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Report of the Meeting of the *ad hoc* Committee on Large Marine Ecosystems

22-23 March 1991
UNESCO Headquarters
Paris, France

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INTRODUCTION

The first meeting of the *ad hoc* Committee on Large Marine Ecosystems was held on 22 March 1991 at the Paris headquarters of the United Nations Educational, Scientific, and Cultural Organization (UNESCO). The meeting was hosted by UNESCO's Intergovernmental Oceanographic Commission (IOC) and welcomed by Dr. Klaus Voight. The agenda and list of participants are given in Appendix A. The terms of reference for the committee, as set forth in the report of the Conference on the Large Marine Ecosystem (LME) Concept and Its Application to Regional Marine Resource Management (held during 1-6 October 1990 in Monaco) were reviewed and served as a basis for the meeting agenda. Among the major topics for which decisions were made were:

1. provisional designating of LMEs around the globe,
2. monitoring of LMEs,
3. modeling, and
4. holding regional workshops and conducting comparative LME studies.

THE LME CONCEPT

The LME concept was reviewed. On the basis of U.N. Food and Agriculture Organization (FAO) statistics, it was noted that 95 percent of the global fisheries biomass yields are produced in 49 provisionally identified LMEs. It was further emphasized that the LME is an ecologically defined unit of ocean space that is considered useful for ocean research, monitoring, and management. On a global basis, LMEs are defined as natural systems, thereby avoiding artificial definitions of regional space such as 200-mile exclusive economic zones (EEZ), or of geopolitical space such as those used by the United Nations Environment Program's (UNEP) regional seas programs.

Within LMEs, it is possible to identify the principal driving forces of changing ecosystem states, whether they be, for example, pollution, fishing, or climate change. It is also possible to pursue scientific understanding of such systems through a comparative method. Where LMEs overlap political jurisdictions, it is in the self-interest of states to work together to develop joint monitoring efforts and compatible management strategies.

IDENTIFICATION OF LMEs

A working paper by Dr. Lewis Alexander of the University of Rhode Island, describing the criteria used to designate the boundaries of the regional LMEs, was tabled and discussed (Appendix B). The provisional designation of provisional regional LMEs will require relatively minor adjustments to boundaries based on the meeting discussions. For example, Dr. Doumenge, Chairman of the International Commission for the Scientific Exploration of the Mediterranean Sea (ICSEM), indicated that the Mediterranean Sea-Atlantic Ocean boundary was located within the Mediterranean Sea approximately 200 miles east of the Straits of Gibraltar in the vicinity of the Alboran front off western Algeria. He was also concerned with the placement of the boundaries of the Celtic-Biscay Shelf Ecosystem, and suggested that the Kuroshio Current and Oyashio Current Ecosystems be extended several hundred miles to the east. Dr. John Pope of the United Kingdom's Ministry of Agriculture, Fisheries, and Food, representing the International Council for the Exploration of the Sea (ICES), suggested that the boundaries of the North Sea varied depending on the objective of the research and monitoring effort, with different perspectives among physical, chemical, and biological/fisheries interests. However, the boundaries as depicted on the provisional map were adequate for initial discussions.

Dr. Voight of the IOC suggested that we include open-ocean pelagic systems as part of the LME concept. In this regard, the committee asked Dr. Annelies Pierrot-Bults, Chairperson of the IOC's Scientific Committee on Ocean Research's (SCOR) Working Group (WG) 93 on Pelagic Biogeography, for her opinion. Dr. Pierrot-Bults indicated that the LME regions were, in general, not inconsistent with the provisional designation of biogeographic zones under consideration by SCOR WG 93, and in fact, could be considered as complementary ecosystems around the margins of the Atlantic, Pacific, and Indian Oceans. Dr. Doumenge suggested that WG 93 should consider plate tectonics in the designations of LMEs in the Southwest Pacific. A recent paper in *Nature* suggests that biogeochemical provinces of the pelagic ecosystem could provide boundaries for open-ocean LMEs.[1]

Following discussion of the provisional LME map, it was agreed that the map was important and provided the needed initial designation of LMEs for guiding research, monitoring, and management, and that it should be reviewed by regional experts over the next several months. As part of the review process, Dr. Alexander will make a presentation based on the map to the International Council of Scientific Union's (ICSU) International Association of Marine Geographers (IAMG) at the annual meeting during 22-24 May in Seville, Spain. Dr. Sherman will review the LME concept and provisional map with scientists of the Mediterranean Seas area in an invited presentation scheduled for 22-27 September in Genoa, Italy, at the "Mediterranean Seas 2000" symposium.

Other possibilities for regional reviews of the map include an IOC-sponsored meeting planned to be held in Kenya 9-13 August 1992 to review the LMEs of the Indian Ocean, and the International Conference on Ocean Management in Global Change during June 1992 in Genoa, Italy. In addition to the representatives of IOC, UNEP, ICES, and ICSEM in attendance, the map will also be discussed under less formal conditions with representatives of FAO, UNEP, The World Conservation Union (IUCN), ICES, the Nordic

[1] Platt, T.; Sathyendranath, S.; Ulloa, O.; Harrison, W.G.; Hoepffner, N.; Goes, J. 1992. Nutrient control of phytoplankton photosynthesis in the western North Atlantic. *Nature* 356: 229-231.

Council, the European Economic Community (EEC), and other regional ocean research organizations to obtain their comments on the regional LME designations.

IMPROVING THE LME APPROACH/ MONITORING

The next order of business, based on the Monaco report, was identifying ways of improving our ability to monitor the changing states and "health" of LMEs. Dr. Robert Williams of the United Kingdom's Natural Environment Research Council's Plymouth Marine Laboratory, discussed its relatively-low-cost data collection system, the continuous plankton recorder (CPR), and its technologically advanced follow-on system, the undulating oceanographic recorder (UOR). Dr. Williams pointed out that when the CPR system was initiated in 1939, its originator, Dr. Alister Hardy, likened it to the global meteorological monitoring system upon which we now base much of what we know about global climate change.

The UOR system can monitor up to 18 oceanographic parameters, and requires minimal technical training to operate. Moreover, due to its relatively low operational costs when deployed from ships of opportunity, it has the potential of providing a long-term, oceanographic data set for most, if not all, of the world's LMEs. As such, it is a good candidate for funding through the newly created global environmental facility administered by The World Bank, together with UNEP and the United Nations Development Program.

LME MONITORING

Following a presentation by Dr. Williams on the utility of the CPR and UOR as a means for monitoring bioenvironmental conditions within LMEs, the committee endorsed the new series of CPR systems instrumented with sensors for nitrate/nitrite, temperature, salinity, light, petrogenic hydrocarbons, chlorophyll, primary productivity, bioluminescence, large phytoplankton cells, and zooplankton as being most useful as a means for monitoring changes in the levels of nutrient loadings, water quality, water column and frontal structure, phytoplankton species diversity and biomass, and zooplankton community dynamics in LMEs. The use of CPRs in this regard would be consistent with: (1) the recommendations of the UNEP-IOC-World Meteorological Organization Group of Experts on the Long-Term Monitoring System of Coastal and Near-Shore Phenomena Related to Climate Change[2]; (2) the report of the Workshop on Oceanographic Data and Training Needs for the LME Approach to Fishery Management (Appendix C); and (3) the Workshop on LME Monitoring held in July 1991 at Cornell University in Ithaca, New York.

At present, the standard CPR is being used on transects that monitor changes in several LMEs, including the North Sea and the Northeast U.S. Continental Shelf. Extensions are planned for 1991-92 to transect the Celtic-Biscay Shelf Ecosystem, the Iberian Shelf Ecosystem, and several subsystems of the Mediterranean Sea Ecosystem. Proposals to support the extensions have been made to the EEC by Dr. Williams. The possibilities of establishing a CPR operation and processing center in Italy and Greece for Mediterranean samples are being considered by committee members Dr. Vagn Hansen of the EEC and Danish Marine Fisheries Institute in Hirtshals, Dr. A. Boussoulengas of the IOC in Paris, and Dr. R. Williams.

To augment the plankton monitoring component, it was suggested by Dr. Pope that consideration be given to the inclusion of a bottom trawl and/or midwater trawl and acoustics survey of demersal and pelagic fish stocks as part of the long-term LME monitoring strategy. The survey would provide a means for obtaining time-series measurements of changes in fish communities, while serving as a source of fish samples to study multispecies interactions and environmental effects on fish demographics, and to conduct pathological examinations related to possible effects of pollution on fish populations. Such a survey can be conducted by using small commercial trawlers from which oceanographic and plankton measurements can be made simultaneously. Dr. Pope cited the excellent time series of fisheries data collected by the government of Thailand using small chartered trawlers as an example of the great utility of several decades of time-series data.

The committee considered LME monitoring strategies that would be suitable for implementation by developing nations. It was agreed that a monitoring strategy designed around minimal requirements for indexing primary production, plankton, fish, selected levels of pollution, and environmental parameters would be appropriate. It was agreed that initially the sampling strategy be built around readily transferable technology aimed at measuring long-term changes in the productivity and biomass yields of LMEs. Low-cost monitoring could be initiated using: (1) CPRs from ships of opportunity, and (2) trawling methods with chartered vessels that would serve as platforms for simultaneous collections of plankton and oceanographic measurements. Atmospheric observations bearing on weather and climate change would be included in the initial monitoring effort by using standard, internationally approved log forms.

Both the CPR/UOR and fish sampling strategies were endorsed by the participants at the Large Marine Ecosystem Monitoring Workshop held in July 1991 at Cornell University in Ithaca, New York.[3]

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[2] Intergovernmental Oceanographic Commission. 1990. Global ocean observing system status report on existing ocean elements and related systems. Intergovernmental Oceanographic Commission and World Meteorological Organization Report IOC/INF-833, SC-91/WS-4. Available from: Intergovernmental Oceanographic Commission, Paris, France.

[3] Sherman, K.; Laughlin, T., eds. [1992.] Large Marine Ecosystems Monitoring Workshop report, Cornell University, 13-14 July 1991, Cornell University, Ithaca, New York. NOAA Technical Memorandum NMFS-F/NEC-93, in press. Available from: National Marine Fisheries Service, Narragansett, RI.

GLOBAL OCEAN OBSERVING SYSTEM

Muriel Cole described a resolution adopted by the just-completed IOC General Assembly describing a global ocean observing system. One component of this system is to focus on coastal areas. This component will be designed not only to identify the effects of global climate change on regions of the ocean, but also to "monitor and predict anthropogenic environmental change in the ocean and atmosphere involving a number of physical, chemical, and biological processes...." It was agreed that a logical unit within which regional monitoring systems could be elaborated is the LME. As a follow-on to this suggestion, a presentation to the IOC Executive Council was made in March 1992.[4] The IOC resolution has been referred to the U.N. Conference on Environment and Development (UNCED) for consideration.

MANAGEMENT

The report of the Monaco meeting recommended consideration of establishment of a working group to examine ways in which the LME concept could be made useful to ocean managers. The present group's discussion focussed instead on other means of pursuing the management implications of LMEs.

It was pointed out that one important management problem to which the LME approach would apply is the need to integrate consideration of artisanal and offshore fisheries, currently treated separately by international institutions such as FAO. An opportunity for raising this issue is presented by UNCED.

Increased international attention in regard to the environmental effects of fisheries, for example the effect of bottom trawls on benthic communities and gill nets on bird populations and marine mammals, was identified as another area in which the LME approach could contribute.

The fisheries implications of the LME approach were thought to be most important to developing countries because of the obvious near-term economic implications of fisheries development and long-term sustainability. The narrow focus of fisheries management and the exclusion of commercial fisheries issues from UNEP regional seas programs were thought to be issues which also might be addressed through an ecosystemic approach.

Technology transfer and training would be an important component of a global LME management effort.

There was a general view that the international marine system remains rather sectoral with FAO focused on fish and UNEP on pollution, with the U.N. system not yet prepared to fully adopt an ecosystem approach to marine resource management, although the recent rise in multiagency international programs is promising. The LME is a unifying concept which would help bridge existing gaps in linking science to management. However, the nature of the international system is such that the LME idea will need to be supported by member governments at relevant international meetings if the concept is to become practice.

One existing mechanism for integration is the Ecosystem Conservation Group, which includes FAO, UNEP, UNESCO, IOC, and IUCN. In short, the best means of drawing international attention to the implications of the LME approach for science and management would be publication of papers describing the science and management implications of LMEs and bearing multinational sponsorship. Such a paper should have several examples of the successful application of the LME approach in developing countries.

REGIONAL WORKSHOP CONCEPT

The committee was briefed by Dr. Alheit of POLARMAR in Bremerhaven, Germany, on the substance of the discussions leading to the recommendations made in Monaco for convening a series of regional workshops to focus on the application of the LME concept to fisheries, habitat, and pollution problems (see Appendix C). He indicated that the interest in the LME concept was growing among fisheries research organizations, particularly in developing countries. Other committee members agreed, but emphasized the desirability to extend the framework of LME studies to encompass research, management, and monitoring of marine habitats in the coastal zone, wetlands, and estuaries. Consensus was reached on a strategy for linking inshore-offshore research, monitoring, and modeling efforts through a focus on the problem of seaward extensions of coastal pollutants and eutrophication related to increased nutrient loadings, and to the impact of elevated productivity levels on the entire ecosystem. Other issues of merit to be addressed include the impact of offshore fisheries on artisanal fisheries, and the apparent stresses on coral reefs and mangroves within tropical ecosystems. Dr. Arthur Dahl of UNEP indicated that the inshore-offshore linkage approach to ecosystem productivity was consistent with UNEP's research and monitoring strategy.

With regard to specific regional efforts in LME research for 1991 and 1992, the committee was pleased to take note of the first announcement of an International Symposium and Workshop on the Status and Future of Large Marine Ecosystems of the Indian Ocean scheduled for Mombasa, Kenya, during 2-7 August 1992 as a first effort of the Kenya Marine Fisheries Research Institute (KMFRI), the Kenyan-Belgian Project, and UNEP's Regional Dispatch Center (Appendix D). Dr. E. Okemwa, Director of the KMFRI, is organizing the meeting. It was agreed that Dr. Arthur Dahl should contact Dr. Okemwa upon his return to Nairobi to ascertain whether, and if so in what form, the assistance of the *ad hoc* Committee is desired. Possible forms of assis-

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[4] Sherman, K. 1992. The use of large marine ecosystem concept in the global ocean observing system (GOOS). Paper presented at: Intergovernmental Oceanographic Commission Executive Committee Meeting XXV/7; 10 March; Paris, France. English only. Available from: National Marine Fisheries Service, Narragansett, RI.

tance include: presentations by LME experts, assistance in bringing developing country participants to the meeting, and presentations on appropriate monitoring technology such as the CPR or the use of small boats for monitoring purposes.

Dr. Dwivedi of India has proposed to hold an LME conference on the Bay of Bengal Ecosystem. At the last minute, Dr. Dwivedi, who was to attend the *ad hoc* meeting, was forced to cancel. Therefore, little planning progress could be made. Dr. Dwivedi indicated that he was continuing to explore the possibilities with his government for convening the meeting. This proposal was heartily endorsed by the committee. Dr. Doumenge indicated that it was most opportune that India was considering a meeting at this time as the purse seine fleets of several countries were now operating in the Southwest Indian Ocean, thereby providing a good data base for studies of biomass yields in the Southwest Indian Ocean in the region of the Seychelles, Chagos, and Maldives Islands.

The committee recommended that Dr. Dwivedi be contacted as soon as possible for information on the status of planning of the Bay of Bengal Ecosystem symposium from the Indian side. As the timeframe for organizing the meeting during 1992 is narrowing, consideration should be given to slip the dates of the conference to follow the Mombasa and Oman meetings.

Dr. Alheit informed the committee that The Netherlands and Germany are planning expeditions to the Indian Ocean during 1994-95. ICSEM is planning a meeting in Trieste, Italy, for January 1992 to compare the Black Sea and Adriatic Sea Ecosystems. Dr. Hansen indicated that Denmark planned an expedition around the Andaman Sea Ecosystem in the eastern Indian Ocean during 1992. Dr. Elder indicated that IUCN would be willing to support attendance at regional LME meetings. Other regional meetings pertinent to LMEs are planned for the IOC's Ocean Science and Living Resources (OSLR) Program for comparisons of clupeoid recruitment among the Humboldt Current Ecosystem, Patagonian Shelf Ecosystem, and the California Current Ecosystem. Dr. Pope indicated that the ICES Multispecies Working Group plans to review multispecies models of the Gulf of Alaska and Norwegian Shelf Ecosystems in September in La Rochelle, France.

TWINNING

One concept identified in Monaco as a means of pursuing the LME approach, while at the same time providing technical assistance and training in LME monitoring strategies, was a coupling between developing- and developed-countries' marine institutions. Dr. Alheit pointed out that this approach is working very well in the case of a joint arrangement between Belgium and Kenya.

Dr. Doumenge suggested that upcoming ICSEM meetings could provide an opportunity for discussion of twinning institutions for monitoring the changing states and health of the Black Sea Ecosystem.

Several other opportunities for twinning, based on distinct types of LMEs, include the North Sea/Yellow Sea Ecosystems and the California Current/Humboldt Current Ecosystems.

In summary, the comparative monitoring approach was endorsed by the committee as a valid scientific effort for advancing understanding of causes of changes in the states or health of LMEs.

IUCN

Dr. Elder indicated that the IUCN's Commission on Ecology was being reorganized under the new chairmanship of Dr. Doumenge. The commission will include among its themes of marine and coastal programs, the LME strategy for research and monitoring to encourage actions leading to long-term sustainability of living marine resources. An important change is a new focus on LMEs as an organizing principle for the commission. Thus, the commission will have 12 members, one from each of 12 regions. The focus and function of these members will be on LMEs within their regions. This change will be valuable in developing the LME concept because of both the substantive focus and result in regional networks of expertise which can be brought to bear in discussion of the concept worldwide. Dr. Doumenge will be organizing experts on LMEs for 12 regions of the globe. In each region a leading expert would be supported by 10-20 associate experts on particular LMEs.

UNEP REGIONAL SEAS

Dr. Arthur Dahl indicated interest on the part of UNEP to assist countries interested in adopting the LME approach in research, monitoring, and management of living marine resources and their habitats. Dr. Dahl reported that the regional seas secretariat staff supports the LME approach and has been active in discussing it with representatives of member states. However, he emphasized that to assure that the approach is fully vetted and incorporated in the UNEP agenda, member states will have to emphasize this approach at UNEP meetings. The next opportunity to do this is at the annual meeting of the Governing Council of UNEP.

GENERAL LME WORKSHOPS

In addition to regional conferences and symposia, as proposed by India and Kenya, the Monaco meeting recommended a set of workshops aimed at translating the LME concept into operational specifics. For example, such a workshop could introduce participants of developing countries to the types of data needed for monitoring the changing states or "health" of LMEs and the methods for data collection and aggregation.

After such a workshop, developing-country participants would spend several months receiving training in monitoring methods and in applying these techniques. This would ensure a series of regional followup workshops aimed at making the use of the concept an operational reality. It was agreed that the Kenya and India regional workshops might be opportunities to test on a pilot basis this approach.

ACTION ITEMS[5]

1. **LME Provisional Map:** Drs. Alexander and Sherman will conduct reviews of the map with regional experts. Dr. Alexander will be making a presentation on the area designations of LMEs at meetings and workshops of the IAMG. They will be discussing the map **during regional scientific meetings** dealing with the Mediterranean, Baltic, Northeast Atlantic, and western Indian Ocean.

2. **Monitoring, Modeling, and Theory of LMEs:** The consensus reached by the committee for pursuing the implementation of a relatively low-cost, high-yield system consisting of deployment of instrumented continuous plankton and environmental recorders, and of small trawlers from which to conduct surveys of fisheries stocks and oceanography, will be discussed at upcoming multilateral regional and bilateral regional meetings. Workshops on LME theory, modeling, and monitoring will be held during the summers of 1991 and 1992 at Cornell University. Topics for discussion will include strategies for monitoring the "health" of LMEs and methods for comparing the relative health among LMEs as suggested by Dr. Pope.

3. **Management Group:** No consensus was reached on the immediate formation of a management group. The committee endorsed the strategy for incorporating the LME concept in multilateral agreements and conferences including the UNCED scheduled for 1992 in Brazil. The committee also agreed that it was important to pursue the means for greater integration of the LME approach into the international marine scientific and management communities. In this regard, Tom Laughlin will explore developing a multilateral approach to LMEs that can be presented to the next UNCED preparatory meeting.

4. **Kenya LME Meeting:** The Kenya meeting on LMEs scheduled for Mombassa in August 1992 should be supported.

5. **GLOBEC:** Efforts should be made to develop closer links between the implementation of LME monitoring strategies and the Global Ocean Ecosystems Dynamics Program and Joint Global Ocean Flux Study process-oriented studies and theory development, model building, and testing.

6. **Indian Proposal:** The present status should be determined of the proposal for a conference and workshop on the Bay of Bengal Ecosystem on the Indian side. Contingent on the answer, it may be necessary to delay the conference until 1993.

7. **Other Twinning Possibilities:** Dr. Doumenge will explore the possibility of twinning at the upcoming ICSEM meeting.

8. **General LME Meetings:** General LME workshops on a 3-6 year schedule should be organized to improve understanding of how LMEs can be efficiently monitored with the objective of comparing their changing states of "health" in relation to stress, sustainability, and mitigation. Dr. Alheit will explore the possibility of using the Kenya meeting as a pilot test for the "general" LME workshop approach.

   Provide opportunities to develop and implement research and monitoring strategies, particularly among developing countries.

9. **Monitoring:** Global monitoring of regional LMEs should be strengthened.

   Funding should be explored for extensions of CPR "routes" and for organization of regional sample-processing centers. Representatives of The World Bank and other international organizations should be met with to explore the potential for implementing CPR routes that cross the LMEs in the Mediterranean Sea, the Indian Ocean, the South China Sea, and the East and West Coasts of Africa.

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[5] Prepared by T. Laughlin and K. Sherman on 11 April 1991.

APPENDIX A

AD HOC COMMITTEE ON LARGE MARINE ECOSYSTEMS MEETING AGENDA AND ATTENDEES

AGENDA

Topic	Speaker
22 March 1991	
Introduction/Greeting	G. Kullenberg
Review of Recommendations from Monaco -- Round Table Discussion on Implementation of Recommendations and Functions of Committee	Discussants: T. Laughlin, K. Sherman, D. Elder, and participants
Relevance of LMEs to Regions Supporting 95 Percent of Global Fisheries Biomass Yields and Improvements to Statistical Base for Potential and Actual Fishery Yields of LMEs	Discussants: K. Sherman and participants
Action Items Related to Terms of Reference for the Committee	
1. Identification of LMEs	K. Sherman and participants
2. Establishment of a Working Group of Scientists to Examine Research, Monitoring, and Modeling Needs	
a. Monitoring of Changing Ecological States of LMEs	R. Williams, K. Sherman, and participants
b. Modeling Review	
3. Establishment of a Working Group to Examine Ways and Means to Apply the LME Approach to Management	D. Elder, T. Laughlin, and participants
23 March 1991	
4. Regional Workshop Concept	
a. Indian Proposal for a Focus on the Bay of Bengal Ecosystem	S.N. Dwivedi, J. Alheit, and participants
b. Potential for Candidate LME Twinning Studies (*e.g.*, Baltic, Adriatic, & Black Sea Ecosystems, Northeast U.S. Shelf, North Sea, & Yellow Sea Ecosystems; California Current, Humboldt Current, Benguela Current, & Patagonian Shelf Ecosystems; Gulf of Mexico & Bay of Bengal Ecosystems	S.N. Dwivedi, J. Alheit, J. Caddy, F. Doumenge, K. Vagn Hansen, J. Pope and participants
c. Comparative LME Studies from IUCN Regional Perspective	D. Elder and participants
d. Comparative LME Studies from UNEP Regional Perspective	A. Dahl and participants
5. General LME Workshops	J. Alheit and participants
6. International Conferences on State of the Ocean	G. Kullenberg and participants
a. UNCED	T. Laughlin and participants
b. Other	

ATTENDEES

Name	Organization	Phone & Fax
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Dr. Francois Doumenge	International Commission for the Scientific Exploration of the Mediterranean Sea & World Conservation Union c/o Musee Oceanographique Avenue Saint-Martin MC 98000 MONACO	33-93-153600 33-93-505297
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Ms. Dorothy Bergamaschi	Office of Ocean Affairs U.S. State Department Washington, DC 20520 USA	(202) 647-0239 (202) 647-1106
Dr. T. Karker	Intergovernmental Oceanographic Commission U.N. Educational, Scientific, and Cultural Organization 7 Place de Fontenoy 75007 Paris FRANCE	33-1-45684016 33-1-40569316
Dr. Muriel Cole	Intergovernmental Oceanographic Commission U.N. Educational, Scientific, and Cultural Organization 7 Place de Fontenoy 75007 Paris FRANCE	33-1-45684046 33-1-40569316
Dr. A. Boussoulengas	Intergovernmental Oceanographic Commission U.N. Educational, Scientific, and Cultural Organization 7 Place de Fontenoy 75007 Paris FRANCE	33-1-45683992 33-1-40569316

APPENDIX B

BACKGROUND DESCRIPTION AND MAP[6]

Large marine ecosystems are extensive areas of ocean space, measuring about 200,000 km^2 (60,000 nm^2) or greater, and characterized by: (1) distinct hydrographic regimes, (2) submarine topographies, (3) productivity, and (4) trophically dependent populations.[7] During the past several years, 29 LMEs have been scientifically analyzed by a series of international experts (Table B1), including analyses of the principal forces driving the annual variability in biomass yields of these LMEs. Such analyses constitute a baseline against which to measure periodically the effects of natural and human-induced stress, and of actions taken to mitigate the stress, on the long-term sustainability of fishery resources.

Also recently, a world map has been prepared showing the boundaries of 49 identifiable LMEs (Figure B1). Several of these LMEs have been identified as occupying semi-enclosed seas, such as the Black, Mediterranean, and Caribbean Seas. Some of these, in turn, can be divided into domains, or subsystems, such as in the case of the Adriatic Sea, a subsystem of the Mediterranean Sea Ecosystem.

Other LMEs have been recognized as having their limits defined by the scope of continental margins. The seaward limits of these LMEs extend beyond the physical outer limits of the shelves themselves to include all or a portion of the continental slopes as well. Among these are the Northeast U.S. Shelf, the East Greenland Sea, and the Northern Australian Shelf.

In relation to ocean current LMEs, the seaward boundaries have been carefully limited to the areas affected by the currents, rather than relying simply on the 200-mile exclusive economic or fisheries zone limits. Among these are the Humboldt, Benguela, Canary, and Kuroshio Currents.

Most of the usable global marine biomass yield (greater than 95 percent) is caught annually within the boundaries of the EEZs of coastal nations. In 1987, the global yield of marine fisheries was 80.5-million metric tons (mmt). Of this amount, only 4.2 percent (3.4 mmt) -- including catches of tunas, billfishes, and bonitos -- was attributed to catches outside of EEZs. The major biomass, constituting 95 percent of the annual yield, was caught within the geographic limits of the 49 identifiable LMEs (Table B2).

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[6] Prepared by L. Alexander and K. Sherman in April 1991.

[7] Sherman, K.; Alexander, L.M., eds. 1986. Variability and management of large marine ecosystems. AAAS Sel. Symp. 99. Boulder, CO: Westview Press, Inc. 319 p.

Table B1. List of 29 LMEs and subsystems for which syntheses relating to principal, secondary, or tertiary driving forces controlling variability in biomass yields have been completed for inclusion in LME volumes through February 1993

Large Marine Ecosystem	Volume Number*	Authors
Northeast U.S. Shelf	1	M. Sissenwine
	4	P. Falkowski
Southeast U.S. Shelf	4	J. Yoder
Gulf of Mexico	2	W. Richards and M. McGowan
	4	B. Brown *et al.*
California Current	1	A. MacCall
	4	M. Mullin
	5	D. Bottom
Eastern Bering Shelf	1	L. Incze and J. Schumacher
West Greenland Shelf	3	H. Hovgaard and E. Buch
Norwegian Sea	3	B. Ellertsen *et al.*
Barents Sea	2	H. Skjoldal and F. Rey
	4	V. Borisov
North Sea	1	N. Daan
Baltic Sea	1&5	G. Kullenberg
Iberian Coastal	2	T. Wyatt and G. Perez-Gandaras
Mediterranean-Adriatic Sea	5	G. Bombace
Canary Current	5	C. Bas
Gulf of Guinea	5	D. Binet and E. Marchal
Benguela Current	2	R. Crawford *et al.*
Patagonian Shelf	5	A. Bakun
Caribbean Sea	3	W. Richards and J. Bohnsack
South China Sea - Gulf of Thailand	2	T. Piyakarnchana
Yellow Sea	2	Q. Tang
Sea of Okhotsk	5	V. Kusnetsov *et al.*
Humboldt Current	5	J. Alheit and P. Bernal
Indonesia Seas - Banda Sea	3	J. Zijlstra and M. Baars
Bay of Bengal	5	S. Dwivedi
Antarctic Marine	1&5	R. Scully *et al.*
Weddell Sea	3	G. Hempel
Kuroshio Current	2	M. Terazaki
Oyashio Current	2	T. Minoda
Great Barrier Reef	2	R. Bradbury and C. Mundy
	5	G. Kelleher
South China Sea	5	D. Pauly and V. Christensen

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ERRATUM: Refer to this sheet in place of page 11.

Table B2. Percentage contribution by country and LME representing 95 percent of the annual global catch in 1987

Country	Percentage of world marine nominal catch*	LMEs producing annual biomass yield	Cumulative percentage
Japan	14.43	Oyashio Current, Kuroshio Current, Sea of Okhotsk, Sea of Japan, Yellow Sea, East China Sea, West Bering Sea, Eastern Bering Sea, and Scotia Sea	
Union of Soviet Socialist Republics	12.63	Sea of Okhotsk, Barents Sea, Norwegian Shelf, West Bering Sea, Eastern Bering Sea, and Scotia Sea	
United States of America	7.03	Northeast U.S. Shelf, Southeast U.S. Shelf, Gulf of Mexico, California Shelf, Gulf of Mexico, California Current, Gulf of Alaska, and Eastern Bering Sea	
Peoples Republic of China	6.72	West Bering Sea, Yellow Sea, East China Sea, and South China Sea	
Chile	5.98	Humboldt Current	
Peru	5.65	Humboldt Current	52.44
Republic of Korea	3.50	Yellow Sea, Sea of Japan, East China Sea, and Kuroshio Current	
Thailand	2.48	South China Sea and Indonesian Seas	
Indonesia	2.45	Indonesian Seas	
Norway	2.40	Norwegian Shelf and Barents Sea	
India	2.09	Bay of Bengal and Arabian Sea	
Denmark	2.07	Baltic Sea and North Sea	
Iceland	2.02	Icelandic Shelf	
Democratic Peoples Republic of Korea	1.99	Sea of Japan and Yellow Sea	
Philippines	1.78	South China Sea and Sulu-Celebes Seas	
Canada	1.75	Scotian Shelf, Northeast U.S. Shelf, Newfoundland Shelf	74.97
Spain	1.69	Iberian Coastal Current and Canary Current	
Mexico	1.55	Gulf of California, Gulf of Mexico, and California Current	
South Africa	1.12	Benguela Current and Agulhas Current	
France	1.00	North Sea, Biscay-Celtic Shelf, and Mediterranean Sea	80.33

*Percentages based on fish catch statistics from *FAO Yearbook*, vol. 64, 1987.

Table B2. Percentage contribution by country and LME representing 95 percent of the annual global catch in 1987

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Japan	14.43	Oyashio Current, Kuroshio Current, Sea of Okhotsk, Sea of Japan, Yellow Sea, East China Sea, West Bering Sea, Eastern Bering Sea, and Scotia Sea	
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United States of America	7.03	Northeast U.S. Shelf, Southeast U.S. Shelf, Gulf of Mexico, California Shelf, Gulf of Mexico, California Current, Gulf of Alaska, and Eastern Bering Sea	
Peoples Republic of China	6.72	West Bering Sea, Yellow Sea, East China Sea, and South China Sea	
Chile	5.98	Humboldt Current	
Peru	5.65	Humboldt Current	52.44
Republic of Korea	3.50	Yellow Sea, Sea of Japan, East China Sea, and Kuroshio Current	
Thailand	2.48	South China Sea and Indonesian Seas	
Indonesia	2.45	Indonesian Seas	
Norway	2.40	Norwegian Shelf and Barents Sea	
India	2.09	Bay of Bengal and Arabian Sea	
Denmark	2.07	Baltic Sea and North Sea	
Iceland	2.02	Icelandic Shelf	
Democratic Peoples Republic of Korea	1.99	Sea of Japan and Yellow Sea	
Philippines	1.78	South China Sea and Sulu-Celebes Seas	
Canada	1.75	Scotian Shelf, Northeast U.S. Shelf, Newfoundland Shelf	74.97
Spain	1.69	Iberian Coastal Current and Canary Current	
Mexico	1.55	Gulf of California, Gulf of Mexico, and California Current	
South Africa	1.12	Benguela Current and Agulhas Current	
France	1.00	North Sea, Biscay-Celtic Shelf, and Mediterranean Sea	80.33

*Percentages based on fish catch statistics from *FAO Yearbook*, vol. 64, 1987.

Table B2. Continued.

Country	Percentage of world marine nominal catch*	LMEs producing annual biomass yield	Cumulative percentage
Ecuador	0.84	Humboldt Current	
United Kingdom - Scotland	0.82	North Sea	
Poland	0.80	Baltic Sea	
Vietnam	0.77	South China Sea	
Malaysia	0.74	Gulf of Thailand, Andaman Sea, Indonesian Seas, and South China Sea	
Brazil	0.72	Patagonian Shelf and Brazil Current	
Turkey	0.72	Black Sea and Mediterranean Sea	
Argentina	0.69	Patagonian Shelf	
Namibia	0.64	Benguela Current	
Italy	0.62	Mediterranean Sea	
Morocco	0.61	Canary Current	
New Zealand	0.54	New Zealand Shelf	
Netherlands	0.53	North Sea	
Portugal	0.49	Iberian Shelf and Canary Current	
Faeroe Islands	0.44	Faeroe Plateau	90.30
Pakistan	0.42	Bay of Bengal	
Ghana	0.40	Gulf of Guinea	
Senegal	0.35	Gulf of Guinea and Canary Current	
Venezuela	0.34	Caribbean Sea	
Ireland	0.31	Biscay-Celtic Shelf	
United Kingdom - England & Wales	0.30	North Sea	
Bangladesh	0.29	Bay of Bengal	
Hong Kong	0.28	South China Sea	
Sweden	0.26	Baltic Sea	
Australia	0.25	Northern Australian Shelf and Great Barrier Reef	
Cuba	0.25	Caribbean Sea	

*Percentages based on fish catch statistics from *FAO Yearbook*, vol. 64, 1987.

Table B2. Continued.

Country	Percentage of world marine nominal catch*	LMEs producing annual biomass yield	Cumulative percentage
Romania	0.25	Black Sea	
German Democratic Republic	0.22	Baltic Sea and Scotia Sea	
Panama	0.21	California Current and Caribbean Sea	
Sri Lanka	0.19	Bay of Bengal	
Nigeria	0.18	Gulf of Guinea	
Uruguay	0.17	Patagonian Shelf	
Finland	0.16	Baltic Sea	95.13

*Percentages based on fish catch statistics from *FAO Yearbook*, vol. 64, 1987.

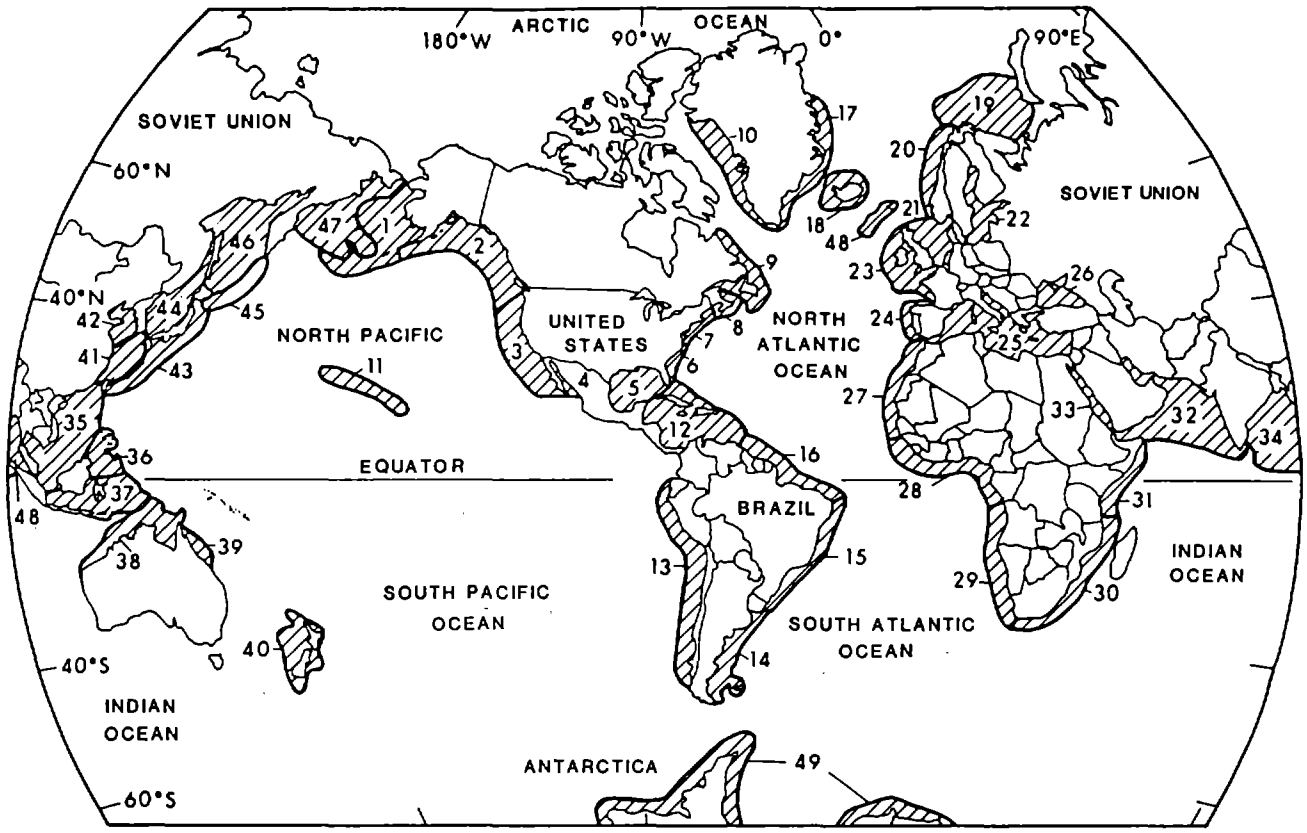

Figure B1. Boundaries of 49 LMEs: (1) Eastern Bering Sea, (2) Gulf of Alaska, (3) California Current, (4) Gulf of California, (5) Gulf of Mexico, (6) Southeast U.S. Shelf, (7) Northeast U.S. Shelf, (8) Scotian Shelf, (9) Newfoundland Shelf, (10) West Greenland Shelf, (11) Insular Pacific--Hawaiian, (12) Caribbean Sea, (13) Humboldt Current, (14) Patagonian Shelf, (15) Brazil Current, (16) Northeast Brazil Shelf, (17) East Greenland Shelf, (18) Iceland Shelf, (19) Barents Sea, (20) Norwegian Shelf, (21) North Sea, (22) Baltic Sea, (23) Celtic-Biscay Shelf, (24) Iberian Coastal, (25) Mediterranean Sea, (26) Black 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) South China Sea, (36) Sulu-Celebes Seas, (37) Indonesian Seas, (38) Northern Australian Shelf, (39) Great Barrier Reef, (40) New Zealand Shelf, (41) East China Sea, (42) Yellow Sea, (43) Kuroshio Current, (44) Sea of Japan, (45) Oyashio Current, (46) Sea of Okhotsk, (47) West Bering Sea, (48) Faroe Plateau, and (49) Antarctic.

APPENDIX C

REPORT OF THE WORKSHOP ON OCEANOGRAPHIC DATA AND TRAINING NEEDS FOR THE LME APPROACH TO FISHERY MANAGEMENT[8]

A workshop on "Oceanographic Data and Training Needs for the LME Approach to Fisheries Management" was held in conjunction with the International Conference on the Large Marine Ecosystem (LME) Concept and Its Application to Regional Resource Management held during 1-6 October 1990 in Monaco. The workshop met on the morning of 5 October in the library of the Musee Oceanographique de Monaco. It was sponsored by OSLR. A list of names and addresses of workshop attendees is included at the end of this workshop report.

Dr. Jurgen Alheit, having been asked by the General Secretary of IOC to chair the workshop, opened the discussions. He suggested that Andrew Bakun act as rapporteur. This was accepted by the attendees without discussion. Dr. Alheit suggested the discussions be structured so as to separately treat: (1) oceanographic data needs, and (2) training needs.

OCEANOGRAPHIC DATA NEEDS

It was recognized that the workshop title may be to some degree a misnomer. We certainly don't have soundly based, widely accepted procedures for direct input of oceanographic data into fishery management activities available at this time. It was therefore agreed to direct discussion toward oceanographic data needed to support the necessary research leading toward development of such procedures. The need to forge a connection between ocean science and fisheries science was emphasized by several participants. It was suggested that establishment of an appropriate model framework would be of great aid in this respect. Of course, the development of such a model framework is itself one of the ultimate goals of the advocated interdisciplinary research.

There appeared to be a consensus that the comparative approach offered one very useful avenue into the problem area. Interregional comparisons among various classes of LMEs allow incorporation of a wide variety of available data; integrative analysis may be rather immediate and direct through a process of pattern recognition. Cited examples of useful "frameworks" for such comparative studies included the seasonal/geographical comparisons by Parrish *et al.* (1983) of habitat climatology versus reproductive habits of eastern boundary pelagic fishes, and the extension by Cury and Roy (1989) to comparison of empirical time-series relationships. Classes of LMEs amenable to such approaches might include upwelling ecosystems, semi-enclosed seas (Baltic, Mediterranean, Great Lakes, *etc.*), shallow shelf ecosystems situated along western ocean boundaries, coral reef systems, ocean shelf — deltaic — riverine interactive systems, and various other classes of comparable systems. As an alternative to structuring comparative studies in terms of physical ecosystem settings and processes, analysis of biogeographic pattern would lead to informative structures based on life history and food web patterns (*i.e.*, a comparative approach via biotic assemblages or "biomes").

In terms of generic data types, the participants enumerated the customary list: temperature, salinity, density, wind, nutrients, currents, sediment load, light, sea level, fishery statistics, *etc.* The need for more ecological, behavioral, and other "less customary" biological information was emphasized, as was the need for data requirements to be model-driven rather than assembled as a "shopping list." Because of the need to direct the studies toward a variety of concerns including fisheries, tourism, and pollution, certain terrestrial data such as runoff and information on various coastal characteristics (vegetation, dredging and filling, erosion, *etc.*) are often needed. The connection between estuarine and offshore processes may be a key issue. Expense of data acquisition is an important concern. Ship-of-opportunity programs may cut expenses, but coverage may be uneven. Sharing of data among countries may present problems as data perceived as having military applications may remain classified for undue periods; this may be an area where actions of international agencies could have beneficial effects.

On the subject of international data banks for LME research, it was pointed out that within the Marine Science and Technology Program of the EEC, it has been decided not to create a general EEC data bank. Instead, a network among national data banks will be set up to provide access to the broad range of available data. The network system and the intercalibration of instruments will be coordinated. However, specific quality control will be a national responsibility.

Continuous plankton recorder systems offer a means for tracking large time-scale/space-scale biological variability within LMEs. The burden of analysis of the samples is the main impediment to their wide use and utility. Because of this, samples may be incompletely analyzed; thus it was suggested that representative samples be saved for more complete analysis when more advanced biotechnological and/or computer imaging methods become operational. The importance of bolstering taxonomic capabilities was stressed, as was the necessity for interinstitutional and international collaboration to share the long-term analysis burden in-

[8] Prepared by J. Alheit, Chairman, and A. Bakun, Rapporteur, in La Jolla, California, on 27 November 1990.

volved in generating a data base having broad utility to a variety of scientific concerns. In this connection, advantages of siting international sorting and taxonomic centers in countries where costs of analysis may be lowered were cited.

Satellite data appear to have great potential for LME research. However, difficulties of access (although improving in very recent years) remain a problem. There is presently a trend among national agencies toward "marketing" of satellite data and products in order to recover part of the cost of technological development, satellite launching, and operations. The workshop participants suggested that international agencies register strong complaints about this trend. It makes little sense that, after enormous expenditures to put the systems into operation, their data should be unavailable to support ongoing scientific research programs for lack of relatively minor specific funding within these programs. The comparative method has been identified as one of the most promising avenues for scientific progress in LME research. Therefore, the withholding of such data from use by any country or region effectively robs the taxpayers of the country having borne the heavy expense of establishing a satellite observation system of an important potential "payback" (in terms of their own LME concerns) for their investment. It was reported that a 10-year series of "Landsat" data lies essentially unutilized for LME research. The use of this data resource to support broad-scale scientific advance could be enormously enhanced by free processing and free provision of charts and maps. The practice of encoding data streams to prevent broad access is shortsighted and should be protested.

Assembling data from various ecosystems for use in applications of the comparative method may present problems. Scientists of any region who have made large personal investments of their time and expertise to assemble important data sets may be understandably reluctant to give them up for primary analysis by unspecified scientists of other regions. However, the problems of LME research are both crucial and difficult. Precedent guidelines for research progress tend to be lacking. Innovation and inspiration are at a premium. Thus, it is particularly important that an international community of scientists have access to interregional data bases in order to be able to build upon each other's ideas and insights, and to thereby participate in broad scientific advance to the benefit of all. The IMARPE/GTZ/ICLARM [Peru Institute of the Sea/German Society for Technical Cooperation/International Center for Living Aquatic Resource Management] Peruvian ecosystem project was cited as an interesting example of an innovative way to accomplish these goals. Two substantial volumes (Pauly and Tsukayama 1987; Pauly *et al.* 1989) analyze and display a large variety of time series of monthly data extending over three decades; with the second volume, ICLARM is prepared to provide all the extensive sets of basic and derived data in computer-readable form (14 floppy disks in IBM-PC compatible format). A key aspect is that the various chapters in the volumes are authored by the scientists who have assembled and provided the data. This affords them, in a single, readily identifiable reference, the opportunity to: (1) publish their own initial analysis of their data; (2) to establish identification with their data sets so that follow-on users will know where to enquire about specific details, *etc.*; and (3) provide a basis for proper citation of their contribution to follow-on integrative scientific analysis efforts.

In a somewhat similar area of concern, the issue of research cruises by ships of one country within the EEZ of another country was mentioned. It was pointed out that notification of cruise plans is often not timely enough to allow for appropriate participation by local scientists. Earlier notification would be very advantageous in terms of training opportunities and in terms of participation of local scientists in making use of the acquired data with respect to local scientific and socioeconomic issues.

TRAINING NEEDS

It was noted that needs for training in developing countries are of several types. First, there is a need to develop the scientific capabilities of research workers. This needs to be on two levels: (1) postgraduate studies, and (2) specific training for officers involved in fishery development and management. Secondly, training in effective data management is needed. Thirdly, training on the technician level is needed both in data collection and in instrumentation, where instrument failure and a lack of expertise to make appropriate repairs is a recurring problem. It was also noted that there are two aspects of training, that of students and that of teachers.

Dr. Alheit here reiterated a proposal, made earlier in the general conference discussions, for involvement of developing countries in LME research. In outline, the proposal includes: (1) a conference to be held on the subject which would demonstrate the use of modeling, identify data needs, and develop an example program for integrative LME studies in developing countries which would include "twinning" arrangements (agency to agency, institution to institution, and with potential funding sources); (2) a period within which to compile data (approximately one year); (3) regional conferences to design programs on an integrated ecosystem basis; and (4) followup activities to include training packages on methods to study ecosystems, and on management of national EEZs in a regional context, to include short-term (approximately two weeks) and long-term (master's level) courses.

Several participants emphasized the need for expansion of international research programs to the LMEs of the Indian Ocean. For example, it was noted that there was specific concern for expansion of OSLR projects into the Indian Ocean regions at the recent meeting of the IOC-FAO Guiding Group of Experts on OSLR (Paris, February 1990). It was announced that Kenya will consider proposing (next year) and offering to host a regional conference on the LMEs of the Indian Ocean. A special focus would be directed

toward the linkage between research and training. Participants reiterated the training value of comparative studies of ecosystem function.

The development of pilot projects was a recurring theme in the discussions. These could foster exchange programs, training opportunities, and scientific collaboration between institutions in developed and developing countries. Suggested specific types of training included: (1) rational use of the EEZ; (2) use of remote sensing in coastal ecology studies; (3) CPR operation and analysis; and (4) methods for study of estuaries, particularly with respect to silt, waste disposal, and pollution.

A concern for development of adequate taxonomic capabilities for LME research was expressed. In the past, many countries had a major portion of their biological expertise within the taxonomic specialties. The situation has changed radically. There are presently few experienced taxonomic specialists and a consequent lack of university courses for an increasing number of students interested in taxonomy. It was recommended that courses and workshops in taxonomy be organized as components of regional LME symposia and other types of LME training activities. These should include modern techniques such as application of molecular and biotechnological methods. With regard to the subject of taxonomy of phytoplankton species involved in toxic or noxious blooms, it was announced that recurrent three- to four-week courses are presented at Copenhagen University, Denmark, under the IOC-FAO OSLR Program and the IOC Training, Education, and Mutual Assistance Program. To assist in these activities, a Danish associate expert in phytoplankton will be assigned to the IOC Secretariat.

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APPENDIX D

ANNOUNCEMENT OF INTERNATIONAL SYMPOSIUM AND WORKSHOP ON "STATUS AND FUTURE OF LARGE MARINE ECOSYSTEMS (LME) OF THE INDIAN OCEAN"

Organized by:	Kenya Marine and Fisheries Research Institute in collaboration with the Kenyan-Belgian Project "Higher Institute for Marine Science" and Recoscix-WIO Regional Dispatch Center
Convener:	Dr. Ezekiel Okemwa
Date:	9-14 August 1992

INTRODUCTION AND BACKGROUND

The necessity of integrated interdisciplinary marine research beyond national or regional boundaries has led to the concept of LMEs. The concept's importance for conservation and management of the world's oceans has been recognized worldwide by many scientists and scientific organizations.

Following the recommendations of the International Conference on the Large Marine Ecosystem (LME) Concept and Its Application to Regional Marine Resource Management held during 1-6 October 1990 in Monaco, the Kenya Marine and Fisheries Research Institute is now pleased to announce the organization of an international symposium and workshop on "Status and Future of Large Marine Ecosystems of the Indian Ocean."

The concept of LMEs is little understood or applied in the Indian Ocean. It is difficult to relate the differences in hydrography, bathymetry, and floral or faunal assemblages within the Indian Ocean. A comprehensive study of the Indian Ocean ecosystem covering biological, chemical, and physical parameters is needed. The application of the LME concept to different areas of the Indian Ocean will be extremely important for the conservation and management of the Indian Ocean's living resources.

The meeting will be held in Mombasa, Kenya, from 9 to 14 August 1992. The symposium will consist of consecutive panels in which the principal subject areas will be discussed. In each of the review panels, the presentation of a review paper will be followed by a series of selected papers on the subject area. The symposium will be followed by a workshop.

The convener of the symposium and workshop is Dr. E. Okemwa, assisted by Prof. P. Polk, Dr. N. Mweu, Dr. K. Delbeke, Mrs. H. Oyicke, and Mr. K. Kairu.

SYMPOSIUM OBJECTIVES

1. To bring together experts in the field of marine science to review and discuss achievement to date on LMEs.

2. To review and discuss the status of marine research in the Indian Ocean and relate the current knowledge to the LME approach.

3. To identify constraints and gaps in knowledge that affect the application of the LME concept, and promote action to diminish such constraints.

4. To provide guidelines for the planning, launching, and evaluation of future projects on LMEs.

5. To provide participants with a broad understanding of the main principles and methods used in LME studies.

SYMPOSIUM THEME

The symposium will, within the concept of the LME, examine the physical, chemical, and biological interactions and their implications for resource utilization. In more detail, this encompasses: (1) case studies on LME concepts; (2) rational use of EEZs; (3) oceanographic studies; (4) ecological cycling; (5) fisheries; (6) pollution; (7) conservation measures, including coastal parks and protected areas; (8) resources utilization from LME perspectives; and (9) integration of scientific data in the LME approach to fisheries management.

WORKSHOP TOPICS

1. Inform participants on the methods of the LME approach, such as remote sensing, taxonomy, *etc.*

2. Demonstrate the use of modeling.

3. Identify suitable scientific data needs for LME studies.

4. Develop an example program for integrative LME studies in developing countries, which would include "twinning" arrangements: (a) agency to agency, (b) institution to institution, (c) scientist to scientist, and (d) with potential funding sources.

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