LARGE MARINE ECOSYSTEM APPROACH

BRAD BROWN
IOCEA
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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

Large Marine Ecosystems of the World with Linked Watersheds

1. East Bering Sea
2. Gulf of Alaska
3. California Current
4. Gulf of California
5. Gulf of Mexico
6. Southwest U.S. Continental Shelf
7. Northeast U.S. Continental Shelf
8. Scotian Shelf
9. Newfoundland-Labrador Shelf
10. North Pacific Herring
11. Pacific Central American
12. Central American
13. Humboldt Current
14. Pelagic Current
15. South Shetland Shelf
16. East Brazil Shelf
17. North Brazil Shelf
18. West-Central Shelf
19. East-Central Shelf
20. Bantry Bight
21. Norwegian Shelf
22. North Sea
23. Baltic Sea
24. Canaries-Canary Shelf
25. British Coastal
26. Mediterranean
27. Canary Current
28. Georgia Current
29. Benguela Current
30. Agulhas Current
31. Namib Coastal Current
32. Arabian Sea
33. Red Sea
34. Bay of Bengal
35. Gulf of Thailand
36. South China Sea
37. Solu-Cambria Sea
38. Indonesian Sea
39. North Australia
40. Northeast Australia
41. Southeast Australia
42. Southwest Australia
43. West-Central Australia
44. Northwest Australia
45. New Zealand Shelf
46. East China Sea
47. Yellow Sea
48. Yellow Sea
49. Kuroshio Current
50. Sea of Japan
51. Oyashio Current
52. Sea of Okhotsk
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
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
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
Support LME Restoration and Sustainable Development

- **Productivity Module Indicator**
  - Photosynthetic activity
  - Zooplankton biodiversity
  - Oceanographic variability

- **Socioeconomic Module Indicator**
  - Integrated assessments
  - Human forcing
  - Sustainability of long-term socioeconomic benefits

- **Pollution & Ecosystem Health Module Indicator**
  - Eutrophication
  - Biotoxins
  - Pathology
  - Emerging disease
  - Health indices

- **Fish & Fisheries Module Indicator**
  - Biodiversity
  - Finfish
  - Shellfish
  - Demersal species
  - Pelagic species

- **Governance Module Indicator**
  - Stakeholder participation
  - Adaptive management
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.
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

For each LME…

• Mean annual trophic levels of fish catches and FiB
• Fisheries conditions relative to stock conditions (developing, fully exploited, over exploited, collapsed)

Daniel Pauly, Villy Christensen, Sea Around Us
South China Sea Stock Status
(Sea Around Us Project 2007)
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
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).
Socio-Economic Development and Marine Activity
SST Net Warming in Large Marine Ecosystems, 1982-2006

- Slow LME
- Moderate LME
- Fast LME
- Super-Fast LME
- Global SST (IPCC-2007; 1979-2005)
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).
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.
GEF International Waters Operational Strategy

Supports New Paradigm

• Ecosystem-based LME Restoration Actions

• TDA/SAP Priority Actions
Component 1:

Multi-country process and frameworks for understanding and addressing priority transboundary concerns
Component 2:

Strengthened policies and management, based on improved knowledge and demonstration actions, to address priority transboundary concerns on declining marine living resources of the CCLME.
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Component 3

Strengthened knowledge, capacity and policy base for transboundary assessment and management of habitat, biodiversity and water quality critical to fisheries
Component 3
Demonstration Activities

• Demonstration of Marine Protected Areas (MPAs) as tools for multiple-resource management benefits

• Development of a regional mangrove conservation plan with pilot mangrove restoration actions
Management

• The GEF Agencies for the CCLME project are FAO and UNEP
• FAO is responsible for overall implementation and for executing components 1 and 2 of the project as well as parts of Component 3
• UNEP is the main responsible agency for Component 3
Implementation (1)

• Expect to have the coordinator operational within the next few weeks
• Sweden has generously seconded one officer to the project (initially for a period of one year) and the successful candidate, Birgitta Liss Lymer, took up her post as the Marine and Coastal Management Officer of the CCLME in February. She is currently in Rome
Implementation (2)

• The Director of Fisheries of Senegal has kindly offered the CLME project temporary space at their premises