



4TH GLOBAL CONFERENCE ON OCEANS, COASTS, AND ISLANDS

Working Group on Large Marine Ecosystems



POLICY BRIEF ON LARGE MARINE ECOSYSTEMS



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Global Forum on Oceans, Coasts, and Islands--Strategic Oceans Planning to 2016

The Global forum on Oceans, Coasts, and Islands has undertaken a strategic planning effort for the period 2006-2016 to develop policy recommendations for specific next steps needed to advance the global oceans agenda aimed at governments, UN agencies, NGOs, industry, and scientific groups. To this effect, Working Groups have been organized around 12 major topic areas related to the global oceans commitments made at the 2002 World Summit on Sustainable Development and to emerging issues facing the global oceans community.

The Working Groups have been organized and coordinated by the Global Forum Secretariat, under the direction of Dr. Biliana Cicin-Sain, Co-Chair and Head of Secretariat, Global Forum on Oceans, Coasts, and Islands, and involving the following staff from the Gerard J. Mangone Center for Marine Policy, University of Delaware: Miriam Balgos, Kateryna Wowk, Caitlin Snyder, Shelby Hockenberry, and Kathleen McCole.

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Global Forum on Oceans, Coasts, and Islands

Working Group on Large Marine Ecosystems

**Policy Brief:
Large Marine Ecosystems**

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Table of Contents

Foreword by Biliانا Cicin-Sain, Global Forum	iii
Policy Brief	
1. Introduction: the LME concept as an approach for ecosystem-based management	1
2. The LME Approach and its applications	1
3. Large Marine Ecosystem Assessment and Management and the GEF	2
4. Sixteen GEF supported LME projects and the WSSD	3
5. Two governance commissions	11
6. Other LME applications	11
7. The IUCN, LME Projects, and global outreach	12
8. The IW:Learn global outreach for GEF-LME projects	13
9. Findings on warming trends	14
10. Findings on fisheries biomass yields	14
11. Findings on eutrophication	15
12. Socioeconomic benefits	15
13. Governance Declarations	16
14. Developing a global LME network of scientists, technicians, policy-makers and managers	16
15. Educational outreach	17
16. Planned activities of the LME Program (2008-2010)	17
17. Conclusion	19
Annex I: “The LME Time Wave”—the history of the LME concept	20

FOREWORD

In 1995, the Global Environment Facility (GEF) Council included the concept of Large Marine Ecosystems (LMEs) in its Operational Strategy as a vehicle to foster ecosystem-based approaches to the management of coastal and marine resources and address the land-sea interface. LMEs encompass coastal areas from river basins and estuaries to the seaward boundaries of continental shelves, enclosed and semi-enclosed seas, and the outer margins of the major current systems. LMEs are typically 200,000 square kilometers or greater, and are characterized by distinct bathymetry, hydrography, productivity, and trophically dependent populations. To date, 64 LMEs have been identified in the global oceans. The GEF uses LMEs as units for facilitating integration across sectors, developing adaptive management frameworks with site-specific targets, and providing tools for engaging stakeholders. With GEF assistance, and in partnership with several UN agencies, 110 different nations are cooperating to improve place-based management for 17 LMEs.

This Working Group assessed progress made in LMEs, challenges to managing LMEs, and provide guidance for the enhanced management of LMEs. Moving forwards, there is a need to keep a focus on regional, transboundary projects. Furthermore, it is crucial to train the next generation of LME professionals to the ecosystem-based approach to assessments of management of LMEs.

The Global Forum Secretariat extends its deep appreciation to Dr. Kenneth Sherman and his team for overseeing the Working Group and developing the policy brief.

Biliana Cicin-Sain
Global Forum on Oceans, Coasts, and Islands

Policy Brief: The Large Marine Ecosystem assessment and management approach (2008-2010)

1. Introduction: the LME concept as an approach for ecosystem-based management

Since 1984, the NOAA-National Marine Fisheries Service Large Marine Ecosystems (LME) Program has been engaged in the development and implementation of an ecosystem-based approach to support the assessment and management of living marine resources and their environments.

Large Marine Ecosystems (LMEs) are regions of ocean space of about 200,000 km² or greater. They encompass coastal areas from river basins and estuaries seaward to the break or slope of a continental shelf (e.g. Scotian Shelf), or out to the seaward extent of a well defined current system (e.g. Benguela Current, Kuroshio Current). Some LMEs (e.g. Baltic Sea) are partially enclosed geographical areas. Collaborating oceanographers and biologists have defined 64 LMEs worldwide, based on ecological criteria including (i) bathymetry, (ii) hydrography, (iii) marine productivity, and (iv) trophodynamics. LMEs annually produce 80% of global marine fishery yields. LMEs are also centers of coastal pollution, habitat degradation, nutrient over-enrichment, climate change, and biodiversity loss.

The Large Marine Ecosystems (LME) assessment and management concept is based on the operationalization of five modules focused on measuring changes in ecosystem (i) productivity; (ii) fish and fisheries; (iii) pollution and ecosystem health; (iv) socioeconomic conditions; and (v) governance. One hundred and ten coastal countries in Africa, Asia, Latin

America, the Caribbean, and Eastern Europe are moving ahead with \$1.8 billion in financial support from the Global Environment Facility (GEF) and the World Bank to implement LME assessment and management projects around the margins of the Atlantic, Pacific, and Indian Oceans. Seventeen Arctic LMEs and 23 LMEs in the Asia-Pacific Economic Cooperation (APEC) region are also highlighting opportunities for international collaboration in LME projects. Through LME programs, the GEF is encouraging countries to move forward in a paradigm shift from a sector by sector approach to a more comprehensive and integrated resource management approach for the restoration and protection of shared transboundary LME goods and services. The objectives of GEF funded LME projects are in keeping with the 2002 Johannesburg World Summit on Sustainable Development (WSSD) targets to (i) achieve substantial reductions in land-based sources of pollution; (ii) introduce an ecosystems approach to marine resource assessment and management by 2010; (iii) designate a network of marine protected areas by 2012; and maintain and restore fish stocks to maximum sustainable yield levels by 2015

2. The LME approach and its applications

The LME assessment strategy is an ecosystem-based approach to look beyond individual sectors such as marine fisheries assessment and management, pollution discharge, mineral extraction, or transportation, and consider the multi sectoral effect

on sustaining the goods and services of LMEs.

3. Large Marine Ecosystem Assessment and Management and the GEF

The LME approach offers a strategy for reducing coastal pollution, restoring damaged habitats and recovering depleted fisheries, based on an integration of science and management at the LME scale. Ecosystem management requires a paradigm shift from individual species to ecosystems, from the small spatial scale to multiple scales, from a short term perspective to a long term perspective, from management divorced from research to adaptive management, from managing commodities to sustaining the production potential for marine goods and services, from humans independent of ecosystems to humans as an integral part of ecosystems. 25 years after its initial pioneering, the LME concept for ecosystem-based management and its five-module approach (productivity, fish and fisheries, pollution and ecosystem health, socioeconomics and governance) are being applied to 16 international projects in Africa, Asia, Latin America and Eastern Europe. These LME projects are funded by the Global Environment Facility (GEF), the World Bank, participating countries, and other donors at a level of \$1.8 billion. Scientific and technical support is provided to the GEF LME projects by NOAA and other donor agencies. Governments, international organizations, and scientists worldwide have embraced the LME concept as demonstrated by the following examples:

- Five United Nations agencies (UNEP, UNIDO, UNDP, FAO and IOC-UNESCO) are

partnering with LMEs in 16 GEF-funded LME projects that assist developing countries to maintain their fisheries for the wellbeing of their growing coastal populations;

- The ministries of fisheries and the environment of 110 countries support the LME projects;
- The US National Oceanic and Atmospheric Administration (NOAA) has adopted the LME as the basic unit to implement an ecosystem-based approach to marine resource management in the 10 LMEs of the United States;
- The International Union for the Conservation of Nature and Natural Resources (IUCN) partners with NOAA and the LME Program Office in assisting developing countries to maintain community based artisanal fisheries;
- The GEF learning exchange and resource network (IW:Learn) promotes experience sharing and learning among participants in GEF International Waters projects;
- Fourteen peer-reviewed scientific volumes and over 200 technical papers have been published containing descriptions and case studies of LMEs worldwide.
- More than 2,500 experts and partners participate in LME projects;
- One hundred and ten countries have already taken the lead and are considering how to link biophysical processes across several spatial and temporal scales, with the human needs and way of life of those living in coastal societies.

The GEF provides grants to developing countries for projects that benefit the global environment and promote sustainable livelihoods in local communities. With GEF funding now reaching US\$1.8 billion for LME projects, the 5-module approach to ecosystem-based management is being applied in the developing countries sharing LMEs in Africa, Asia, Latin America and Eastern Europe, where there is the greatest potential to reduce poverty and increase environmental sustainability. It is in those regions that the needs of a growing population must be met while preserving Earth's support systems. Five modular assessments have identified for example the need for a precautionary approach in addressing the encroachment of industrial fisheries on artisanal fisheries in the Guinea Current LME; the need for improved forecasts of fishery fluctuations for the long-term sustainability of pelagic and demersal fish stocks in the very productive Humboldt Current LME; and the need to curb nitrogen loading where the pressure from excessive nutrients coming from land-based sources can disrupt the nitrogen cycle and influence the integrity and health of LMEs.

A GEF-funded LME project engages in a humanistic, country-driven process, in which the countries bordering an LME jointly prepare documents based on consensus that rank coastal resource issues, identify and prioritize transboundary problems, analyze socioeconomic impacts, and advance possible remedies and actions for sustaining LME resources. In a Transboundary Diagnostic Analysis (TDA), the countries sharing an LME begin to scientifically characterize the LME, to identify the root causes of trends in LME biomass yields and the most pressing transboundary

characteristics of coastal pollution, damaged habitats and depleted fish stocks. In a Strategic Action Plan (SAP), the countries commit to making institutional arrangements and taking policy actions based on sound science, to address the issues identified in the TDA. The SAP addresses to correct institutional fragmentation, ecosystem assessment gaps, lack of cooperation, and weak coastal policies, and is signed by high-level government authorities of each participating country. Once countries have agreed on the issues facing their marine resources and have put forward strategies for improvement, the GEF can provide additional funding to help implement actions that realize those strategies. The operational strategies for the fourth replenishment of the GEF (2007-2010) will further augment international LME activities by US\$230 million. Supplemental financing of the LME foundation projects with World Bank investment funds is likely to increase support of LME projects to a level of US\$3 billion by 2010. This unprecedented level of financial support provides developing countries with the means to operationalize the five-module LME approach to marine resource assessment and management, and to acquire and operate advanced sampling systems for obtaining time series data on productivity, coastal oceanography, nutrients, climatology, fish and fisheries, and pollution and ecosystem health.

4. Sixteen GEF supported LME projects and the WSSD

The following profiles of selected LME projects illustrate the important contributions of the TDA and SAP process, the bottom-up, country-driven approach, and the movement forward to recover and sustain depleted fish stocks, restore degraded habitats, and

reduce coastal pollution and eutrophication. These projects have made progress in reaching the marine targets put forward at the Johannesburg 2002 World Summit for Sustainable Development (WSSD). Within the global LME Program, NOAA and marine stewardship agencies from other countries contribute scientific and technical expertise in applications of marine resource recovery and sustainability, oceans and atmospheric assessments and forecasting, high speed data processing, and database management. Countries participating in GEF-LME Projects have requested scientific and technical assistance from NOAA and other ocean agencies in the operationalization of the 5-module approach to LME assessments and the use of ecosystem indicators in productivity, fish and fisheries, pollution and ecosystem health, socioeconomics, and governance.

The Yellow Sea LME Project

The TDA jointly prepared by China and Korea has identified a change in fish species composition and feeding habits. Ecosystem drivers under consideration are climate change, overfishing, eutrophication, and pollution in the coastal areas. The Project goals are to advance in the understanding of the structure and functioning of the Yellow Sea ecosystem and its watershed; to forecast its responses to global change; to develop ecosystem-based, environmentally sustainable management strategies to restore food fish for the sustenance of growing populations; to restore biodiversity, improve water quality, protect human health, and reduce nutrient over-enrichment, oxygen depletion and coastal pollution. In early 2008, the Yellow Sea LME project launched a cooperative scientific cruise in which both China and Korea participated for

the first time (see the TV programme on the web at www.yslme.org).

The Guinea Current LME project

Sixteen West African countries have come together in an effort to improve the depleted condition of fisheries, restore the degraded condition of coastal habitats and especially the critically important mangroves, and reduce and control pollution on behalf of the 300 million people living on the West African coast. The coastal waters of the Guinea Current LME support significant biomasses of plankton species and multiple year-classes of tunas, sardines, mackerel, shrimp, bottom fish, octopus, and other species providing food security and supporting viable commercial and artisanal community-based fisheries. Among the growth industries are tourism, vessel transportation taking goods to and from the countries of West Africa, oil and gas resources and extractive industries for sand and diamonds (the recently produced DVD, “Africa on the Cutting Edge”, describes the accomplishments of the 16 countries working together in the Guinea Current LME).

The Benguela Current LME project

Namibia, Angola and South Africa have identified their most serious transboundary problems: declining fish stocks, massive red tides, deteriorating water quality, and habitat destruction caused by diamond mining along the coast. Their fisheries have been overfished by fleets from Europe. One of the nominators for Dr. Sherman and the Japan Prize says that Dr. Sherman’s work and the team effort of collaborating scientists, geographers, economists, technicians, marine policy makers, administrators, and politicians have helped to harvest from science the benefits that societies can potentially derive from it by providing

a strategy for the three Benguela Current countries to cope with climate variability and how to track its effects in the marine environment. For instance, Dr. Sherman's recent 50-year time series for warming trends in each of the 64 LMEs has provided baseline data from which to measure regime shifts and other impacts of change in the Benguela Current LME. It highlights the strong link between climate change and fisheries.

The Gulf of Mexico LME Project

Mexico and the United States have begun to scientifically characterize the LME and to identify its most pressing transboundary issues: the depleted level of fishery stocks, the shift from single species to ecosystem-based management, eutrophication and harmful algal blooms, habitat modification, and the value of ecosystem goods and services. The focus of the project is on restoring and sustaining fisheries and fish stocks and on reducing and controlling nutrient over-enrichment to safe ecosystem health levels. The two countries will carry out LME-wide surveys of productivity and oceanography, monitoring major ecological events (in regard to pollutants) and developing a system that places particular emphasis on changes in productivity and other indicators of ecosystem health. The project will promote new technology to reduce non-target species interaction, bycatch, and discards. It will investigate the commercial aspects of the shrimp, reef fish, blue crab, red snapper, mackerel, herring, sardines, and anchovy fisheries. In addition it will assess ecosystem-wide nutrient over-enrichment and contaminant sources, flows and levels with due consideration of the impacts from multiple uses of the Gulf of Mexico LME goods and services, including gas and oil production, mining,

transportation, and tourism. It will develop strategies and actions for the elimination of dead zones in the LME. It will restore degraded marine coastal wetlands and mangroves, strengthen marine and coastal land use with particular emphasis on biodiversity, and establish a marine protected area network based on an ecosystems approach to protect biodiversity as it relates to fish and fisheries, in accordance with WSSD targets. It also plans to initiate an LME-wide economic valuation of near-shore and marine goods and services to gain an improved understanding of the economic importance of the Gulf of Mexico LME. The process provides for the definition of harmonized approaches for policy, legal, and institutional reforms for addressing priority transboundary issues and for rendering them effective through reforms and investments at the national level. Strong interaction with the private sector including the oil and gas industry is considered important.

The Caribbean Sea LME

The Caribbean Sea has a wide variety of tropical ecotones, including a large proportion of the world's coral reef resources, associated natural resources, and biodiversity. The LME region is highly diverse and complex from a geopolitical and cultural perspective, as it includes 33 states and 19 associated territories of the United States, United Kingdom, France and the Netherlands, with countries of differing size and levels of economic development. The region is highly dependent for its livelihood on marine resources, especially fisheries and tourism-related activities. Food security and resource sustainability are important concerns, given the area's high dependence on fish as a source of protein. The GEF funded LME project has a level of funding of just under

US\$1 million to support project planning. Most fisheries resources are overexploited. Most of the effort goes into lobster, shrimp, and conch. Caribbean fisheries are small-scale and artisanal, mostly multispecies and transboundary, utilizing widely-scattered landing sites and small, open engine powered boats. Management is fragmented because of the high number of participating states and territories. The major issue needing to be addressed is the governance of the fisheries resource. Approaches by governments and organizations to reverse the trends of overexploitation and degradation have been piecemeal and uncoordinated. The overall goal of the Caribbean Sea LME project is the sustainable management of the shared living marine resources of the Caribbean Sea LME and adjacent areas, through an integrated management approach that will meet WSSD targets for sustainable fisheries. Other specific objectives are to improve the shared knowledge base for sustainable use and management of the transboundary living marine resources, implement legal, policy, and institutional reforms, and develop mechanisms for LME-level monitoring, evaluation, and reporting. Pilot programs will provide the opportunity to explore regional and subregional governance mechanisms, supported by sound science-based information.

The Baltic Sea LME Project

Eutrophication caused by nutrient loading from land, atmospheric deposition, and internal nutrient loading by biological and geochemical pathways, has been identified as a major threat to the Baltic Sea LME. The Baltic Sea LME has a large catchment area, with land use activities having a strong effect on water quality. Both nitrogen and phosphorus loads

affect the environmental quality of the Baltic Sea LME. Other threats to the Baltic Sea LME are overfishing (particularly of cod and other demersal species), toxins, and invasive species. The working structure of the Baltic Sea LME project is multilayered, with participating international managing bodies and governance institutions such as the Helsinki Commission (HELCOM), the European Commission, the International Baltic Sea Fishery Commission, and the International Council for the Exploration of the Sea (ICES), providing scientific and coordination expertise to the project, as well as coordination centers, lead national laboratories, local implementation units, and institutes in the participating countries. Ships of opportunity provide an operational monitoring system for the Baltic Sea, its state, and recent changes. Assessments and strategies to reduce Baltic Sea nutrient loads were put forward by HELCOM in the fourth Baltic Sea Pollution Load Compilation and also in a source apportionment study conducted by the European Environment Agency (European Environmental Agency 2005). It is expected that legislative actions, along with the economic incentives provided by the European Union, can be used to coordinate the reduction of nutrient inputs to inland and marine waters. Approximately 20% of phosphorus loads originate from point sources and can be reduced simply through improved waste water treatment.

The Bay of Bengal Large Marine Ecosystem Project

Some 400 million people live in the catchment and coastal areas of Bangladesh, India, Indonesia, Malaysia, Maldives, Myanmar, Sri Lanka, and Thailand, many subsisting at or below the poverty level and heavily depending on part time and

small scale fishing for their livelihood. The FAO-executed Bay of Bengal LME Programme has provided technical assistance and advice in the area for more than 25 years, focusing on the support of fishing communities and the sustainable development of fisheries with increased attention to fisheries management and environmental issues. In 1998, GEF approved a PDF-Block B for the Sustainable Management of the Bay of Bengal Large Marine Ecosystem, with FAO as executing agency, the World Bank as implementing agency, and GEF, the Swedish International Development Cooperation Agency (SIDA), and NOAA as development partners. Seven priority issues were identified, which included the overexploitation of living marine resources, critical habitats and land-based pollution. The PDF-B selected sharks, Indian mackerel and hilsa as priority transboundary species. An objective of the Bay of Bengal LME Programme is to enhance food security and reduce poverty for coastal communities. The program will develop a Strategic Action Plan (SAP) to protect the ecosystem and manage the living resources in a sustainable way. Following the tsunami event, the Bay of Bengal LME project received GEF pipeline approval (April 2005) for a level of US\$12 million. The expected cash and in-kind co-funding (from national Bay of Bengal governments, NOAA, FAO and development agencies) is expected to bring the total funding to US\$ 30.5 million. Formal endorsement by the governments of all eight countries is expected to come soon. Once national counterpart cofinancing and donor cofinancing arrangements are finalized, an "appraisal" workshop is to be held with the participating countries. The workshop is to be used as a forum to discuss evolving priorities in light of

the tsunami. Once the project starts up, a regional workshop will be held to agree on the priorities for project year 1 and to prepare the national and regional work plans. A Project Appraisal Document is to be submitted to the World Bank Board for final approval so that the project can start in 2007.

The Black Sea LME

The six countries, Bulgaria, Georgia, Romania, Russia, Turkey, and Ukraine, bordering the Black Sea LME have completed phase 2 (2004-2007) of a 15 year GEF-LME Project. Eleven more countries are part of a GEF-sponsored Black Sea watershed project to eliminate pollution inputs to the Black Sea drainage basin. The ecosystem has seen deep water anoxic conditions, ctenophore increases, and a pelagic fishery collapse. The most significant threat, and main focus of the Black Sea LME Project, is the issue of eutrophication, requiring three coordinated actions: (1) reduce the nitrogen and phosphorus loads to the Black Sea; (2) enhance the services provided by wetlands and benthic (seabed) plant communities for the assimilation of nutrients; and (3) improve the management of critical habitats, allowing for the economic recovery of fisheries and improvements to the marine ecosystem. There is a need to better quantify the nutrient discharges to the LME and to determine how the nutrients are cycled through the system and what factors control eutrophication in the system. Eutrophication in the Black Sea LME has resulted from the failure of a wide range of sectors to understand the relationship between their activities and the decline of marine and coastal ecosystems. For a reversal of this situation there is a need to make available cost-effective practical alternatives to current

practices and to put in place appropriate laws and enforcement practices with environmental quality objectives. The effective reduction of eutrophication in the Black Sea LME requires the full cooperation of all 17 countries within the basin. A TDA and an SAP were first developed in 1996 and are now to be updated with the gathering and interpretation of information on environmental impacts, the socioeconomic consequences of each identified issue, and the setting of priority actions for improving and sustaining the health of the Black Sea LME. The scientific assessments are to come from four planned cruises on the northwest shelf of the Black Sea LME; an atmospheric deposition study; a vessel traffic oil pollution information system; and a nutrient content assessment of livestock manure near the coasts of Romania and Bulgaria. The results of the research undertaken in 2003-2006 show clear signs that the Black Sea LME is recovering at a slow rate. While there is a slow recovery of biodiversity in the northern part of the LME, the recovering ecosystem is still very vulnerable.

The Canary Current LME Project

The Canary Current Large Marine Ecosystem is an upwelling and wind-driven ecosystem, with a high productivity of plankton and pelagic fish. The seven countries, Morocco, Mauritania, Senegal, the Gambia, Guinea-Bissau, Guinea, and Cape Verde, involved in the project are seeking in this project to reverse the depletion of fisheries and conserve the ecosystem from overfishing and pollution. A preliminary TDA resulted from a steering committee meeting and two TDA workshops held in October 2005 and July 2006. Committees have prepared national reports. The first workshop identified the main transboundary issues to be the decline

of pelagic and demersal resources, loss of critical habitat and biodiversity, environmental fluctuations and water quality in urban coastal areas, shipping, petroleum and agricultural pollution. The project is on target for phase 1 (2007-2012). There is a need for cohesive monitoring in this LME extending from Morocco to South Africa.

The Agulhas Current LME and Somali Current LME Project

The eight countries (Comoros, Kenya, Madagascar, Mauritius, Mozambique, Seychelles, South Africa and Tanzania) involved in the project are to engage in a TDA and SAP process to identify the priority transboundary concerns. The Project is in partnership with NEPAD, the Census of Marine Life, SWIOFP, ACEP, GOOS, WIOMSA, WCS, CI, the Sustainable Seas Trust, and other agencies to ensure the long-term sustainability of the living resources of the Agulhas and Somali Currents Large Marine Ecosystems for the benefit of humankind. The funding agencies are the IUCN, NOAA, IOC-UNESCO, the GEF and The World Wildlife Fund. The Project goals are (i) to develop the knowledge necessary to better manage fisheries and biodiversity through capacity building and ecosystem studies; (ii) to understand the processes that drive the energy and economies of the Western Indian Ocean; and (iii) to contribute to the achievement of the Millennium Development Goals and WSSD targets. A cruise along the east coast of Africa on board the *Algoa* in 2003 monitored biophysical conditions, conductivity, temperature, and depth. The LMEs support nutrient-rich areas which have a direct impact on the livelihoods of millions of people living in coastal communities. Economic growth lies in biodiversity and MPAs rather than fish biomass.

The project has been revised to include small scale fisheries, socioeconomic conditions and efforts towards a joint TDA with the South West Indian Ocean Fisheries Commission and land-based sources of pollution projects. The project document has been prepared and signed by the eight countries.

The Mediterranean Sea LME

With the support of GEF and UNEP, 13 GEF-eligible Mediterranean countries are cooperating under the Barcelona Convention on the Protection of the Mediterranean Sea against Pollution to review the TDA initially prepared in 1997. Participating countries are Albania, Algeria, Bosnia and Herzegovina, Croatia, Egypt, Lebanon, Libya, Montenegro, Morocco, Syria, Tunisia, Turkey, and the Palestinian Authority. All Barcelona Convention countries are invited to participate and to be donors to the Project. The major transboundary environmental concerns for the Mediterranean Sea LME are the decline of biodiversity, decline in fisheries and decline in seawater quality, the risks of human health and the loss of groundwater dependent coastal ecosystems. The countries are jointly agreeing on what interventions are needed to address the priority environmental concerns through two Strategic Action Programs (SAPs): to address pollution from land-based activities, and to conserve the Mediterranean's marine and coastal biological diversity. The Partnership will serve as a catalyst in leveraging additional investments for reversing the degradation of the Mediterranean LME, the freshwater basins feeding into it, its habitats and coastal aquifers. The 5 components of the Project are: the sustainable use of fisheries resources through ecosystem-based management approaches; the

conservation of biological diversity; the management of coastal aquifers and groundwater; the reduction of pollution from land based activities; and the reduction of POPs. The total project cost is \$44 million. The Project was successful in obtaining \$6 million in investment funds to support the biological diversity component, MPA network establishment, and sustainable fisheries using the ecosystem based management approach.

The Humboldt Current LME Project

The Humboldt Current LME supports the world's largest industrial fisheries, representing up to 20% of the global fish catch and contributing 10 to 14 million metric tons a year to the global industrialized use of fish protein. Anchovy, sardine, and horse mackerel are used both for fish meal and for human consumption. The LME provides both food security and employment opportunities for tens of thousands of people living in the coastal communities of Chile and Peru. The high productivity of the LME is the result of upwelling processes governed by strong southerly trade winds. The normal seasonal upwelling can be interrupted by the El Nino-Southern Oscillation (ENSO) which results in intrusions of warm water. The two countries after a lull in their relations are moving towards a more balanced use of the large, naturally produced fish biomass, and a long-term sustainable use of the highly industrialized component and use of those fish species vital to maintaining the socioeconomic basis for the local artisanal fisheries. The project will seek to control the impacts on the LME being caused by pollution from land-based industrial and other activities. UNIDO has assisted Chile and Peru in the preparation of a TDA and SAP. NOAA provides longstanding

scientific and technical support to Chile and Peru in the development of an assessment and management strategy, to bring an ecosystem-based approach to the recovery and sustainability of transboundary fisheries, and deal with the need for fish biomass restoration and for improved forecasts of climate-driven fishery fluctuations in a highly variable LME. The Humboldt Current is vulnerable to uncertainties in fisheries production related to an observed reduction in chlorophyll and primary productivity linked to global ocean warming, and the project requires the development and operation of a vastly improved oceanographic/productivity forecasting system to support the industrial and artisanal fisheries of Chile and Peru.

The West Bering Sea LME Project

The high productivity of the West Bering Sea LME, shared by the Russian Federation and the United States, supports a large biomass of fish, crustaceans, mollusks, marine birds and marine mammals. The catch of Alaska Pollock represents one of the world's largest sustainable yields for a highly sought-after commercial fish species suitable for direct human consumption which, after a peak of 1.4 million metric tons in 1987, has undergone two steep declines. One of the proposed objectives of the West Bering Sea LME Project is to assess the main environmental factors affecting the LME and to evaluate plausible options for redressing the steep decline in biomass yields through 5-modular assessments of productivity, fish and fisheries, pollution and ecosystem health, socioeconomic conditions, and governance for the sustainable development of the West Bering Sea LME.

The East Asia LMEs

The Seas of East Asia sustain 30 percent of the world's coral reefs and mangroves; produce about 40 percent of the world's fish catch, and 84 percent of world aquaculture; and represent one of the world's centers for tropical marine biodiversity. However, the Seas of East Asia are under serious threat from human activities, and require a comprehensive and holistic approach, in order to solve the many conflicting uses of coastal and marine resources, and to achieve the sustainable development of coastal and marine resources, as well as adjacent watersheds. PEMSEA (Partnerships in Environmental Management for the Seas of East Asia) includes the Yellow Sea, East China Sea, South China Sea, Sulu-Celebes, Indonesian Sea, and Gulf of Thailand LMEs. The LMEs are all semi-enclosed with a total sea area of 7 million km², a coastline of 234,000 km, and a watershed area of about 8.6 million km². These seas are ecologically and economically important both regionally and globally. PEMSEA along with other GEF IW initiatives in the region are focusing on the need for comprehensive and responsive national coastal and marine policies and the need to avoid conflicting uses of marine and coastal resources. Eight demonstration sites cover a total of 917 km of coastline and 15,118 km² of land and sea areas. Learning from this experience, 18 other local government units in the region are beginning to replicate these programs. A total of 1,674 km of coastline and 27,508 km² of land and sea area are now covered by these programs, affecting over 11 million inhabitants. PEMSEA is targeting to cover 20 percent of the regional coastline by 2015. Several countries have taken steps to develop and implement cross-sectoral national, coastal, and ocean policies.

5. Two governance commissions

The results of the LME approach are becoming visible. The Benguela Current and the Guinea Current LME Projects have already established innovative, ministerial level, ecosystem-based Commissions to oversee the recovery, development and sustainability of their goods and services. The 3 countries of the **Benguela Current** with very different interests have formed the Benguela Current commission to jointly manage the offshore marine resources of the productive Benguela LME, which they share, and to harmonize their legal and regulatory frameworks for managing the coastal waters. The ecosystem-based Commission was signed at the highest ministerial level and is a historic first in the world annals of marine agreements. This places the three countries out in front on LME management and actually ahead of developed nations. The 16 countries of the **Guinea Current LME Project** have since followed suit by also forming a commission. Both commissions are extraordinary accomplishments. In the 16 countries of the Guinea Current LME as in the 3 countries of the Benguela Current LME, coastal and marine resource management had been fragmented due to the legacy of the colonial past, varying political cultures, and the use in the region of different languages. Some of the countries had experienced or were experiencing political instability. Science was able to overcome this by breaking down the barriers between people and between the countries. Joint scientific surveys carried out by young African scientists and technicians in both LMEs have helped to determine changes in fish populations over time. These surveys are the scientific foundation needed by the countries to better manage their fisheries, keep track of algal blooms

and better react to oil spills and other threats. This has implications for the food security of West African countries and for their prosperity and for peace in troubled areas. These African countries are actually ahead of developed nations in managing their LME, with less history and institutional arrangements that get in the way. The example of these Commissions is an important outcome of the bottom up, country-driven approach taken by developing countries going forward with ecosystem-based management at a pace that is faster than in the developed countries caught up with bureaucratic layering.

6. Other LME applications

The Asia-Pacific Economic Cooperation (APEC)

There is an emerging ecosystem-based approach to the assessment and management of marine resources within the APEC nations. The countries bordering the 23 LMEs of the Asia-Pacific region have taken initial steps toward examining their marine ecosystems. The project purpose is to provide APEC economies with an accurate, up-to-date understanding of the marine ecosystems and resources upon which a large portion of their economies depend, and to allow them to sustain the production potential of the goods and services of the region. Workshops were initiated in 2007 and are to continue in 2008 for country participants to agree on the science based criteria to be used in the identification of LMEs, a set of indicators, and a working map of marine ecosystems in the APEC region. The sponsors of this project are the United States, China, South Korea, the Philippines, and Mexico, along with other APEC economies.

Protection of the Arctic Marine Environment (PAME)—LME applications in the Arctic

The 17 Arctic LMEs are diverse and dynamic systems under stress from global warming and the melting of sea ice. Advances in the melting of Arctic ice have implications for zooplankton, fisheries, fish stocks, marine mammals, and marine birds that appear to be shifting northward. The indigenous communities are in need of assistance for adapting to the ice melt conditions which are now causing serious socioeconomic disruption. PAME, the Arctic Council's working group for the protection of the Arctic environment, and its participant countries Canada, Denmark, Finland, Iceland, Norway, Russia, Sweden and the United States, have agreed on a working map of the 17 Arctic LMEs. A group of experts from each of the Arctic countries has been established within the framework of PAME to reach consensus on the application of LME indicators. This will be followed in 2008 by LME Arctic assessments. In addition, an Arctic volume is being prepared in collaboration with the Institute of Marine Research in Bergen, Norway, and is based on the presentations given at the American Association for the Advancement of Science (AAAS) Arctic Symposium convened in St. Louis, MO in 2006. LME indicators will be tested and evaluated during a pilot project focused on the West Bering Sea LME, shared by the United States and the Russian Federation. The LME project is to be supported by \$5 million in GEF funds as a full foundation project designed to operationalize all five LME modules and consider the effects of climate warming on the indigenous peoples of the region. Available evidence is suggesting significant changes in productivity including increases in the yields of Alaska Pollock (*Theragra*

chalcogramma) within the LME. A major effort of the project will focus on the extent and magnitude of these changes and their effects on economic development in an LME under the stress of climate change. The West Bering Sea LME Project will serve as a prototype of the five-modular LME approach for all 17 Arctic LMEs under consideration for assessment and management activities in the Arctic Council and PAME work plan.

7. The IUCN, LME Projects, and global outreach

The International Union for the Conservation of Nature and Natural Resources (IUCN) is a conservation network bringing together countries, government agencies, NGOs, scientists, and experts. The six IUCN Commissions, including three on human related issues, represent many of the world's leading conservation scientists and experts. The IUCN partners with NOAA and the LME Program Office in assisting developing countries to maintain community based artisanal fisheries. In addition, the LME Program Office's outreach activities have been supported by IUCN to promote the application of the LME concept worldwide. The NOAA-LME Program Office has partnered with the IUCN in congresses and conferences for joint presentations on LMEs. The IUCN is one of the sponsors of the annual LME consultative meeting taking place at the IOC Headquarters. Recent IUCN activities relating to the LME community include fisheries agreements concluded in West Africa, Marine Protected Areas, publications on climate change, and combating illegal, unregulated, and unreported (IUU) fishing in the Western Indian Ocean. In the Bay of Bengal the focus is on climate change impacts on

coastal ecosystems and coastal livelihoods.

Marine Protected Areas

The mission of the World Commission on Protected Areas (WCPA) is to promote the establishment and effective management of a world-wide representative network of terrestrial and marine protected areas, as an integral contribution to the IUCN mission.

Marine protected areas (MPAs) are a fundamental tool for ecosystem-based management. A large part of the marine science community, along with the U.S. Commission on Ocean Policy and the Pew Oceans Commission, view MPA programs as fundamentally place-based and involving the spatial protection of marine resources and habitats. The U.S. Ocean Action Plan puts forward a variety of explicitly place-based protection measures, such as promoting coral-reef and deep-coral conservation, and preserving the places that represent the nation's maritime heritage. MPAs are not necessarily fully-protected or “no-take” marine reserves--the range of protection varies widely in accordance with different goals. NOAA's MPA Center recognizes three general goals of MPAs: “Natural Heritage”, established and managed principally to sustain the protected area's natural biological communities, habitats, ecosystems and processes, and the ecological services, uses and values they provide to this and future generations; “Cultural Heritage”, established and managed principally to protect, understand and interpret submerged cultural resources that reflect the nation's maritime history and traditional cultural connections to the sea; and “**Sustainable Production**”, established and managed principally to support the continued sustainable extraction of renewable living

resources (e.g., fish, shellfish, plants, birds, or mammals) within or outside the MPA by protecting important habitat and spawning, mating or nursery grounds; or providing harvest refugia for by-catch species.

MPAs designed to achieve these natural-heritage, cultural-heritage, and sustainable-production goals can contribute to ecosystem approaches to management. MPAs face the challenge of linking issues involving natural science (population and community ecology of marine organisms) with issues involving social science (socioeconomic and other human components of ecosystems and natural-resource management).

(see NOAA website:

http://mpa.gov/pdf/fac/fac_recmd_06_07.pdf).

8. The IW:Learn global outreach for GEF-LME projects

For over a decade, nations partnering to share the benefits of their freshwater and marine ecosystems have learned from one another's experience via the Global Environment Facility's International Waters: Learning Exchange and Resource Network (GEF IW:LEARN). This project advances knowledge-sharing among IW stakeholders through a Web-based information portal, iwlearn.net. In order to advance integrated ecosystem-based ocean management in LMEs and coastal areas at the global, regional and national levels, the GEF has recently approved the next phase of GEF IW:LEARN. This new phase will promote regional, thematic, and portfolio learning and will help ocean projects share experiences through the coordination of global and regional strategic planning processes, especially in advancing implementation of global commitments for oceans, coasts, and small island developing states (SIDS). The project links GEF-supported

transboundary projects with global efforts to improve freshwater, coastal and marine resource management in the context of achieving the 4 Johannesburg Plan of Implementation and Millennium Development Goals and adapting to climate variability and change, with a particular focus on the Asia/Pacific region. For more information on the new GEF IW:LEARN project, please contact Dr Biliiana Cicin-Sain (bcs@udel.edu) or Ms. Janot Mendler (janot@iwlearn.org). An IW:Learn sponsored economic valuation workshop took place in Cape Town in 2007, focusing on principles of ecosystem valuation, LME benefits and costs, and the use of economic valuation to influence decision-making, with examples taken from the Benguela Current LME. This was followed by the 4th biennial International Waters Conference on sustaining marine fisheries and conserving marine resources.

9. Findings on warming trends

We undertook a study of the physical extent and rates of sea surface temperature trends in relation to fisheries biomass yields and SeaWiFS derived primary productivity of the world's 64 LMEs. The most striking result is the consistent warming of LMEs, with the notable exception of two, the California Current and the Humboldt Current LMEs. These LMEs experienced cooling over the past 25 years. The warming trend observed in 61 LMEs ranged from a low of 0.08 degrees C for the Patagonian Shelf LME to a high of 1.35 degrees C in the Baltic Sea LME. The relatively rapid warming exceeding 0.6 degrees C over 25 years is observed almost exclusively in moderate and high latitude LMEs. The warming in low latitude LMEs is several times slower than the warming in high latitude

LMEs. In addition to the Baltic Sea, the most rapid warming exceeding 0.96 degrees C over 25 years is observed in the North Sea, East China Sea, Sea of Japan/East Sea, and Newfoundland-Labrador Shelf and Black Sea LMEs. This information has been assembled for a soon to be published book, "The UNEP Large Marine Ecosystems Report—a perspective on changing conditions in LMEs of the world's Regional Seas".

10. Findings on fisheries biomass yields

A yield catch time series by fish species (groups) and LMEs was begun in 1950 when the FAO started collecting global fisheries statistics, and ends in 2004 with the most recent update of these datasets. The catch data can be used to evaluate the primary production required (PPR) to sustain fisheries catches. PPR, when related to observed primary production, provides another index for assessing the impact of the countries fishing in LMEs. The mean trophic level of species caught by fisheries (the "Marine Trophic Index") is also used, in conjunction with a related indicator, the Fishing-in-Balance Index (FiB), to assess changes in the species composition of the fisheries in LMEs. Also, newly conceived 'Stock-Catch Status Plots' are presented which document graphically, for each LME, both the increase in the number of stocks that moved from the fully exploited to the overexploited and the collapsed stages, and the relative biomass of fish extracted from stocks in these various stages. Altogether these descriptors of fisheries and ecosystem states over the last 50+ years allow a diagnosis of the fisheries of each LME, and inference on global trends, as LMEs are the source of 80% of the global marine catch. This information has been assembled for a soon to be published

book, “The UNEP Large Marine Ecosystems Report—a perspective on changing conditions in LMEs of the world’s Regional Seas”.

11. Findings on eutrophication

Land-based nutrient (nitrogen and phosphorus) inputs to coastal systems around the world have markedly increased due primarily to the production of food and energy to support the growing population of over 6 billion people. The resulting nutrient enrichment has contributed to coastal eutrophication degradation of water quality and coastal habitats, and increases in hypoxic waters, among other effects. There is a critical need to understand the quantitative links between anthropogenic activities in watersheds, nutrient inputs to coastal systems, and coastal ecosystem effects. Many LMEs are currently hotspots of nitrogen loading in both developed and developing countries. A clear understanding of the relative contribution of different nutrient sources within an LME is needed to support development of effective policies. In 73% of LMEs, anthropogenic sources account for over half of the dissolved inorganic nitrogen (DIN) exported by rivers to the coast. In most of these, agricultural activities (fertilizer use and wastes from livestock) are the dominant source of DIN loading, although atmospheric deposition and, in a few LMEs, sewage can also be important. Over the next 50 years, human population, agricultural production, and energy production are predicted to increase especially rapidly in many developing regions of the world. Regions of particular note are in southern and eastern Asia, western Africa, and Latin America. Unless substantial technological innovations and management changes are implemented, this will lead to further increases in nutrient inputs to LME

coastal waters with associated water quality and ecosystem degradation. An approach is needed such as that being developed in GEF-sponsored LME programs where all stakeholders—including scientists, policy makers and private sector leaders—work together to develop a better understanding of the issues and to identify and implement workable solutions. This information has been assembled for a soon to be published book, “The UNEP Large Marine Ecosystems Report—a perspective on changing conditions in LMEs of the world’s Regional Seas”.

12. Socioeconomic benefits

The LME Approach provides a breakthrough in linking scientific information with the economic and social wellbeing of coastal populations. The five information modules (productivity, fish and fisheries, pollution and ecosystem health, socioeconomics, and governance) offer a conceptual way to integrate science, management, and economic wellbeing at the ecosystem scale in each of the world’s 64 LMEs. The innovation provided by the LME concept is to allow resource managers to characterize and develop management approaches at an ecosystem scale, typically vast ocean areas crossing one or more national boundaries, providing a new foundation for cooperation among the countries that share them. The biggest problem faced by our oceans is that the large marine ecosystems are over-fished and are terribly stressed, which has serious implications for the people of the world who depend on fisheries for their livelihoods and food security. The degradation of marine life is a crisis for all humanity. At a time of great global environmental change, the challenge is to maintain the often delicate balance between the ecological sustainability

of the marine ecosystems and the socioeconomic wellbeing of the rapidly increasing coastal populations. For many LME practitioners, the LME concept means an optimal sharing of marine resources and services for the benefit of the many users in the coastal areas of the world.

13. Governance Declarations

The Accra Declaration

In 1998, the environmental ministers of the 6 countries of the Gulf of Guinea LME Project signed the Accra Declaration, which expressed their commitment to the project.

“Management plans and strategies should balance economic development with environmental protection and conservation concerns”.

The Beijing Declaration

In 2005, NOAA partnered with the UNEP Global Programme of Action (GPA) for the Protection of the Marine Environment from Land-based Activities, to assist developing nations in restoring and sustaining the goods and services of the world's LMEs. The Beijing Declaration of October 2006 has furthered the implementation of the GPA by outlining national, regional, and international actions needed to apply ecosystem approaches, and to value the social and economic costs and benefits of the goods and services that oceans and coasts can provide. This resulted in the Beijing Declaration on furthering the implementation of the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities.

14. Developing a global LME network of scientists, technicians, policy-makers and managers

The 2007 Qingdao Conference on LMEs recognized the LME approach and its movement into a global network of activity that is generating a positive influence on marine resource recovery, development and sustainability. Progress toward greater socioeconomic benefits from the estimated \$12.6 trillion in annual LME goods and services to the world economy cannot be done alone. Integration, coordination and cooperation are required in order to succeed. The next decade will focus on strengthening regional LME alliances, North, South, East and West, around the globe following the examples of the African LME Alliance (ALMEA) of 7 LME projects by countries around the entire coast of Africa, and the East Asian Seas LME Alliance (EASLMEA), to be formed by 5 East Asian LME projects. The 7,000 strong LME network provides a mechanism for addressing issues affecting the sustainability and health at the ecosystem level of management, and for requesting further funding towards the consolidation of the LME approach from institutions including the G8, EU, African Union, APEC and regional development banks.

Capacity building is perhaps the single most important issue. Capacity and training need to be urgently addressed within institutions and by private industry to adapt to the ecosystem approach. GEF funding augmented by World Bank financial support to participating countries is now being applied to build the capacity for training the next generation of LME scientists and management experts needed to move the ecosystem approach forward. Greater effort is being directed to linking ocean research activities underway by the academic community with the applied science being practiced by LME

project participants. Innovative approaches need to be encouraged that provide educational opportunities to young people in developing countries to take up science and move forward in a manner that advances their personal education while preparing them as the next generation of LME professionals.

15. Educational outreach

Two DVDs have been produced, one with IW:Learn on “Turning the Tide—Sustaining Earth’s Large Marine Ecosystems” (26 minutes), and another with the Guinea Current LME Project, “Africa on the Cutting Edge—Leading Global Marine Ecosystem Recovery” (18 minutes). The DVDs show how countries working together can help restore our oceans and coasts for the sake of those whose lives depend upon it. The Turning the Tide DVD was screened in elementary, middle and high school classrooms in four schools of Rhode Island, Virginia, and Ghana. The written evaluations by the school children indicated that the LME concept and message, and the scientific complexity of the issues, were understood and that there was a willingness on the part of the younger generation to address the problems described. The positive response to a DVD which had originally been designed for an adult audience led to the design and writing of a school curriculum based on LMEs and on the Turning the Tide DVD by a Rhode Island school teacher who worked with the scientists of the NOAA-NMFS Narragansett Laboratory. The lesson plans produced, highlighting all five LME modules of productivity, fish and fisheries, pollution and ecosystem health, socioeconomics and governance, are interdisciplinary and have the flexibility to adapt to the educational requirements of elementary, middle and high schools. In celebration of NOAA’s 200 years of

science (1807-2007) and of the LME concept, identified as one of 10 major breakthroughs, an event co-sponsored by the URI Office of Marine Programs and by NOAA focused on Large Marine Ecosystems, inviting New England school teachers to attend a workshop, interact with NOAA scientists and explore the potential of the LME curriculum based on the “Turning the Tide” DVD. The keynote and workshop presentations by scientists are available on the LME website and on the Office of Marine Programs website at: <http://omp.gso.uri.edu/omp/nbc/oceansalacarte.htm>. Featured presentations include: “How to Study Primary Productivity in the Oceans from Space”, “Primary Productivity in a Large Marine Ecosystem”, “Fisheries and the Northeast US Shelf Large Marine Ecosystem”, “Ecosystem Based Fishery Management”, and “Assessing Pollution in Large Marine Ecosystems”.

16. Planned activities of the LME Program (2008-2010)

The past year has seen a significant increase in LME activity, with the concept gaining wide acceptance, and with examples of success and accomplishments, including the two LME governance Commissions established for the Benguela Current and Guinea Current LME projects, where 19 countries are demonstrating an advanced approach to ecosystem based assessment and management practices. Angola, a participating country in both the Benguela Current and Guinea Current LME projects, gained full control of its fisheries by prohibiting fishing by countries from outside the LME, with the exception of tuna; and the Mediterranean Sea LME countries at the conclusion of the Beijing meeting, deciding the follow the LME approach.

In 2008-2010, a wide scope of LME activities will advance the implementation and operationalization of LME strategies in Africa, Asia, Latin America and eastern Europe. The focus is broad and includes activities in the Arctic and the Pacific, LME methodology development, coordination with U.N. agencies and other international agencies, LME Foundation Projects, new LME Projects, LME website operations, educational materials, volumes and publications, conferences and workshops. The global scale of activities requires continued participation in pertinent LME-related conferences, symposia and workshops.

In FY 2008-2010, the LME Program will expand its efforts to introduce state of the art indicator methodologies that will advance assessments of multispecies interactions, their linkages to oceanographic processes, food web dynamics, and the modeling and forecasting of ecosystem variability. The scope of planned activities is linked to the 4th GEF replenishment for International Waters, biodiversity and climate change. The LME Program in partnership with the GEF will support the Arctic and Pacific initiatives, in which NOAA will assist developing countries in applying the ecosystem approach for the assessment and management of 17 Arctic LMEs, and initiate the LME approach to the APEC community of 23 Pacific LMEs.

The LME network will continue to develop ecosystem management tools based on ecosystem indicator methodologies and the 5-modular approach. In the international arena, the recent interest expressed by scientists to focus on the regular reporting of changing ocean conditions around the globe has resulted in a UN-

appointed group of experts with a tentative agreement to use baseline information on changing ecological conditions within the world's LMEs. This will serve as a basic input to the global marine Assessment now underway. The UNEP-LME report on changing states of 64 LMEs will be used in the development of the prototype.

The LME program will continue to build on project development with its U.N. agency partners such as the IOC, UNIDO, UNEP, UNDEP and FAO, and with other international partners (GEF, IUCN, IW:Learn). As a result of GEF's new operational strategy, a number of LME Foundation Projects with a full, 5-modular approach, are to be supported with projects focused on fisheries recovery, reduction and control of nutrient over-enrichment and adaptation to climate change at a GEF replenishment level of \$230 million. Additional World Bank Investment Funds will be available to individual countries for improving the health and sustainability of LMEs. The LME Program will continue to support and assist in the planning and operationalization of 16 GEF-supported LME projects. New LME projects are planned for the West Bering Sea LME, based on direct NOAA interaction with the GEF Secretariat, and for the Sulu-Celebes LME, based on NOAA advice and guidance to the participating countries and to GEF. The LME website at www.lme.noaa.gov will continue to be developed as a primary source for LME data and information on key areas of interest. A global LME information network will use the LME website as the gateway into a portal system, making it accessible to users from projects elsewhere in the world. Links with the Guinea Current LME project are already in place.

Curriculum and educational materials are beginning to be included on the website. New materials will be developed and added to the website.

The LME Program will continue publishing works on the LME approach to ocean management. Conferences, meetings and workshops both in the USA and internationally will be convened with institutional partners and stakeholders, will serve as a catalyst for new projects, and will facilitate cooperation and coordination at multiple scales of government, e.g. local, state, federal, regional and international.

17. Conclusion

The 16 GEF funded LME projects are all focused on movement toward the marine targets agreed to by the political leaders at the 2002 Johannesburg World Summit on Sustainable Development (WSSD) for (1) achieving substantial reductions in land-based sources of pollution; (2) introducing an ecosystems approach to marine resource assessment and management by 2010; (3) designating a network of marine protected areas by 2012; and (4) maintaining and restoring fish stocks to maximum sustainable yield levels by 2015. It is clear that the post Summit decade is to be one of significant progress toward the agreed upon targets. Amidst dire predictions that if the world continues at its present pace, marine ecosystems will unravel resulting in a global collapse of all species currently fished, the LME approach offers a way forward. Given the application of appropriate governance and management measures, it should be possible to turn the corner and make substantial gains in advancing the global effort to restore degraded habitats, reduce pollution and nitrogen over-enrichment, and achieve equitable

allocation of the sustainable fishery resources for industrial, artisanal, and other legitimate stakeholder interests. Over 7,000 marine scientists and policy experts are now engaged in LME projects. In the absence of an international organization empowered to monitor and manage marine ecosystems on a global scale, the GEF support to LME projects will help to fill this gap. The GEF supported LME projects in East Asia are to be recipients of \$1 billion in World Bank investment fund and revolving fund financial assistance to construct wastewater treatment plants, support wetlands restoration activities, and assist fishermen from overcapitalized fisheries to pursue alternative livelihoods.

Large Marine Ecosystems are important as holistic and practical units for monitoring, assessing and adopting management strategies for recovering and sustaining ecosystem productivity, fish and fisheries, pollution and ecosystem health, socioeconomic benefits and governance mechanisms, and for maintaining a balance between the requirements of ecosystem sustainability and human needs. Even while humanity's insatiable appetite for marine products and marine protein is stressing the world's Large Marine Ecosystems with serious economic losses for local stakeholders, countries have demonstrated their capacity and willingness to work together toward the recovery and sustainability of ecosystem goods and services.

Annex 1

“The LME Time Wave”—the history of the LME concept

1983

A need to better understand ocean productivity leads to the pioneering of the concept of Large Marine Ecosystems (LMEs), which combines fisheries biology, oceanography, ecology, law, political science and economic disciplines with geographic regions in the ocean to join in a collaborative, ecosystem-based approach to the assessment and management of the goods and services so was to sustain their economic value to countries bordering the world's 64 LMEs. This action follows the premise put forward by Sherman and Alexander that large areas of the oceans function as ecosystems, and that pollution from air, land, and water and overexploitation of living resources, along with natural factors, influence the varying productivity of these ecosystems.

1984

The First Symposium on the assessment and management of Large Marine Ecosystems takes place at the annual meeting of the American Association for the Advancement of Science (AAAS) in New York. It provides a forum to review strategies for measuring the natural variability of LMEs against a background of increasing evidence of anthropogenically-induced perturbations from overexploitation and pollution.

1986

The volume, “Variability and Management of Large Marine Ecosystems”, edited by Sherman and Alexander, is published by the AAAS and is the first in a series of volumes

describing Large Marine Ecosystems and the applications of the concept.

1987

AAAS meeting provides a forum for reviewing the geographic boundaries of LMEs and examining the causes and effects of natural and human perturbations.

1988

A session on changing conditions in LMEs is convened at the annual AAAS meeting.

1989

Selected papers of the 1987 AAAS meeting are peer-reviewed and published by the AAAS in the volume, “Biomass Yields and Geography of Large Marine Ecosystems”, edited by Sherman and Alexander.

1990

A session was held on LMEs at the AAAS meeting. Selected papers were peer-reviewed, leading to a AAAS volume on LME patterns, processes, and yields.

1990

A multidisciplinary group of participants assembles in Monaco to consider the utility of the large marine ecosystem concept as a means of furthering national actions to ensure the conservation and sustainable use of marine resources. The results of this first Global Conference on LMEs are highlighted in the AAAS volume, “Large Marine Ecosystems—stress, mitigation, and sustainability”, edited by Sherman, Alexander, and Gold.

1991

The first LME map, showing 49 LMEs, appears in the volume “Food chains, yields, models, and management of Large Marine

Ecosystems,” edited by Sherman, Alexander, and Gold.

1992

The United Nations Conference on Environment and Development (UNCED) in Brazil commits \$8 billion to marine cleanup and restoration. The Global Environmental Facility (GEF), a partner of the United Nations and the World Bank, pledges some \$650 million to help developing countries restore the world's Large Marine Ecosystems.

1994

The LME approach is published. It offers five information modules (productivity, fish and fisheries, pollution and ecosystem health, socioeconomics, and governance) as a practical way to integrate science, management, and economic wellbeing at the ecosystem scale in each of the world's 64 LMEs. The five modules help scientists and managers understand, integrate and synthesize the elements needed for monitoring, assessing, and managing LMEs.

1999

The first of a series of annual LME Consultative Committee meetings takes place in Paris, France at the headquarters of the Intergovernmental Oceanographic Commission of UNESCO.

2002

The World Summit on Sustainable Development (WSSD) held in Johannesburg makes a commitment to restore the world's fisheries. The World Summit picks up on the LME concept in formulating four targets: 1. to achieve substantial reductions in land-based sources of pollution by 2006; 2. to introduce an ecosystems approach to marine resource assessment and management by 2010;

3. to designate a network of marine protected areas by 2012; and 4. to maintain and restore fish stocks to maximum sustainable yield levels by 2015.

2004

The U.S. Ocean Action Plan recommends the advancement of the use of Large Marine Ecosystems within the United Nations Environment Programme's Regional Seas programs and by international fisheries bodies, as a tool for enabling ecosystem-based management and providing a collaborative approach to the management of resources within ecologically bounded transnational areas.

2007

The Large Marine Ecosystem (LME) concept is selected as one of the National Oceanic and Atmospheric Administration's (NOAA) notable breakthroughs to be commemorated during the 2007 celebration of NOAA's 200 years of ocean sciences.

2007

The 2nd Global Conference on LMEs takes place in Qingdao, China. The LME approach is identified by the Conference as an important global movement toward the WSSD targets. Positive steps are being taken in applying the precautionary principle to reduce fishing effort on depleted stocks through joint surveys. The LME projects are collecting vital information on LME productivity, fish and fisheries, and pollution and ecosystem health.

2008

LMEs are highlighted at the 4th Global Conference on Oceans, Coasts, and Islands in Hanoi in a session on sharing experiences and lessons in ecosystem-based regional ocean

governance, and the practical
implementation of 16 country driven
LME programs.

Steering Committee, Global Forum on Oceans, Coasts, and Islands*

Co-Chairs

Biliana Cicin-Sain, Director, Gerard J. Mangone Center for Marine Policy, University of Delaware (also Head of Secretariat, Global Forum)

Patricio A. Bernal, Executive-Secretary, Intergovernmental Oceanographic Commission, UNESCO, Paris, France

Veerle Vandeweerd, Director, Environment and Energy Group, United Nations Development Programme (UNDP)

Governmental

David Balton, Deputy Assistant Secretary for Oceans and Fisheries, Bureau of Oceans, U.S. Department of State

Phil Burgess, Director, Cetacean Policy and Recovery, Department of the Environment and Water Resources, Australia

Nguyen Chu Hoi, Director, Institute of Fisheries Economics and Planning, Ministry of Agriculture and Rural Development, Vietnam

Aldo Cosentino, Director-General, Directorate for Nature Protection, Sea Protection, Ministry for Environment and Protection of the Territory, Italy

Margaret Davidson, Director, Coastal Services Center, National Oceanic and Atmospheric Administration (NOAA), USA

Antonio Diaz de Leon, Director-General, Environmental, Regional Integration and Sectoral Policy, Environment and Natural Resources Ministry (SEMARNAT), Mexico

Ambassador Angus Friday, Chair, Alliance of Small Island States (AOSIS), Permanent Representative of Grenada to the United Nations

Gi-Jun Han, Ministry of Maritime Affairs and Fisheries, Republic of Korea

Elie Jarmache, Chargé de Mission, Secrétariat Général de la Mer, France

Magnus Johannesson, Secretary-General, Ministry for the Environment, Iceland

Ambassador Jagdish Koonjul, Mauritius, former Chair, Alliance of Small Island States (AOSIS)

Gerhard Kuska, Associate Director and Director of Ocean and Coastal Policy, White House Council on Environmental Quality, USA

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