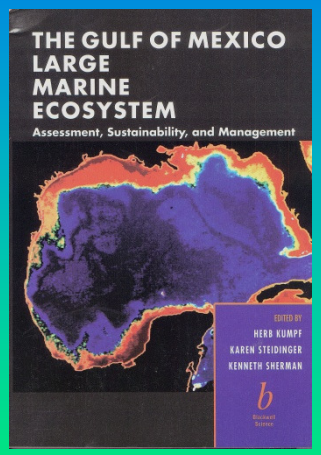


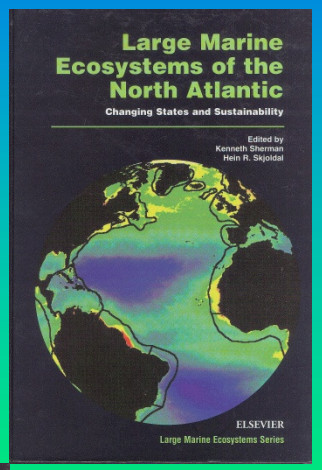


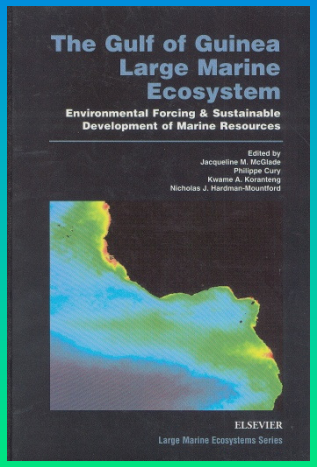


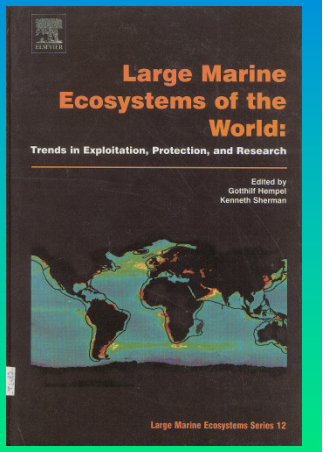


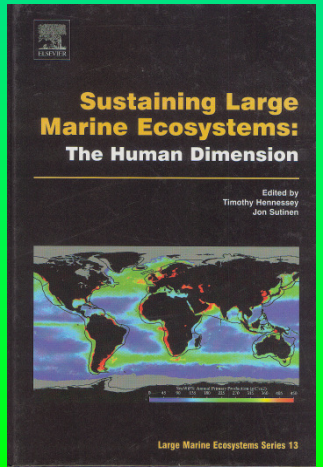


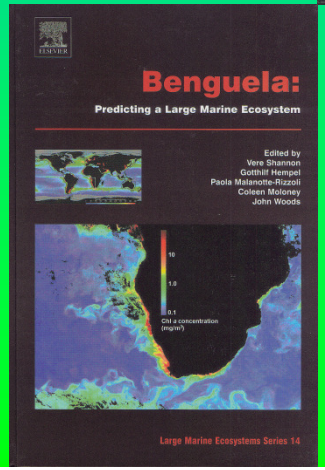








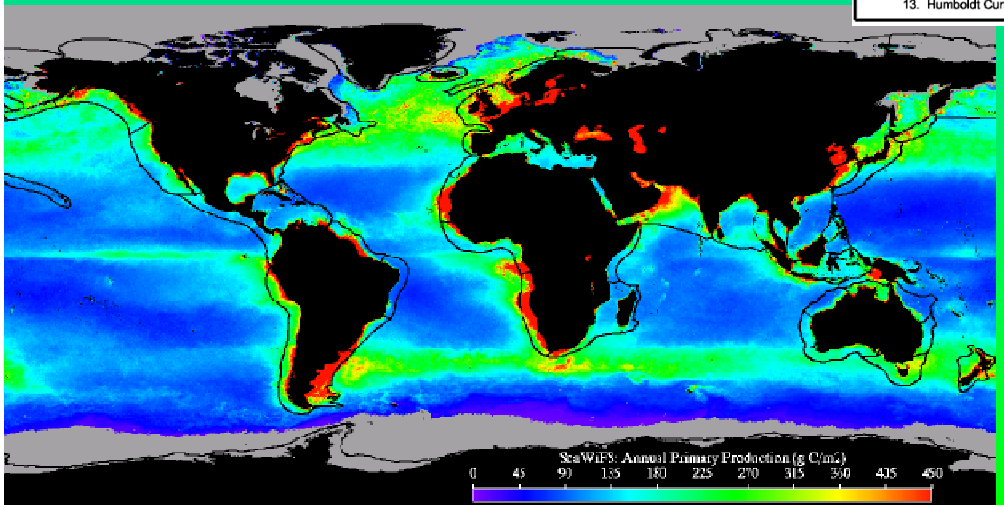


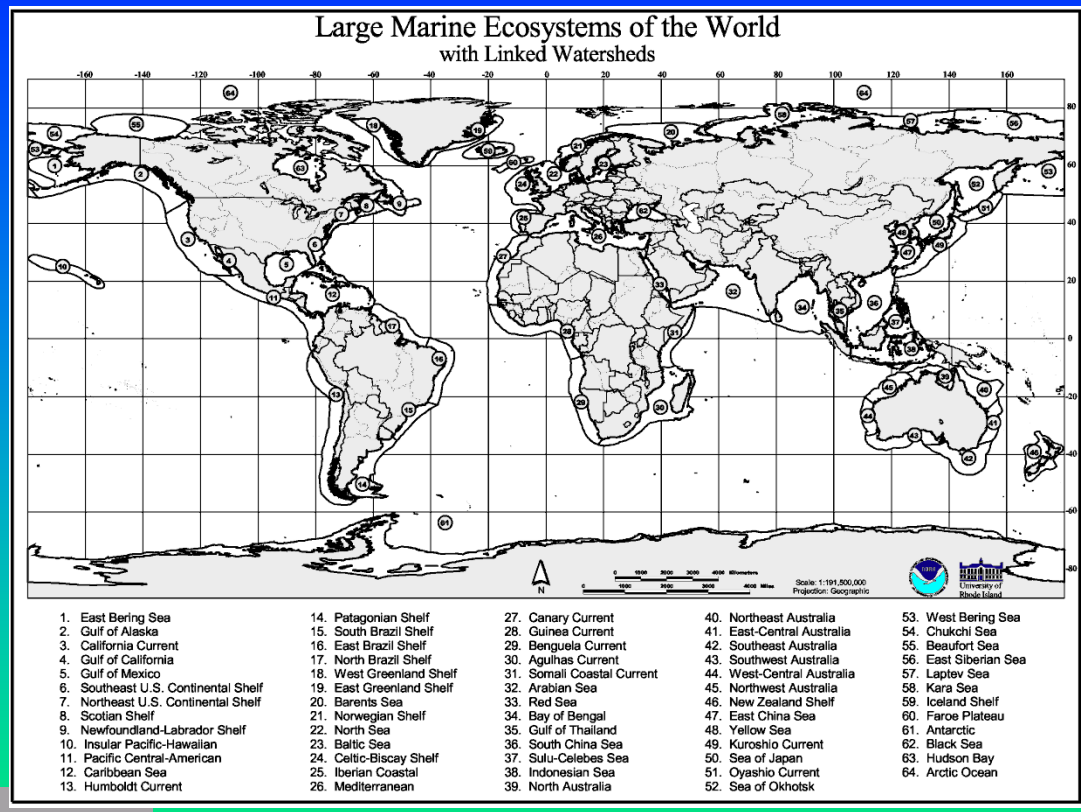


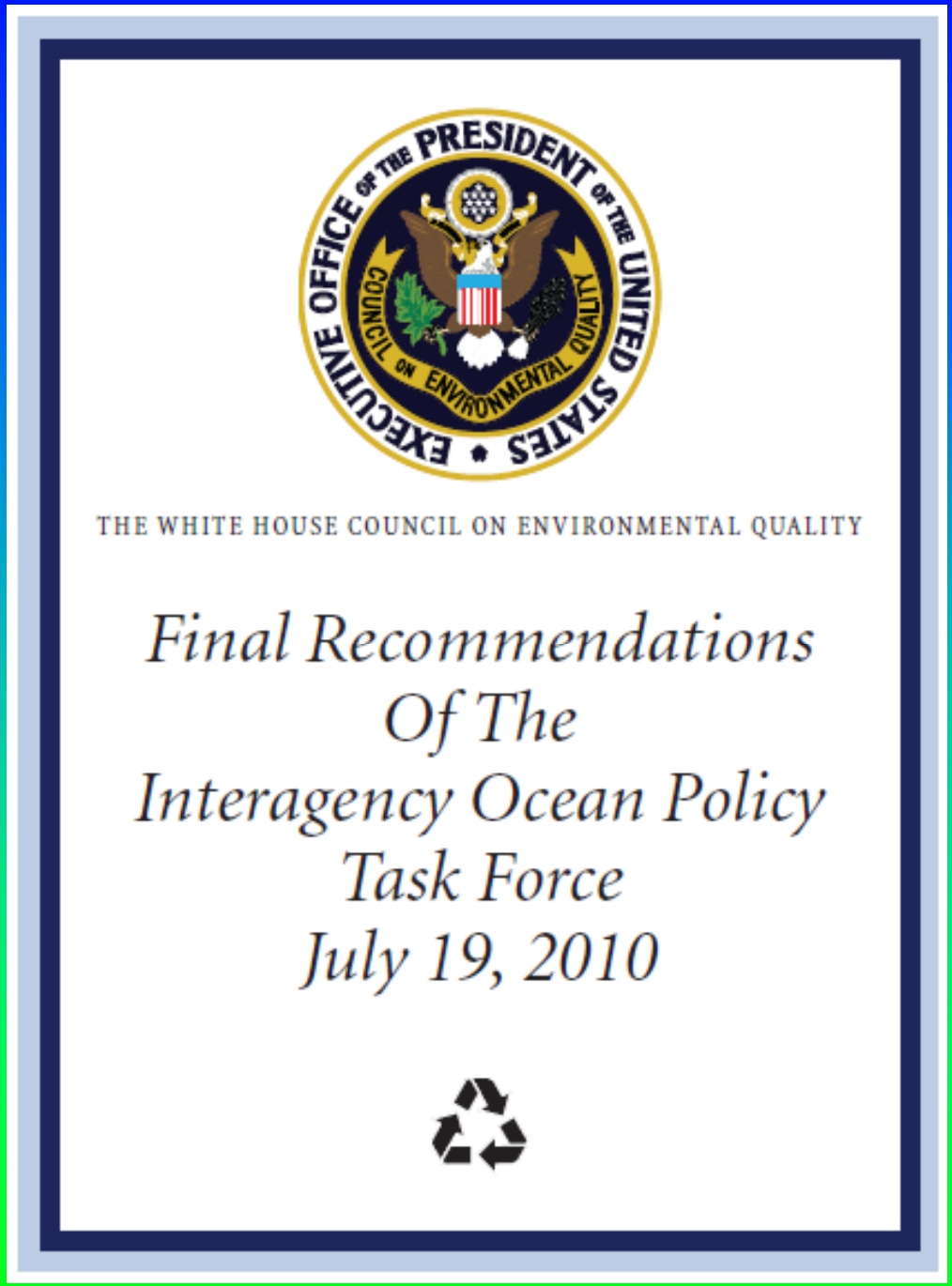
Seminal LME Published Volumes

THE WORLD'S 64 LMES

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

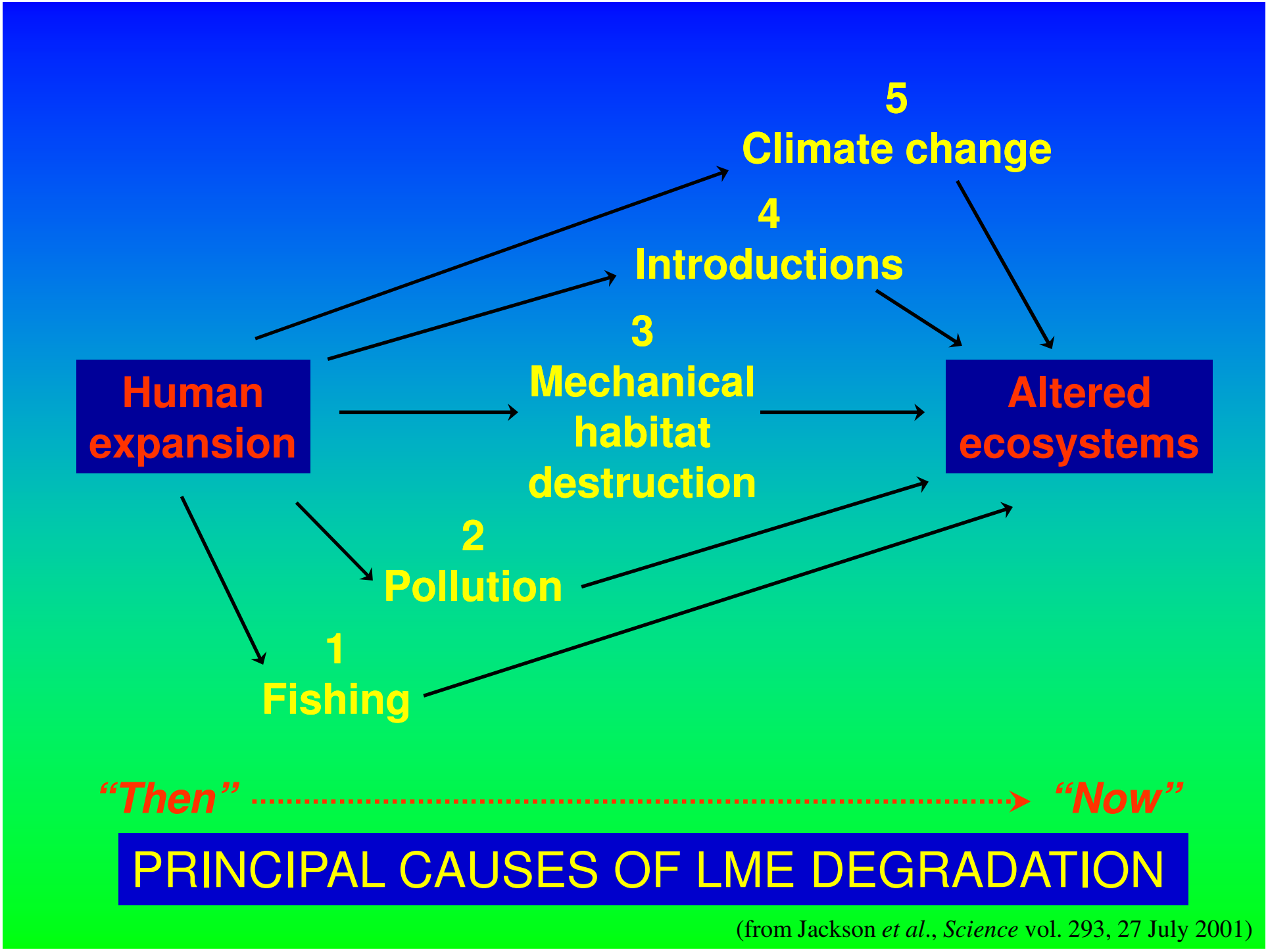






"A consistent planning scale with which to initiate Coastal and Marine Spatial Planning (CMSP) is at the large marine ecosystems (LME) scale ."

Final Recommendations of the Interagency Ocean Policy Task Force, p.51

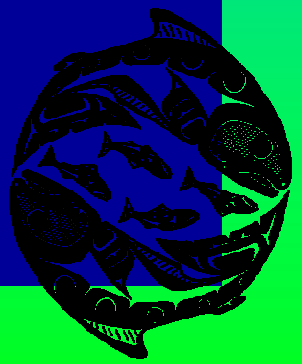


PRINCIPAL CAUSES OF LME DEGRADATION

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

Ocean ecosystems provide many services, most of which are undervalued

- Food
- Medicines
- Recreation & tourism
- Trade
- Education & research
- Water purification
- Shoreline protection
- Nutrient cycling
- Moderation of climate
- Cultural, spiritual, and religious values



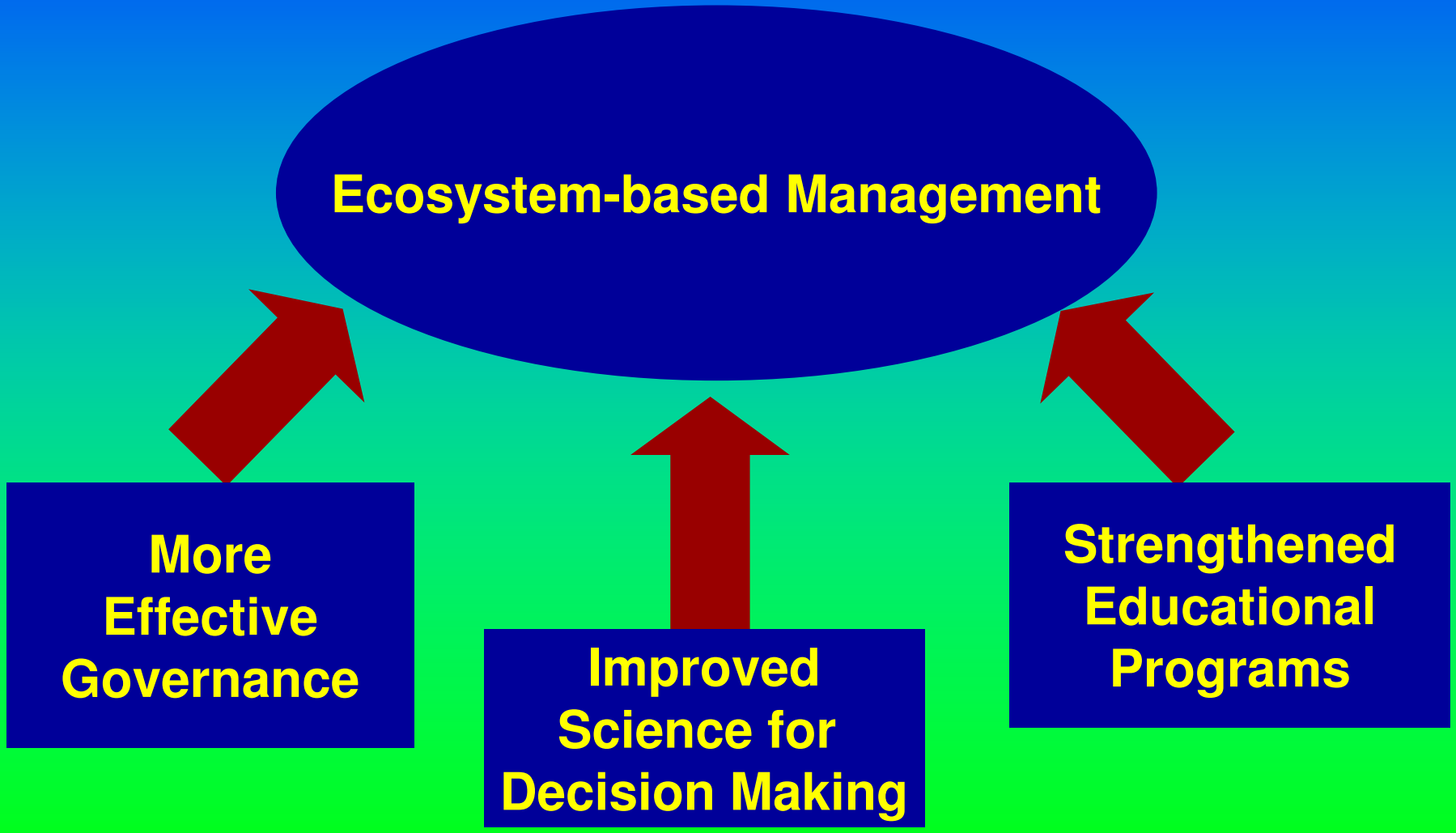
COMPASS

Communication Partnership for Science and the Sea

LMEs ARE GLOBAL CENTERS OF EFFORTS TO:

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

Cross-cutting Themes



INDICATORS OF CHANGING ECOSYSTEM STATES:

Productivity

Fish and Fisheries

Pollution

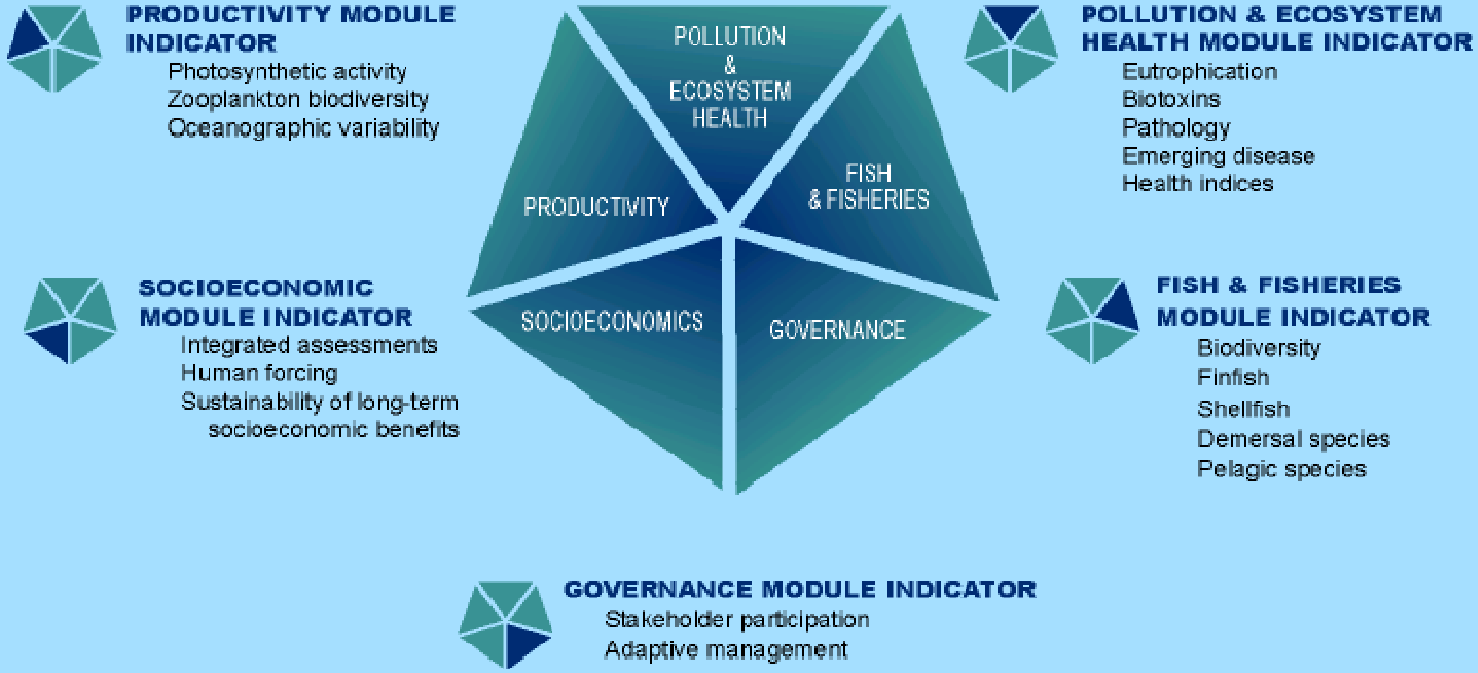
Socioeconomic

Governance

5 MODULES WITH INDICATORS

Modular Assessments

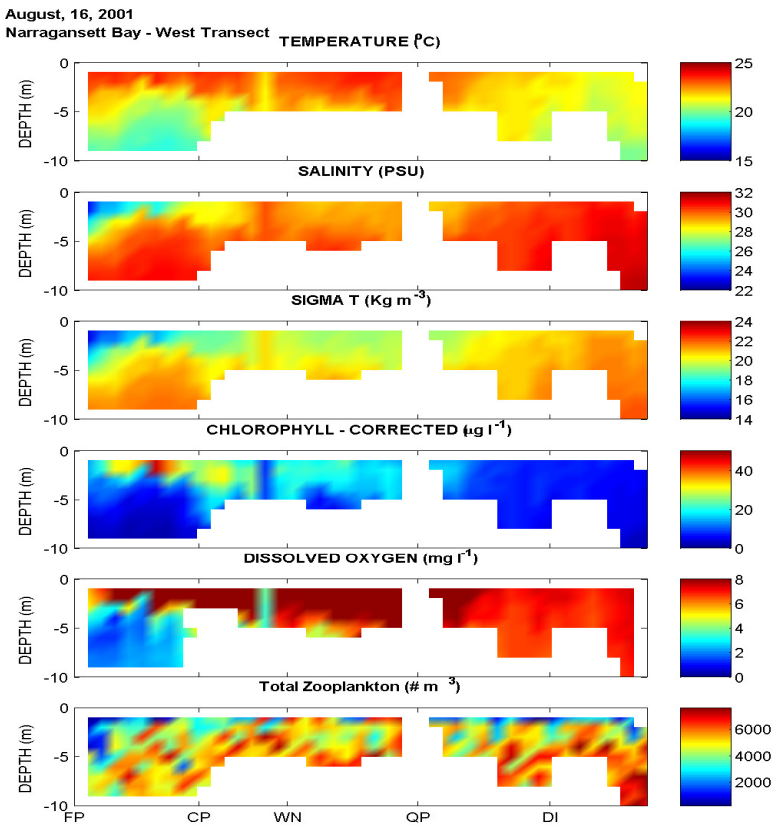
Support LME Restoration and Sustainable Development



Productivity Indicators of changing ecosystem states

- Primary productivity and chlorophyll trends (1998-2006)
- LME fronts (temperature gradients)
- Sea Surface Temperatures (SST) profiles and anomalies (1957-2006 and 1982-2006) at the LME scale.

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).

GOOS AFRICA

-

A- AFRICAN GRASSROOTS APPROACH

B- AFRICAN OWNERSHIP/COMMITMENTS

C- AFRICAN LEADERSHIP in S T I

OPERATIONAL OCEANOGRAPHY

- PIRATA extension –Kizomba Buoy
- HAB's monitoring buoy
- Satellite remote sensing
  - chlorophyll a, SST, upwelling indices
- Weather stations; tide guages
- Moored sensors: temperature, current, salinity, oxygen
- CPR's and TUOR (Aquashuttle)
- Routine monitoring lines- zooplankton

BCLME

The Interface to Coastal Seas : LMEs/GOOS-AFRICA/GEO/GEOSS
Towards building advanced global versus regional scale capability

GOOS-AFRICA/GEO/GEOSS SUPPORT TO THE AFRICAN LMEs

African/European EU 7th Framework Specific Support Action Projects:

- GEONETCast/DevCoCast in AfricanLMEs as Users

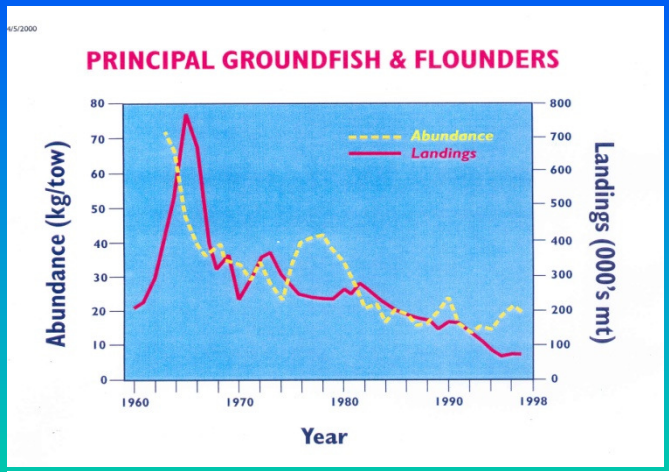
- EAMNet in AfricanLMEs as Users

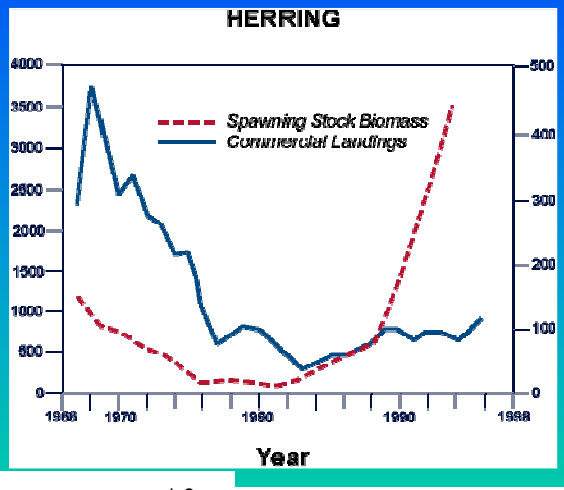
- GCLME University of Ghana: GCLME Satellite RS Applications (Dr. G. Wiafe)
- CCLME LERG/Senegal: CCLME Satellite RS Applications (Dr. Mbaye Diop)
- BCLME NatMirc/Namibia: BCLME Satellite RS Applications (Nande Nickanor)
- ASCLME IMS/Tanzania: ASCLME Satellite RS Applications (Dr. Margareth Kyewalyanga)

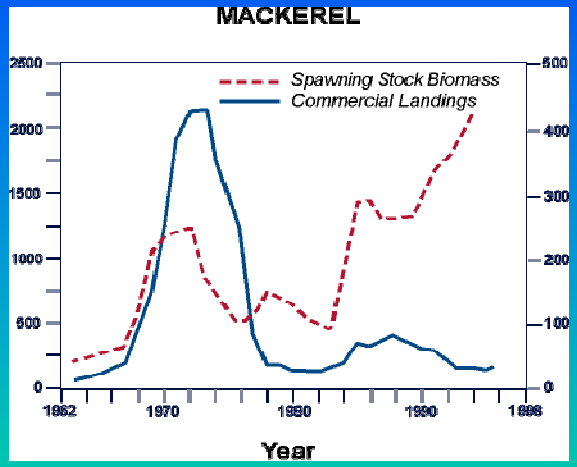
FISH AND FISHERIES INDICATORS

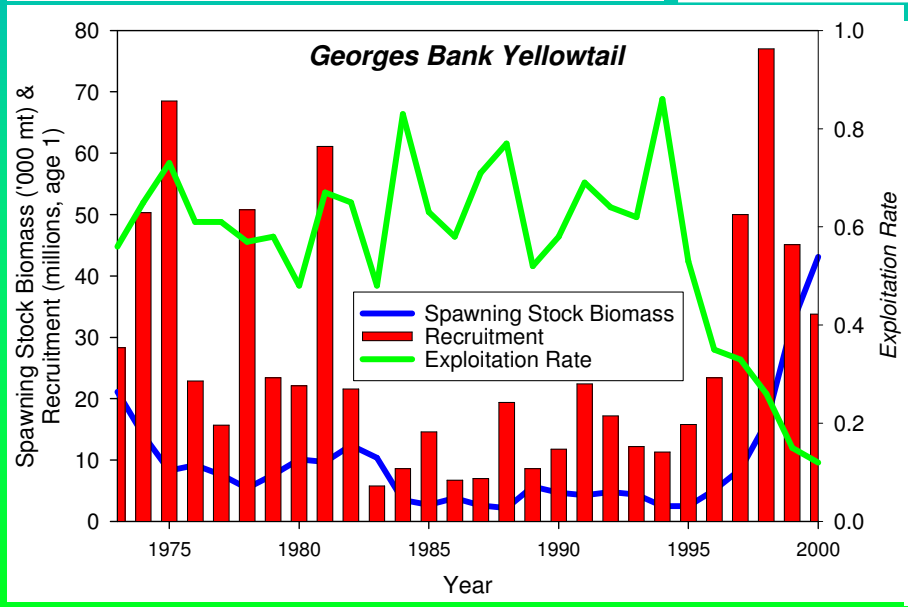
- Demersal species surveys
- Pelagic species surveys
- Ichthyoplankton surveys
- Invertebrate surveys (clams, scallops, shrimp, lobster, squid)
- Essential fish habitat
- Marine protected areas

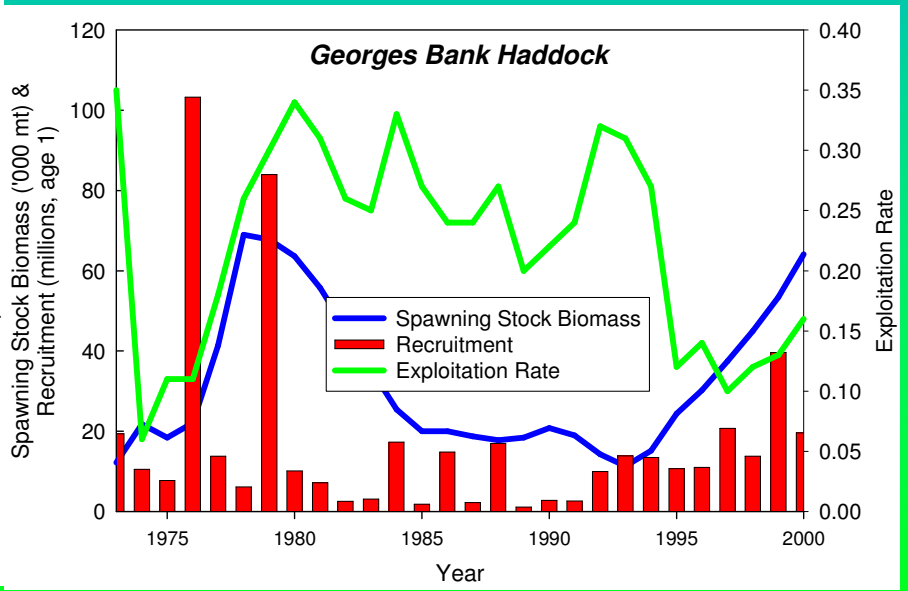
FISH AND FISHERIES INDICATORS



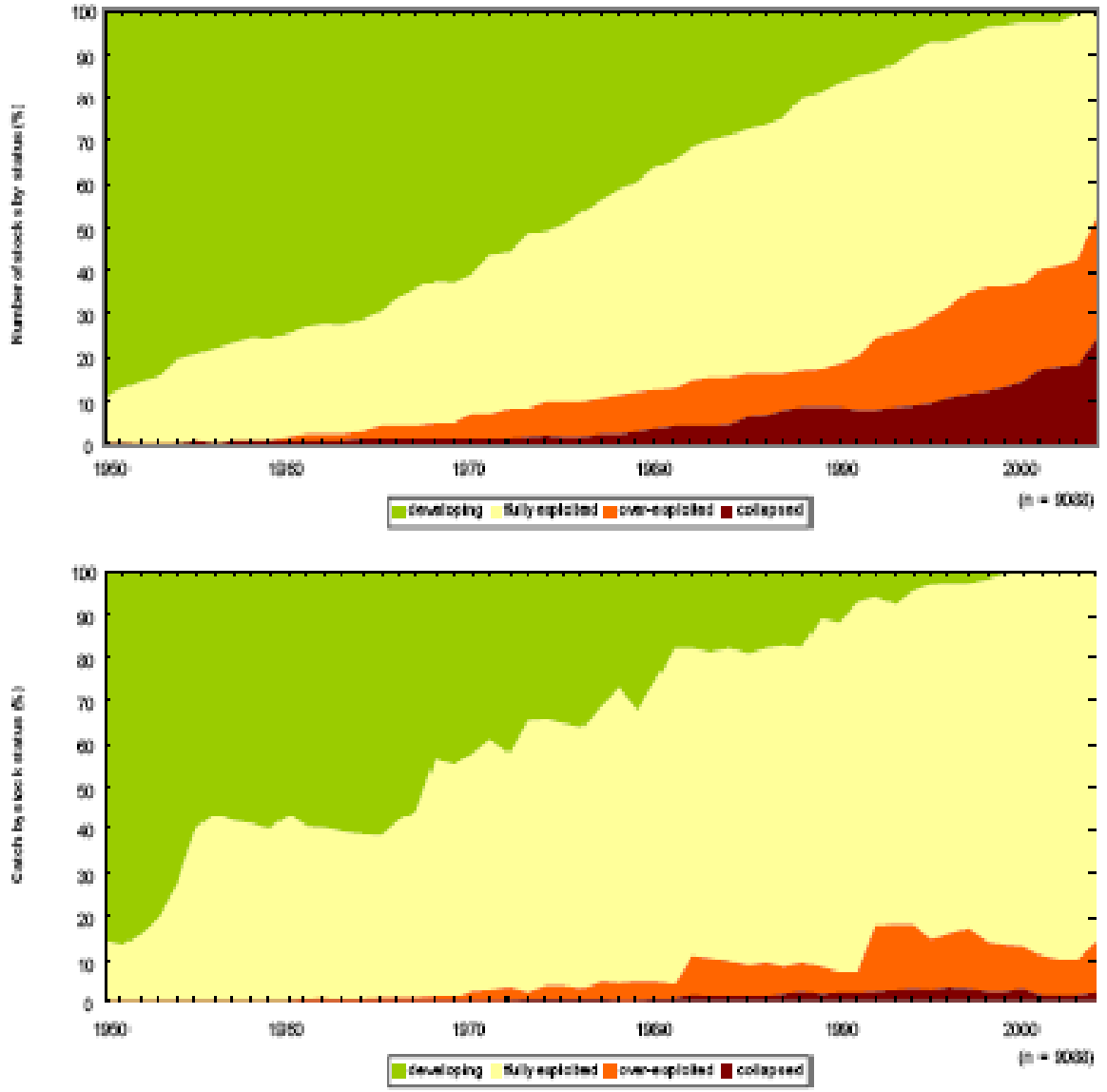








South China Sea Stock Status (Sea Around Us Project 2007)



Pollution and Ecosystem Health
Indicators

The US Environmental Protection Agency's seven pollution and ecosystem health Indicators:

(water quality, dissolved oxygen, coastal habitat, eutrophic condition, sediment quality, benthic index, fish tissue contaminants)

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*

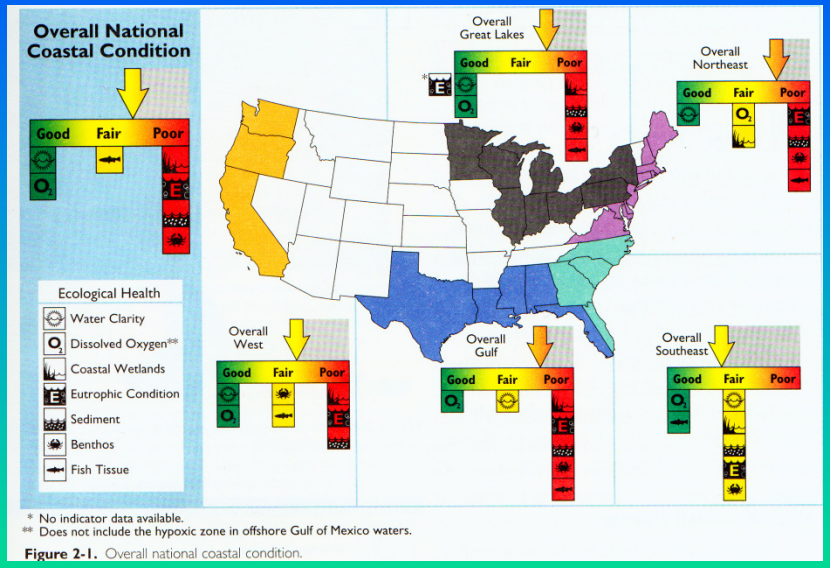
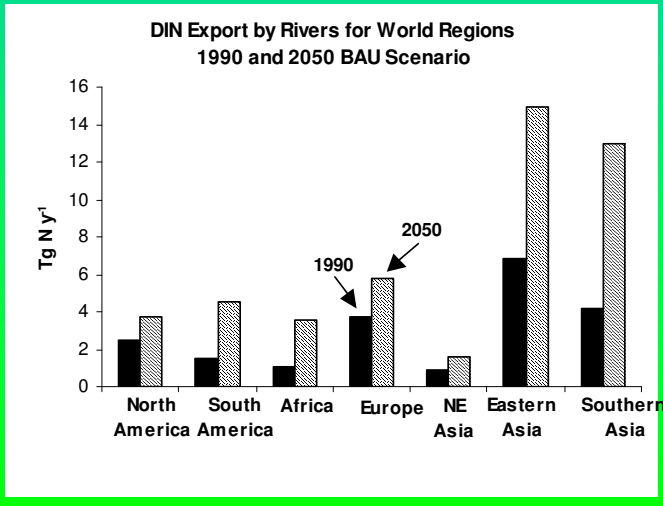
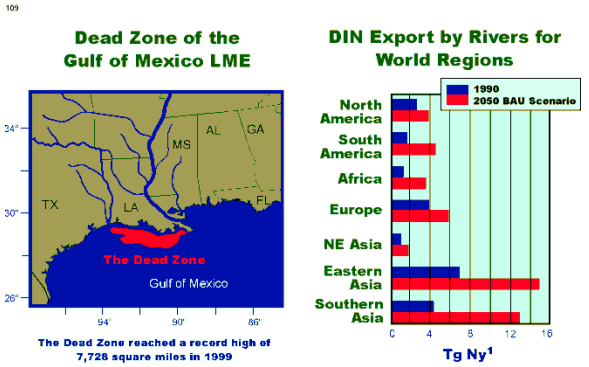


Figure 2-1. Overall national coastal condition.



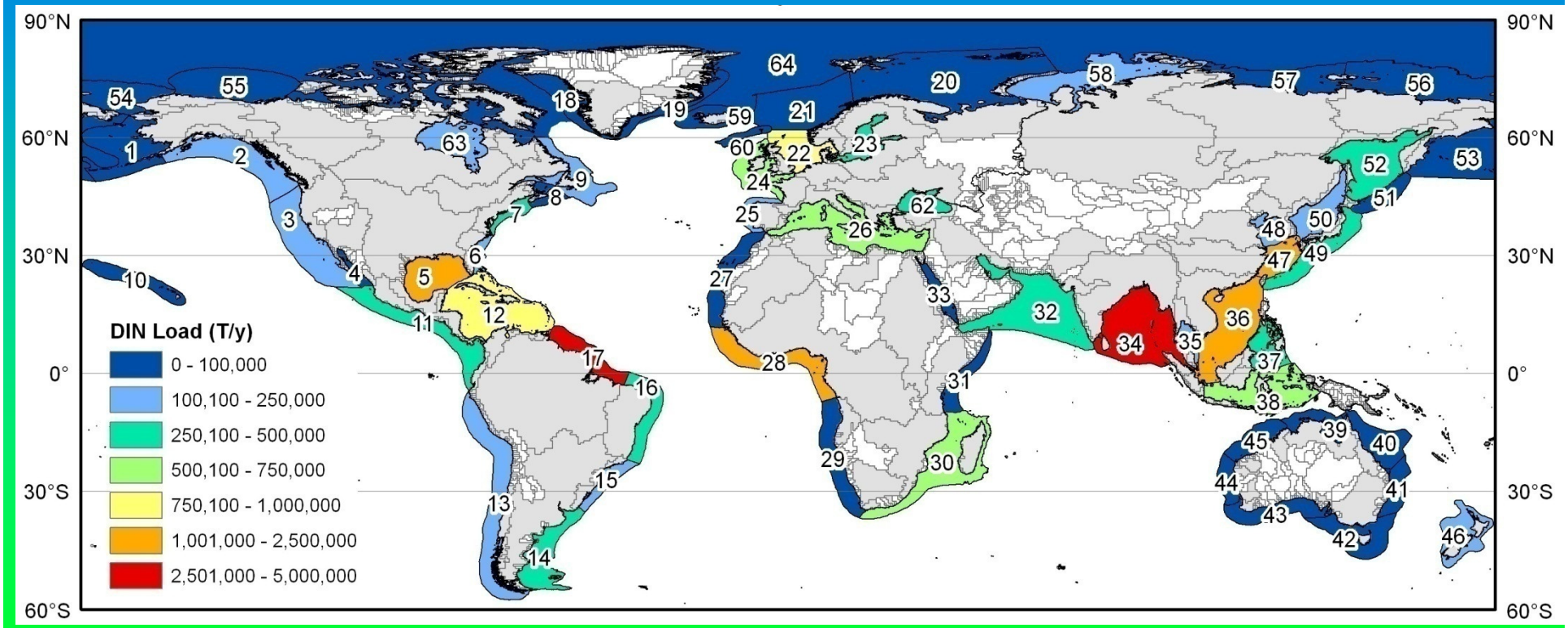


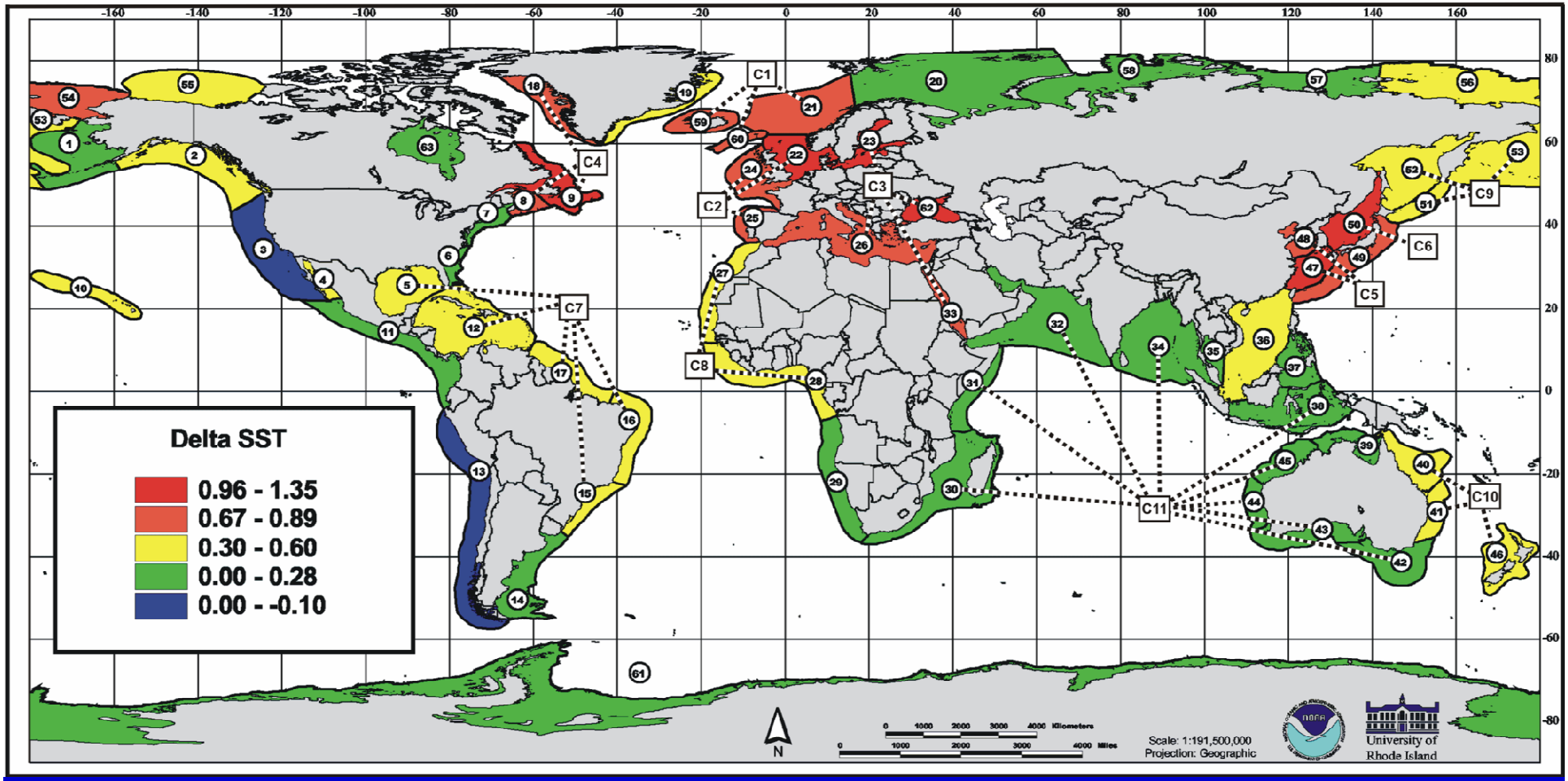
Pollution and Ecosystem Health: nutrient over-enrichment indicators

A Watershed perspective:

- Nutrient export model (Sybil Seitzinger);
- Nitrogen and Phosphorus export to coastal systems;
- Contribution of N sources in watersheds to model-predicted DIN river export to the coastal zone of each continent.

DIN inputs to LMEs from land-based sources predicted by the NEWS DIN model. Watersheds discharging to LMEs are grey; watersheds with zero coastal discharge are white. Units: Tons N/y. See Table 2 for LME identification. (Figure from Lee and Seitzinger submitted).





Warming Clusters of LMEs in Relation to SSTs, 1982-2006:

FAST WARMING:

C1 Northern European Cluster; C2 Southern European; C3 Semi-Enclosed European Seas; C4 of the NW Atlantic; C5 Fast Warming East Asian LMEs; C6 Kuroshio Current and Sea of Japan/East Sea LMEs.

MODERATE WARMING:

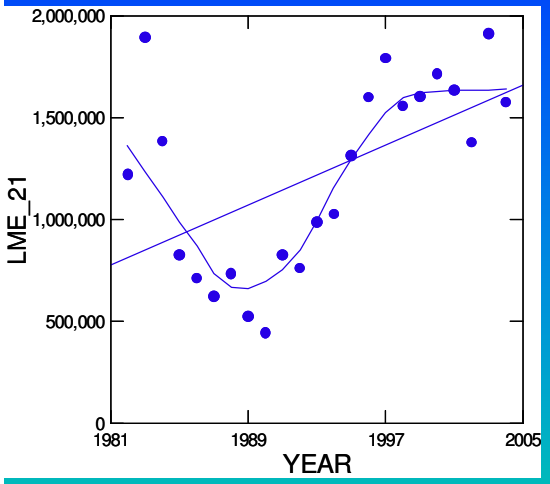
C7 Western Atlantic LMEs; C8 Eastern Atlantic LMEs; C9 NW Pacific LMEs; C10 SW Pacific LMEs. Several Non-Clustered, Moderate Warming LMEs: NE Australia, Insular Pacific Hawaiian, Gulf of Alaska, Gulf of California; South China Sea, East Greenland Shelf;

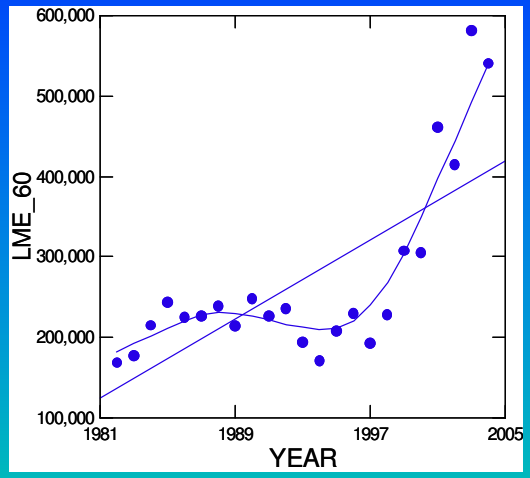
SLOW WARMING:

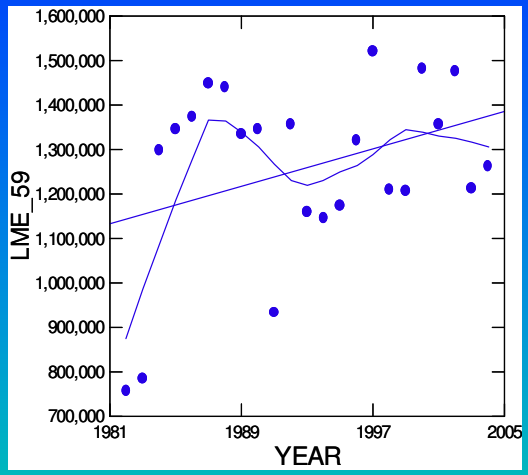
C11 Indian Ocean and Adjacent Waters.

Non-clustered, Slow Warming LMEs include the U.S. Northeast Shelf, the U.S. Southeast Shelf, the Barents Sea, East Bering Sea; Patagonian Shelf, Benguela Current and Pacific Central American Coastal LMEs.

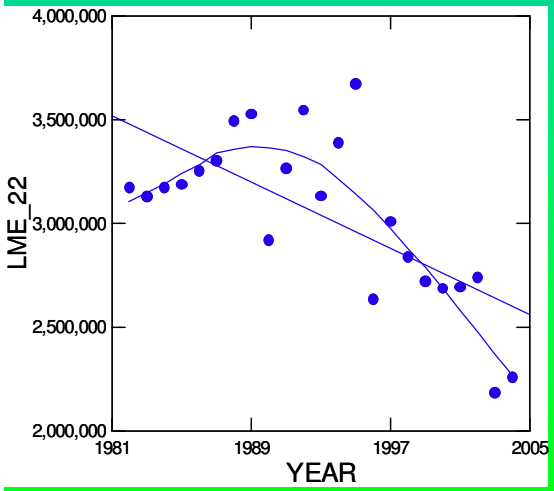
Fisheries biomass yield trends (metric tons) in fast warming cluster 1: Norwegian Sea (LME 21), Faroe Plateau (LME 60), and Iceland Shelf (LME 59).

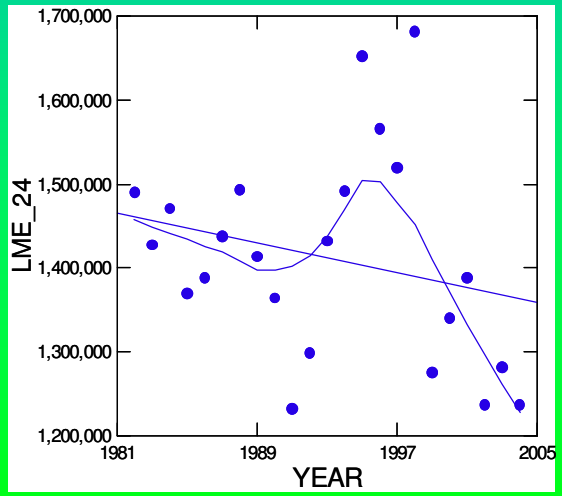


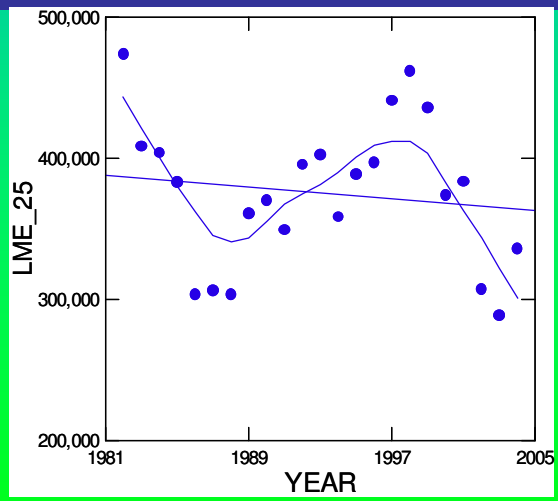


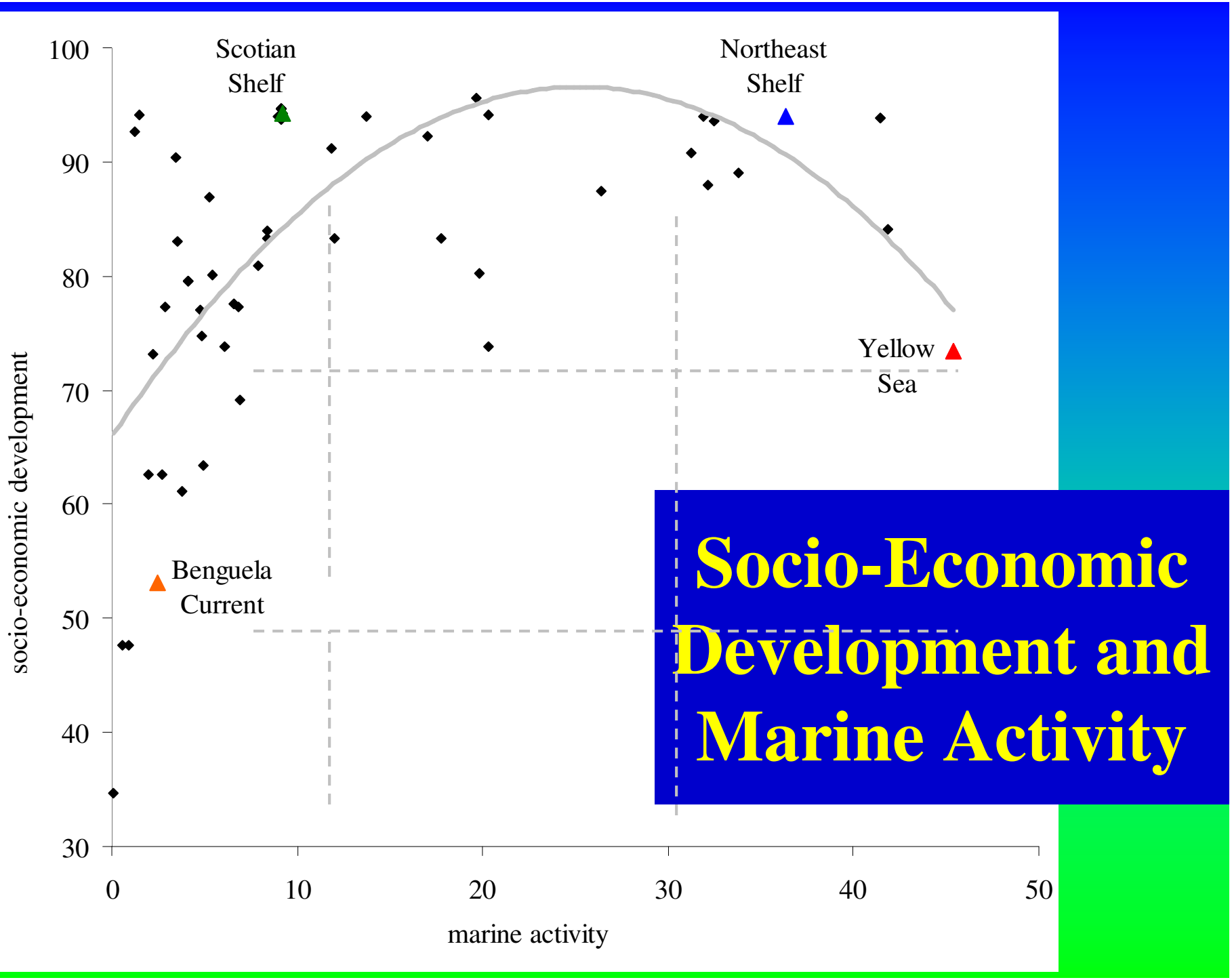


Fisheries biomass yield trends (metric tons) in fast warming cluster 2: North Sea (LME 22), Celtic Biscay (LME 24) and Iberian Coastal (LME 25)









Socio-Economic Development and Marine Activity

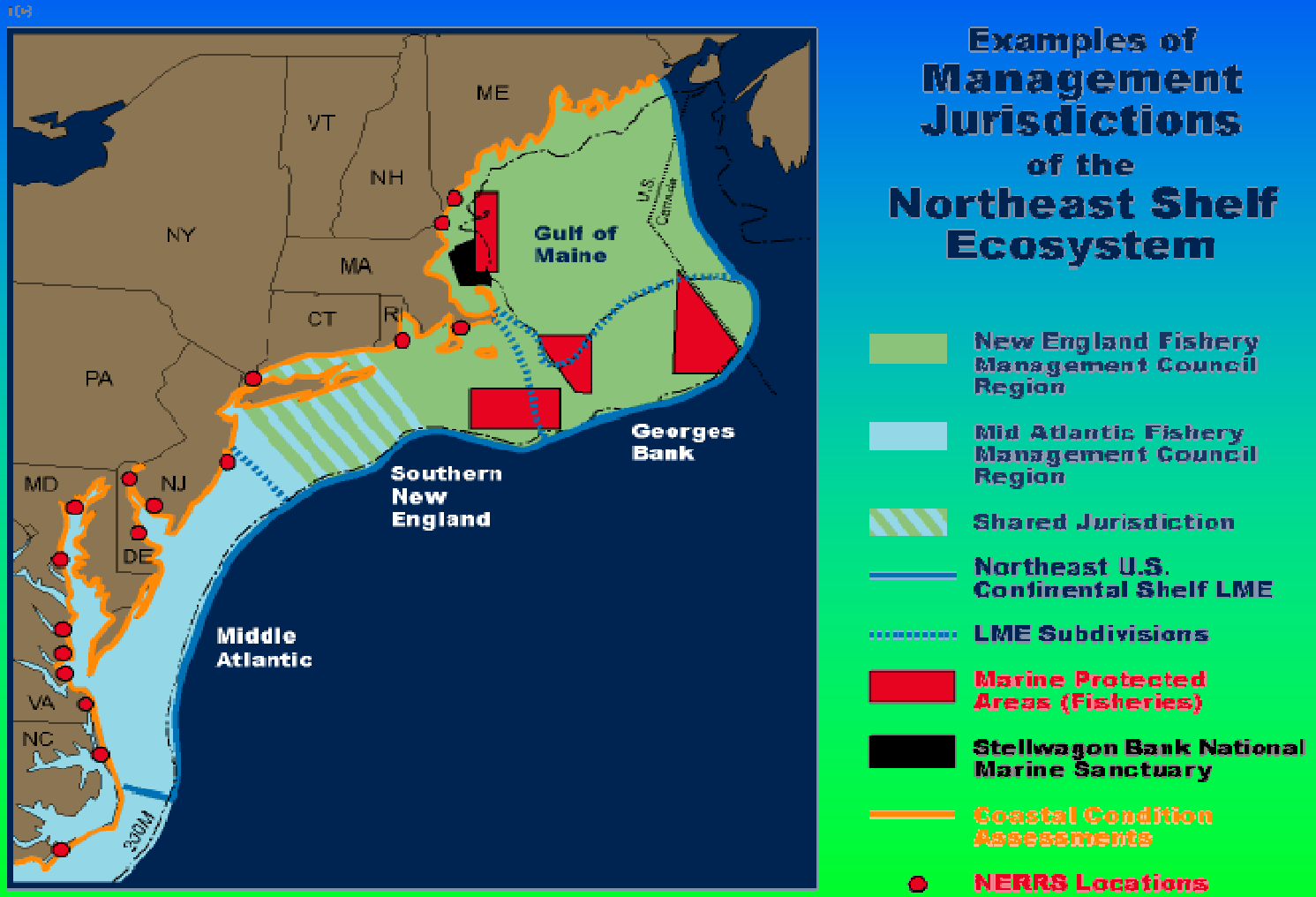
ESTIMATED SOCIOECONOMIC VALUE OF LMEs

Goods and Services Contribute $12.6 Trillion Annually to the Global Economy

Costanza et al. , NATURE, Vol. 287/ 15 May 1997

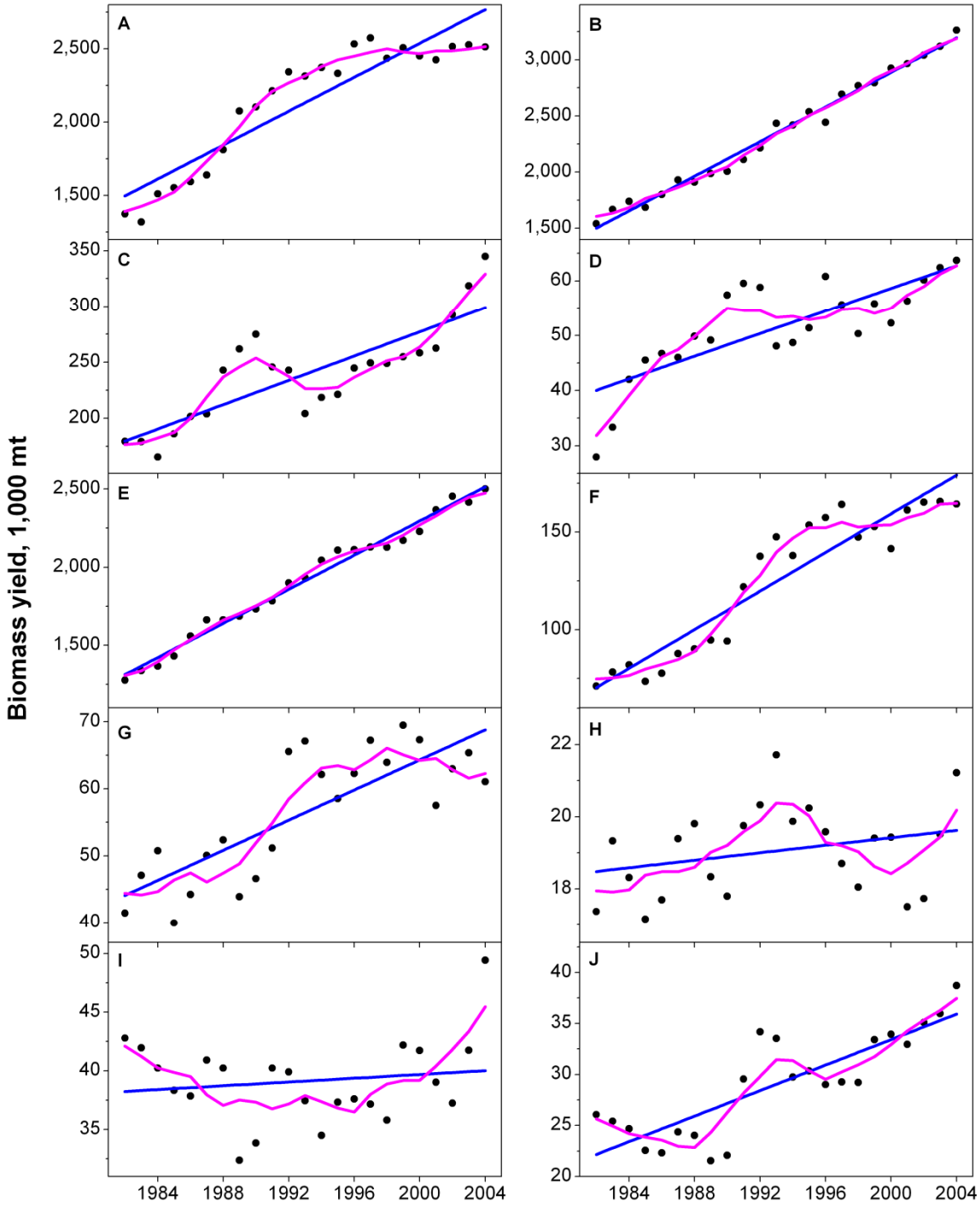
SOCIOECONOMICS AND GOVERNANCE

NORTHEAST SHELF MANAGEMENT JURISDICTIONS



CAP AND SUSTAIN

Comparative dynamics of fisheries biomass yield in the slow warming Indian Ocean and adjacent LMEs (see cluster C11 in Figure 6): Arabian Sea, LME 32 (A); Bay of Bengal, LME 34 (B); Agulhas Current, LME 30 (C); Somali Current, LME 31 (D); Indonesian Sea, LME 38 (E); North Australia, LME 39 (F); Northwest Australia, LME 45 (G); West-Central Australia, LME 44 (H); Southwest Australia, LME 43 (I); and, Southeast Australia, LME 42 (J). Linear regression is shown as blue trend line, adjacent averaging smoothing is shown as magenta trend line.



Benguela CURRENT COMMISSION

On the road to implementing an ecosystem approach to the management of Benguela Current Large Marine Ecosystem by Angola, Namibia and South Africa.

BCLME
Benguela Current Large Marine Ecosystem Programme

The Benguela Current Commission represents the world model for successfully operationalizing the ecosystem-based approach to the assessment and management of LME goods and services for the people of Angola, Namibia and South Africa

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

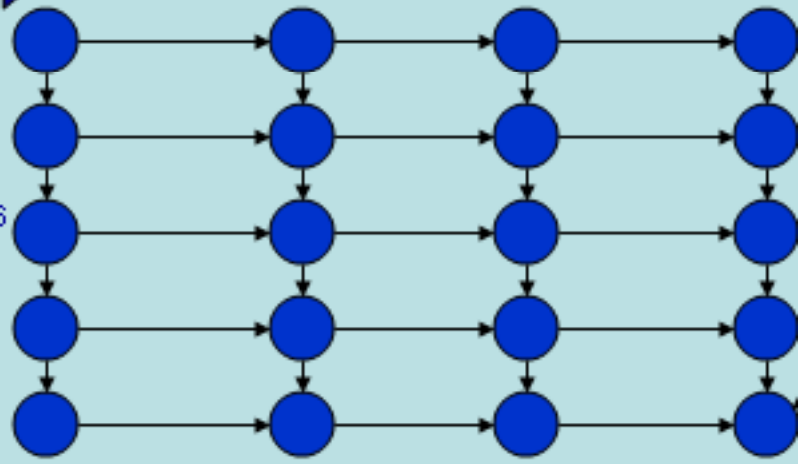
2. Strategic Action Program (SAP) – provides national and regional commitments to policy, legal and institutional reforms, and investments to remedy root causes of priority transboundary issues identified in TDA

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

Integrated Ecosystem-Based, Assessment and Adaptive Management



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

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.

GEF – LME Programs Partner with UNEP Regional Seas Programme

GEF:LME Projects
- In preparation
- Approved

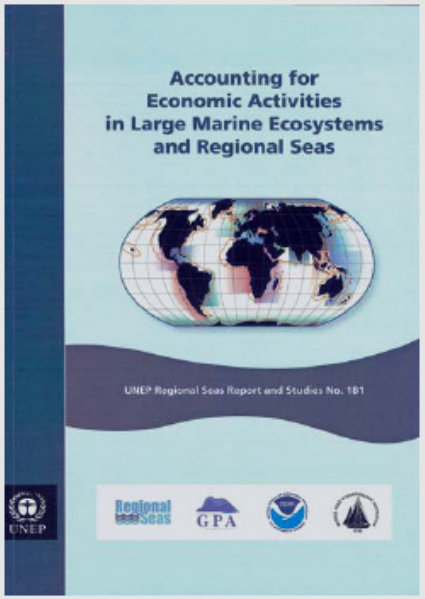
121 countries currently involved in 17 GEF-LME projects

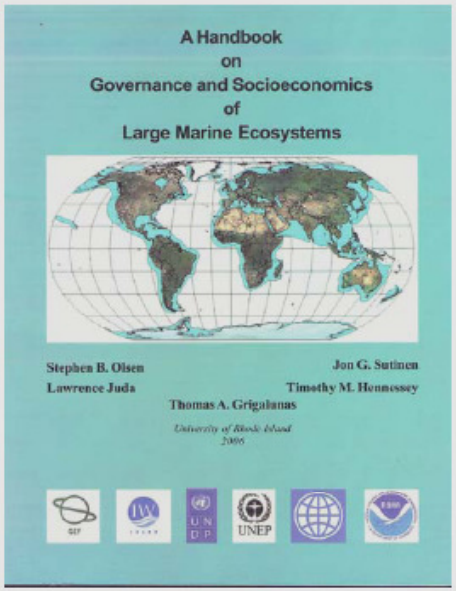
More than 140 countries participate in 13 regional programmes in the Black Sea, Caribbean, East Africa, East Asia, the Kuwait Convention Region, Mediterranean, North-East Pacific, North-West Pacific, Red Sea and Gulf of Aden, South Asia, South-East Pacific, South Pacific, and West and Central Africa—all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

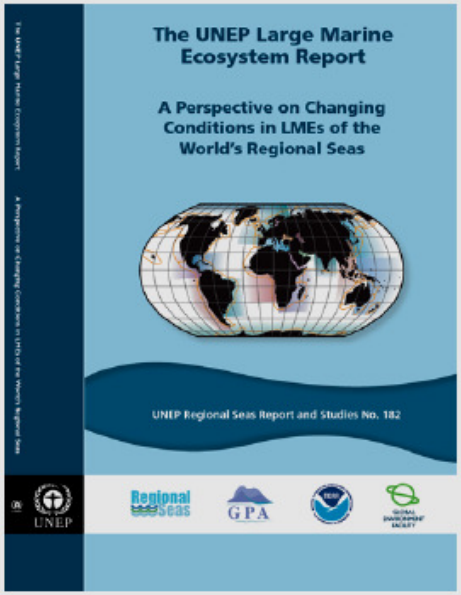
LME / GEF PROJECTS IN SUPPORT OF UNEP REGIONAL SEAS PROGRAMME

- 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

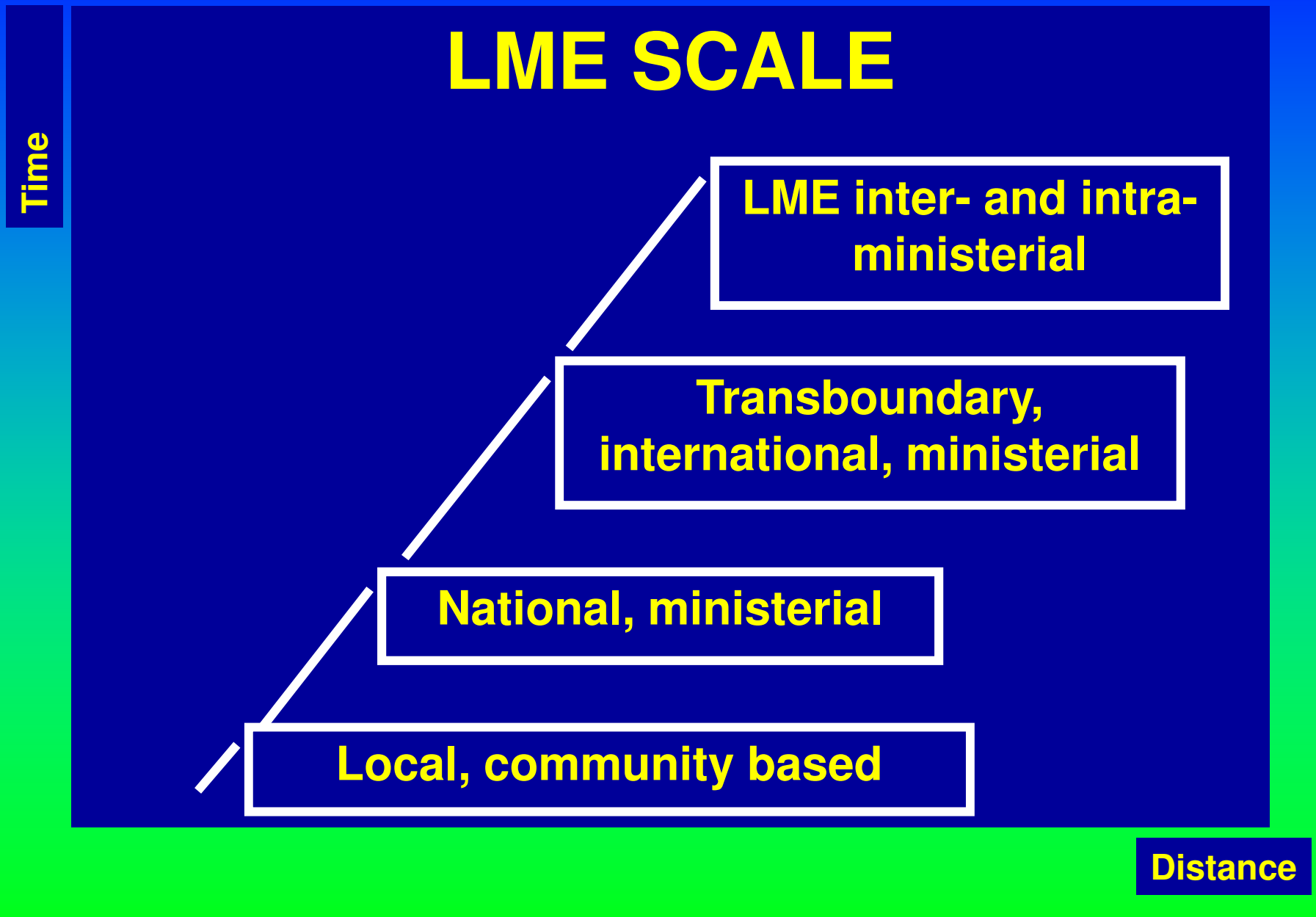
UNEP LME REPORTS 2006-2008



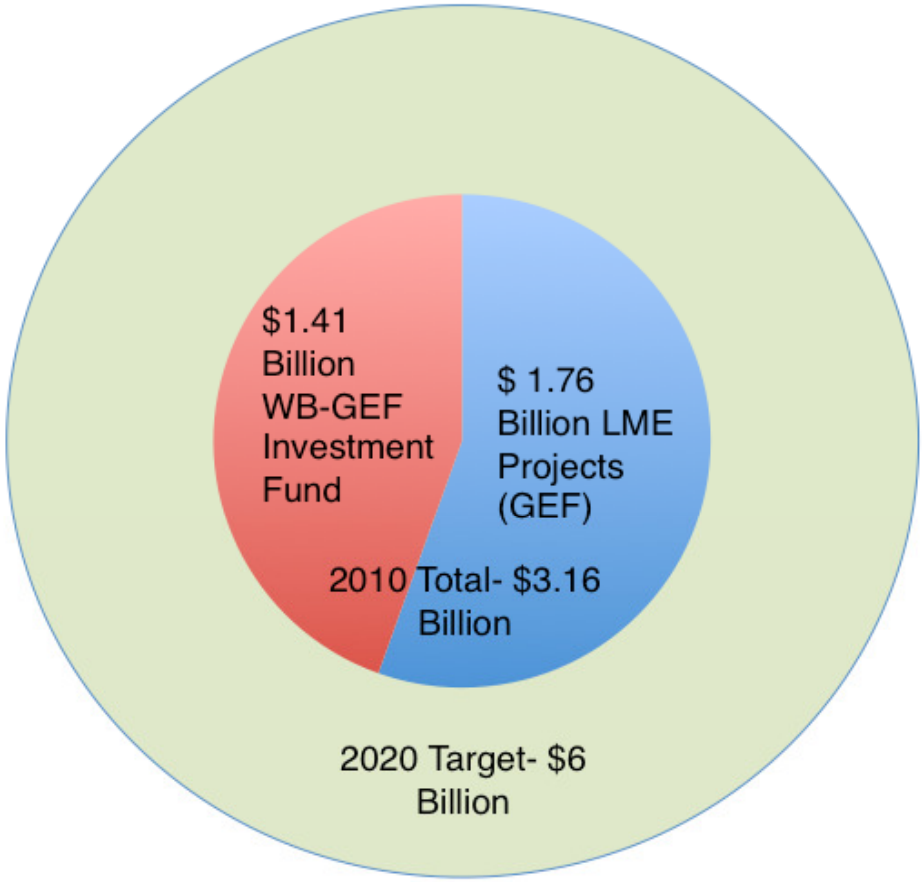




LME SCALE


Time
LME inter- and intra-ministerial
Transboundary, international, ministerial
National, ministerial
Local, community based
Distance

Partnering Toward Sustainable Development of the World's LME's with Integrated ICM and Climate Adaptation Projects



All LMEs

Yellow Sea LME
Benguela Current LME
Guinea Current LME
Baltic Sea LME

Downward Spiral

Upward Spiral

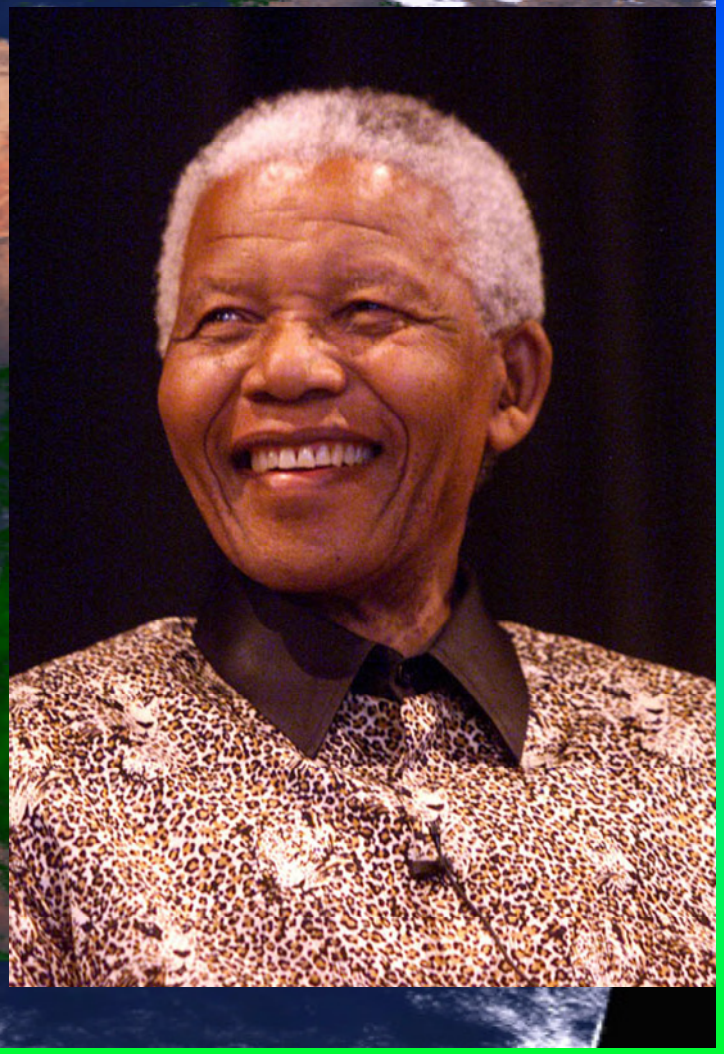
1995 2000 2010 2020

Sustainable Development

WHY?
COUPLING SCIENCES, MANAGEMENT AND HUMAN DEVELOPMENT GOALS

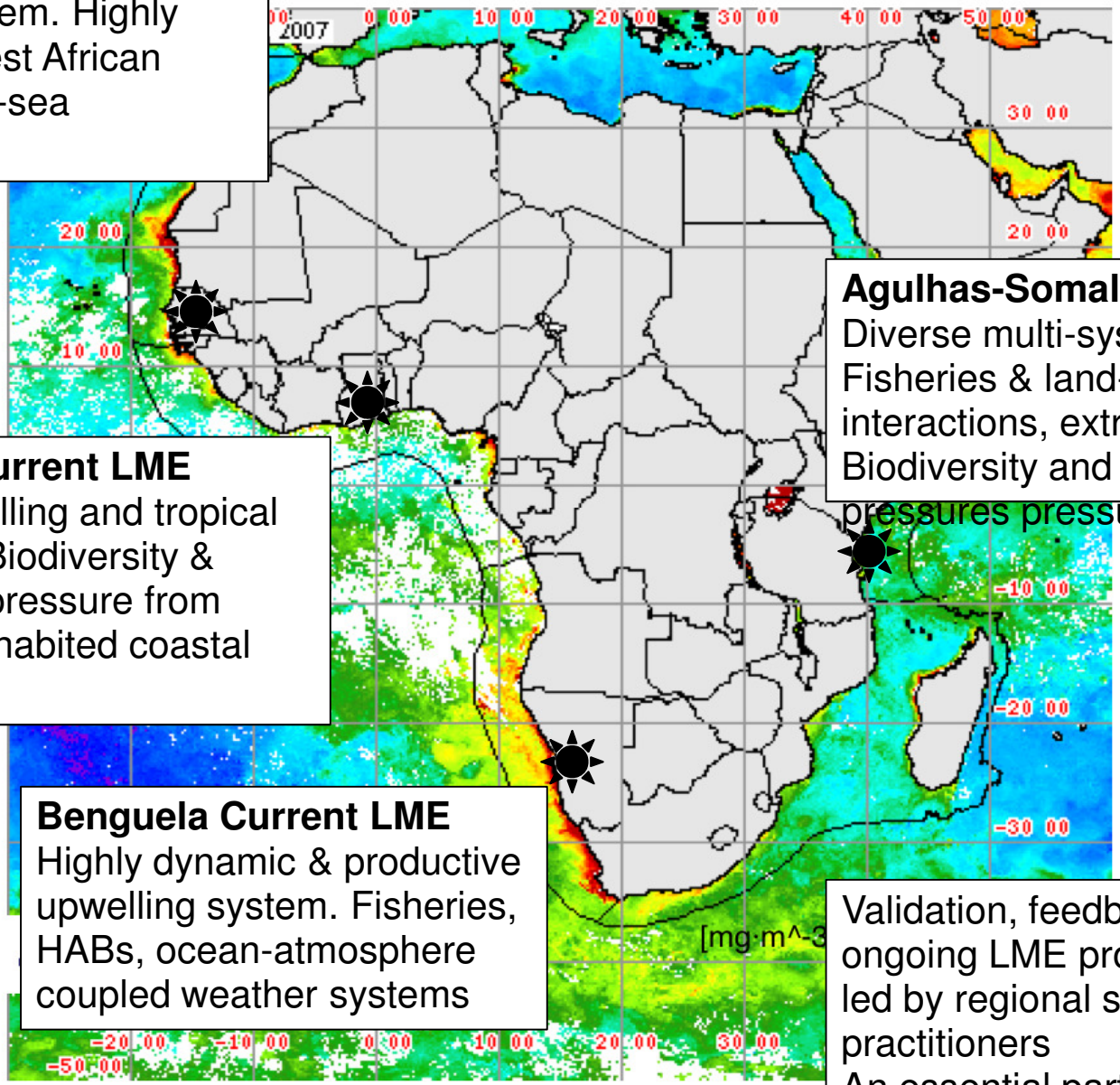
Cape Town Conference in 1998: Political and Legal Framework:

"Africa 's long and beautiful coasts and the abundance of marine resources can contribute to improve economic, food and environmental security for the continent. These coastal and marine resources, like the rest of Africa 's environmental resources, continue to be exploited in a manner that does not benefit AFRICA and her PEOPLE. This is a paradox of a people dying from hunger, starvation and poverty when they are potentially so rich and well endowed".



African Large Marine Ecosystems

Canary Current LME
Major boundary-current upwelling system. Highly productive West African fisheries, land-sea interaction



Agulhas-Somali Current LME
Diverse multi-system LME. Fisheries & land-sea interactions, extreme events. Biodiversity and fisheries pressures pressure

Guinea Current LME
Both upwelling and tropical systems. Biodiversity & fisheries, pressure from densely inhabited coastal zone

Benguela Current LME
Highly dynamic & productive upwelling system. Fisheries, HABs, ocean-atmosphere coupled weather systems

Validation, feedback with ongoing LME project practices led by regional scientists and practitioners
An essential part of the process

Africa provides valuable comparative LMEs

- Canary Current
- Benguela Current
- Guinea Current
- Agulhas Current
- Somali Current
- California Current
- California Current
- Gulf of Mexico
- Southeast US
- Caribbean U.S. (coral reefs)

African Countries in ICATT

South Africa, Ghana, Morocco, Cote D'Ivoire, Angola, Gabon, Cape Verde, Sao Tome & Principe, Guinea Equatorial, Guinea, Libya, Tunisia, Namibia, Senegal,, Nigeria, Egypt, Sierra Leon, Mauritania-former member Benin

40% of members

What makes LMEs dev. projects different?

- Right scale
- Five module strategy ensures ecosystem approach
- Provides a framework for nesting smaller area based projects within a larger context
- Designed to produce a management process regionally controlled and funded by the countries obtaining aid funds for projects directly and not through intermediaries

Progress towards Governance Goal

- Benguela Interim Commission implementation phase
- Agulhas – Somali LMEs – have hired a senior African marine scientist and policy advisor as leader of governance effort
- Canary just starting but has links to the Sub-Regional Fisheries Commission

Progress towards Governance Goal cont.

- Guinea Current LME signed IGCC
- Accra Declaration
- Abuja Declaration
- Osu Declaration

GOG LME
Newsletter
April - October 1998 Number 9

BENIN CAMEROUN CÔTE D'IVOIRE GHANA NIGERIA TOGO

UNIDO/ONUDI UNDP/PNUD NOAA/NOAA UNPE/PNUE

GDG GEM
Bulletin d'Information
avril - octobre 1998 Numéro

Visit our Website: http://www.africaonline.co.ci/AfricaOnline/societies/gogime/gogime.html

FROM THE REGIONAL COORDINATOR

BENIN

SE M. Sylvain AKINDES
Ministre de l'Environnnement et de l'habitat

CAMEROUN

SE Mr. sylvestre NAAH ONDOA
Ministre de l'Environnnement et des Forêts

COTE D'IVOIRE

SE M. Albert KAKOU TIAPANI
Ministre du Logement, du Cadre de vie et de l'Environnement

Yes, all six of them - the Ministers of Environment from Benin, Cameroon, Côte d'Ivoire, Ghana and Togo and the Director General / Chief Executive of the Federal Environmental Protection Agency of Nigeria - came to Accra for the first meeting of the Committee of Ministers of the Project, 9 - 10 July 1998.

The Vice-President of Ghana, His Excellency Prof. J.E. Mills who represented the Head of State, His Excellency Flt. Lt. Jerry John Rawlings (who was out of the country) set the stage with an inspiring speech that challenged the collective will to revolutionise old attitudes and to institutionalise new approaches.

The Ministers reacted appropriately and in two days, hammered out the ACCRA DECLARATION and thus put the GOG-LME region on a solid path to environmentally sustainable development.

Earlier in May, the US Deputy Secretary for Commerce, Mr. Robert Mallet, came calling in Abidjan and planted a mangrove seedling in the Bay of Cocody as one step in a giant campaign to clean up the pollution in the bay of Cocody and restore its previous allure.

All these and more are reported in this issue of the Newsletter.

GHANA

HE Mr. J.E. Atful
Minister of Environment, Scie and Technology (Host/Hôt

NIGERIA

Dr. Adewoye Raphael
Director General / Chief Exec Federal Environment Protecti Agency

TOGO

SE M. Koffi Sany Santy Adac
Ministre de l'Environnement des Productions Forestière

MOT DU COORDONNATEUR REGIONAL

Oui, tous les six Ministres de l'environnement, du Bénin, du Cameroun, de la Côte d'Ivoire, du Ghana et du Togo, le Directeur Général/chef Exécutif de l'Agence Fédérale pour la Protection Environnementale du Nigeria sont venus à Accra pour la première réunion du Comité des Ministres du Projet du 9 au 10 Juillet 1998.

Le Vice-Président du Ghana, son Excellence le Professeur J.E.A. Mills qui représentait le chef de l'Etat, son Excellence Flt. Lt. Jerry John Rawings (qui se trouvait hors du pays) entra en scène avec un discours très suggestif qui interpellait la volonté collective en l'invitant à rejeter les anciennes attitudes et à institutionnaliser de nouvelles approches.

Les Ministres réagirent comme il fallait et en deux jours martelèrent la Déclaration d'Accra et mirent ainsi la région du GEM-GDG sur un chemin sûr vers un développement environnemental durable.

Plus tôt, au mois de Mai, le Secrétaire d'Etat Américain du Commerce, M. Robert Mallett, est venu en visite à Abidjan et a planté une propagule de mangrove dans la Baie de Cocody comme un pas vers une immense campagne de nettoyage de la pollution de la Baie de Cocody et pour lui rendre son allure d'antan.

Ce sont tous ces faits et bien plus encore qui sont relatés dans ce numéro du Bulletin.

OUR GOAL: RESTORE AND SUSTAIN THE HEALTH OF THE GULF OF GUINEA INCLUDING ITS BIODIVERSITY

UNIDO

HE Carlos MAGARINOS
UNIDO
Director-General

NOTRE BUT: RESTAURER ET MAINTENIR LA SANTE DU GOLFE DE GUINEE Y COMPRIS LA BIODIVERSITE

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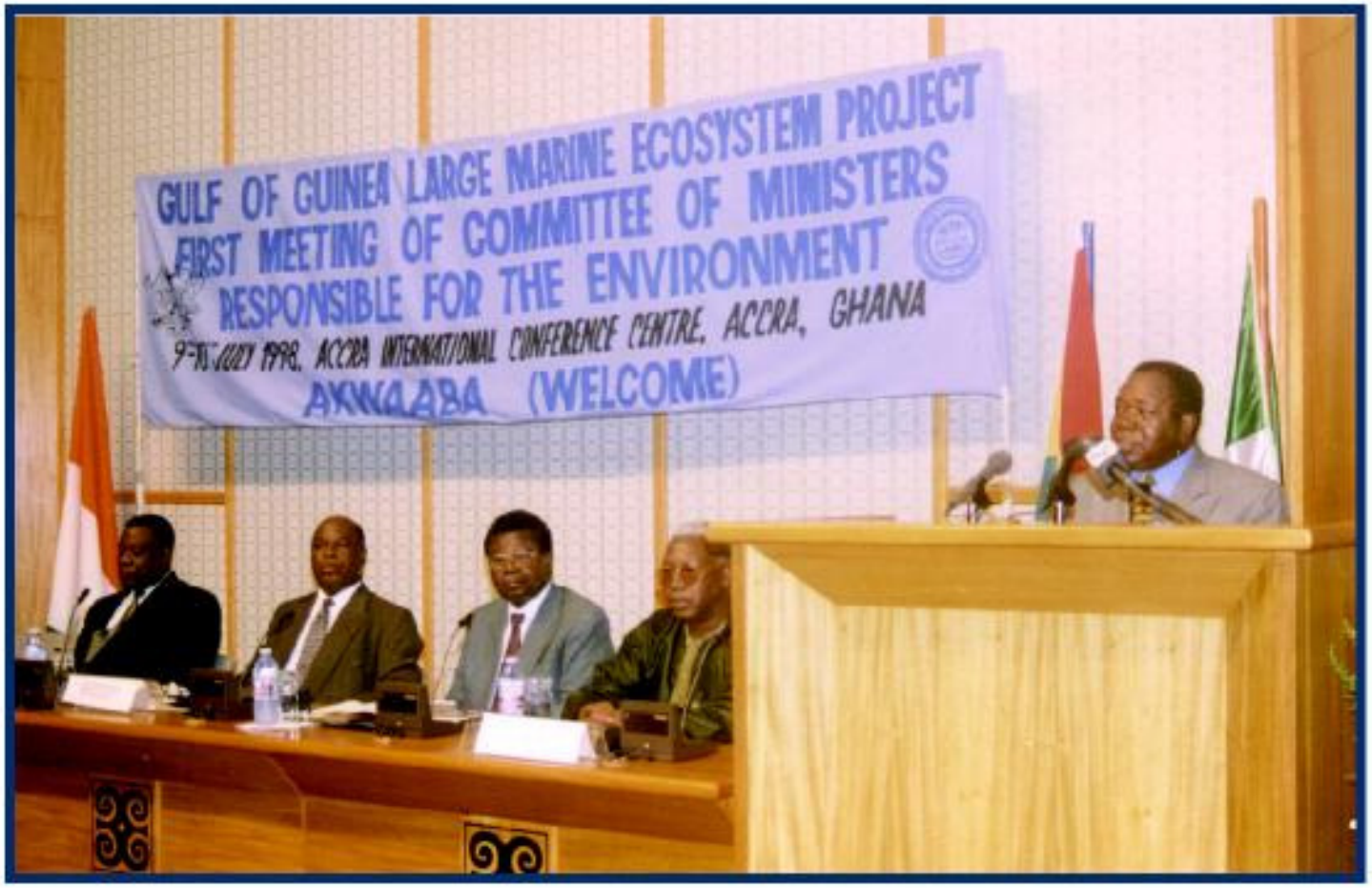

Management plans and strategies should balance economic development with environmental protection and conservation concerns" (Accra Declaration, 1998).

OBSTACLES

- Difficult to move from dependency to independence especially when resources are scarce and much of budget depends on donors
- Donor agencies and agencies that manage donor money may fear failures if management moves to independent country driven and core funded structures and the country support falters.

"AFRICAN RENAISSANCE"

OUR FIRST TASK THEREFORE IS TO TRANSFORM OUR SOCIETY CONSISTENT WITH THIS VISION. OUR SECOND TASK IS TO JOIN HANDS WITH ALL OTHER LIKE MINDED FORCES ON OUR CONTINENT, CONVINCED THAT THE PEOPLES OF AFRICA SHARE A COMMON DESTINY, CONVINCED ALSO THAT PEOPLE OF GOODWILL THROUGHOUT THE WORLD WILL JOIN US IN THE SUSTAINED OFFENSIVE WHICH MUST RESULT IN THE NEW CENTURY GOING DOWN IN HISTORY AS THE AFRICAN CENTURY.

YESTERDAY IS A FOREIGN COUNTY - TOMORROW BELONGS TO US!

THABO MBEKI

LME APPROACH TO INTEGRATED COASTAL MANAGEMENT

PART OF THE AFRICAN RENAISSANCE