



NOAA Technical Memorandum NMFS-NE-208

**Global Applications of the
Large Marine Ecosystem Concept
2007 - 2010**

**US DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Northeast Fisheries Science Center
Woods Hole, MA
June 2007**

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Acronyms

AAAS	American Association for the Advancement of Science
AFS	American Fisheries Society
APEC	Asia-Pacific Economic Cooperation
BCC	Benguela Current Commission
CPR	Continuous Plankton Recorder
EEA	European Environment Agency
EPA	Environmental Protection Agency
FAO	Food and Agriculture Organization of the United Nations
GEF	Global Environment Facility
GEOSS	Global Earth Observation System of Systems
GESAMP	Group of Experts on the Scientific Aspects of Marine Environmental Protection
GFEMN	Global Fisheries Ecosystem Management Network
GIS	Geographic Information System
GLOBEC	Global Ocean Ecosystem Dynamics
GOOS	Global Ocean Observation System
GPA	Global Programme of Action
HAB	Harmful Algal Bloom
HELCOM	Helsinki Commission
IA	International Affairs
ICCAT	International Commission for the Conservation of Atlantic Tuna
ICES	International Council for the Exploration of the Sea
ICTP	International Center for Theoretical Physics
IEA	Integrated Ecosystem Assessment
IGCC	Interim Guinea Current Commission
IIASA	International Institute for Applied Systems Analysis
IOC-UNESCO	Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific, and Cultural Organization
IOOS	Integrated Ocean Observing System
IUCN	International Union for the Conservation of Nature
IW	International Waters
LME	Large Marine Ecosystem
MPA	Marine protected area
MSP	Medium Sized Project
NEFSC	Northeast Fisheries Science Center
NESDIS	National Environmental Satellite, Data, and Information Service (NOAA)
NEWS	Nitrogen Export from Watersheds
NGO	nongovernmental organization
NMFS	National Marine Fisheries Service (NOAA)

NOAA	National Oceanic and Atmospheric Administration
NOS	National Ocean Service (NOAA)
NWS	National Weather Service (NOAA)
OAP	US Ocean Action Plan
OAR	Oceanic and Atmospheric Research (NOAA)
OMES	Office of Marine Ecosystem Studies (NOAA)
PAME	Protection of the Arctic Marine Environment
POP	Persistent Organic Pollutants
RAC	Regional Advisory Committee
RCU	Regional Coordination Unit
TDA	Transboundary Diagnostic Analysis
SAP	Strategic Action Program
SST	Sea Surface Temperature
UBC	University of British Columbia
UN	United Nations
UNCED	United Nations Conference on Environment and Development
UNCLOS	United Nations Conference on the Law of the Sea
UNEP	United Nations Environment Programme
UNDP	United Nations Development Programme
UNIDO	United Nations Industrial Development Organization
USEPA	United States Environmental Protection Agency
WSSD	World Summit on Sustainable Development
WWF	World Wildlife Fund

INTRODUCTION

The Large Marine Ecosystem (LME) concept was 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. In accordance with the US Ocean Action Plan (USOAP 2004), 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 US\$1.8 billion. NOAA is providing technical and scientific support to the projects through close coordination with 5 United Nations (UN) agencies, 2 nongovernmental organizations (NGOs), and the ministries of fisheries and the environment of 110 countries supporting the hands-on participation of 2,500 experts and partners. The operational strategies for the fourth replenishment of the GEF (2007-2010) augmented 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 pertinent to the Global Ocean Observation System (GOOS) and the Global Earth Observation System of Systems (GEOSS). Countries participating in the LME projects welcome NOAA's scientific and technical assistance. With the recent expansion of GEF supported LME projects, opportunities have increased substantially for NOAA Line Organizations such as the National Environmental Satellite, Data and Information Service (NESDIS), the National Marine Fisheries Service (NMFS), the National Ocean Service (NOS), the National Weather Service (NWS), and Oceanic and Atmospheric Research (OAR) to become actively engaged in providing scientific assistance to participating countries in ecosystem assessment and management methods. In keeping with the 2002 Johannesburg World Summit on Sustainable Development (WSSD) target to protect, restore, and manage the use of coastal and ocean resources through an ecosystem approach by 2010, specific opportunities are highlighted for international collaboration with coastal countries and their LME activities around the margins of the Atlantic, Pacific, and Indian Oceans, the 17 Arctic LMEs, and the 23 LMEs in the Asia-Pacific Economic Cooperation (APEC) region. The expanded scale of activities opens pathways for innovative linkages among the LME projects and the global spatial and temporal extent of GOOS and GEOSS. Part I is an overview of the global LME Program. Part II discusses the actions of UN agencies and NGOs engaged in providing support to 16 GEF-LME Projects. Part III outlines the planned activities of the LME program in relation to GEF-supported LME project initiatives for FY 2007-2010.

PART I. OVERVIEW OF THE GLOBAL LME PROGRAM

Advance the Use of Large Marine Ecosystems

The US will promote, within the United Nations Environment Program's regional seas programs and by international fisheries bodies, the use of the Large Marine Ecosystems (LME) concept as a tool for enabling ecosystem-based management to provide a collaborative approach to management of resources within ecologically bounded transnational areas. This will be done in an international context and consistent with customary international law as reflected in 1982 UN Convention on the Law of the Sea. (USOAP 2004, p. 36)

1. The LME Concept as an Approach for Ecosystem-based Management

In 2007, the Large Marine Ecosystem (LME) concept was selected as one of the notable breakthroughs to be commemorated in the NOAA celebration of 200 years of ocean science (www.celebrating200years.noaa.gov/). Since 1984, the NOAA-National Marine Fisheries Service (NMFS) 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. In the course of its 24-year history, it has developed ecosystem management tools, initiated projects that have been funded by partner organizations, and provided training for developing country participants, helping to raise their level of expertise, their scientific understanding, and their capabilities to conduct resource and environmental assessments and to improve resource management practices. Since 1995, 16 LME projects have been planned and implemented internationally within a framework provided by NOAA's LME Program, to which NOAA has contributed scientific and technical assistance. These LME projects are focused on ecosystem-based strategies to recover depleted fisheries, reduce coastal pollution, and restore damaged habitats in Africa, Asia, Latin America, and Eastern Europe. Involved in this activity are an estimated 2,500¹ participants and partners, 5 UN environmental agencies, and 2 NGOs, with grants and investment funds totaling \$1.8 billion (Table 1).

Based on 4 ecological criteria (bathymetry, hydrography, productivity, and trophically-related populations), 10 Large Marine Ecosystems have been delineated for the marine waters of the United States (Sherman et al. 2004). Within each of these 10 LMEs, NOAA has a history of a de facto ecosystems-based approach to fisheries assessment and management, habitat restoration, and research on pollution and ecosystem health. The NOAA-NMFS model for assessment and management has served as the basis for the emergence of a five-module suite of indicators of ecosystem productivity, fish and fisheries, pollution and ecosystem health, socioeconomics, and governance. Taken together, the modules provide time-series measurements used to support actions for the recovery, sustainability, and management of marine resources and their habitats. The effort to better understand climate variability, to improve the long-term sustainability of marine goods and services, and to move in the direction of an ecosystems approach to ocean management applies to the 10 US LMEs and to the world's 64 LMEs and linked watersheds.

¹ ERRATUM: the original publication of this report incorrectly listed this number as 7,000.

The application of these modules to the assessment and management of marine resources has been a focus of the LME Program since its inception.

Table 1. GEF-LME funded foundation grants and investment fund projects

GEF-LME Funded Foundation Grants and Investment Fund Supported Projects-1							
GEF Projects:							
Country, Regional, Global	Project Name	GEF project #	GEF Focal Area	GEF Grant (US\$m)	Co-financing amount, US\$m	Project cost, US\$m	Impl. Agency
REGIONAL - Agulhas & Somali LMEs	Programme for the Agulhas and Somali Current Large Marine Ecosystems: Agulhas and Somali Current Large Marine Ecosystems Project (ASCLMEs)	ID1462	IW	\$ 12.923	\$ 18.263	\$ 31.186	Council approved-9/13/05
8 countries	Comoros, Kenya, Madagascar, Mauritius, Mozambique, Seychelles, South Africa, Tanzania						
REGIONAL - Baltic Sea LME	Baltic Sea LME Project, Tranche 2	ID2349	IW	\$ 5.000	\$ -	\$ 5.000	Pipeline
4 countries	Estonia, Latvia, Lithuania, Russian Federation						
REGIONAL - Bay of Bengal LME	Bay of Bengal Large Marine Ecosystem	ID252	IW	\$ 12.782	\$ 16.386	\$ 29.168	Council Approved-4/6/05
8 countries	Bangladesh, India, Indonesia, Malaysia, Maldives, Myanmar, Sri Lanka, Thailand						
REGIONAL - Benguela Current LME	Implementation of the Strategic Action Programme (SAP) Toward Achievement of the Integrated Management of the Benguela Current Large Marine Ecosystem (LME)	ID789	IW	\$ 15.458	\$ 23.450	\$ 38.908	CEO Endorsed-5/1/02 & approved 2002 through 2006. UNDP has extended Programme through March 2008.
3 countries	Angola, Namibia, South Africa Benguela Current Commission Interim Agreement (BCC) signed by the governments on 29 August 2006						
REGIONAL - Canary Current LME	Protection of the Canary Current Large Marine Ecosystem (LME)	ID1909	IW	\$ 12.700	\$ 25.000	\$ 37.700	PDF B approved 8/26/03- suppl. resources approved 3/30/06
7 countries	Cape Verde, Gambia, Guinea, Guinea-Bissau, Mauritania, Morocco, Senegal						

Table 1. continued

GEF-LME Funded Foundation Grants and Investment Fund Supported Projects-2								
GEF Projects: Country, Regional, Global	Project Name	GEF project #	GEF Focal Area	GEF Grant (US\$m)	Co- financing amount, US\$m	Project cost, US\$m	GEF status	Impl. Agency
REGIONAL - Caribbean LME	Sustainable Management of the Shared Marine Resources of the Caribbean Large Marine Ecosystem (CLME) and Adjacent Regions	ID1032	IW	\$ 9.719	\$ 9.000	\$ 18.719	PDF B- approved March 2007 & govt endorsed	UNDP
23 countries	Antigua and Barbuda, Bahamas, Barbados, Belize, Brazil, Colombia, Costa Rica, Cuba, Dominica, Dominican Republic, Grenada, Guatemala, Guyana, Haiti, Honduras, Jamaica, Mexico, Nicaragua, Panama, St. Kitts and Nevis, St. Lucia, St. Vincent and the Gre., Suriname, Trinidad and Tobago, Venezuela							
REGIONAL - Guinea Current LME	Combating Living Resource Depletion and Coastal Area Degradation in the Guinea Current LME through Ecosystem-based Regional Actions	ID1188	IW	\$ 21.449	\$ 33.871	\$ 55.320	CEO endorsed 11/18/03; approval 11/21/03; final approval 9/6/04	UNIDO/ UNDP/ UNEP
16 countries	Angola, Benin, Cameroon, Congo DR, Cote d'Ivoire, Gabon, Ghana, Equatorial Guinea, Guinea-Bissau, Liberia, Nigeria, Sao Tome and Principe, Sierra Leone, Togo, Congo Interim Guinea Current Commission established September 2006							
REGIONAL- Gulf of Mexico LME	A Transboundary Diagnostic Analysis and Strategic Action Programme for the Gulf of Mexico Large Marine Ecosystem	ID1346	IW	\$ 8.473	\$ 10.000	\$ 18.473	PDF B- approved by CEO 2006	UNDP/ UNIDO
2 countries	Cuba, Mexico							
REGIONAL - Humboldt Current LME	Integrated management of the Humboldt Current Large Marine Ecosystem (HCLME)	ID1443	IW	\$ 8.420	\$ 8.000	\$ 16.420	PDF B approved 2003	UNIDO/ UNDP
2 countries	Chile, Peru							
REGIONAL- Mediterranean Sea LME	Determination of Priority Actions for the Further Elaboration and Implementation of the Strategic Action Programme for the Mediterranean Sea LME	ID461	IW	\$ 6.290	\$ 4.185	\$ 10.475	CEO Endorsed- 3/30/98	
REGIONAL - Yellow Sea LME	Reducing Environmental Stress in the Yellow Sea Large Marine Ecosystem	ID790	IW	\$ 14.744	\$ 10.302	\$ 25.046	CEO Endorsed 5/1/00	UNDP
2 countries	China, Republic of Korea							

Table 1. continued

GEF-LME Funded Foundation Grants and Investment Fund Supported Projects-3								
GEF Projects:								
Country, Regional, Global	Project Name	GEF project #	GEF Focal Area	GEF Grant (US\$m)	Co-financing amount, US\$m	Project cost, US\$m	GEF status	Impl. Agency
GLOBAL-All LMEs	Promoting Ecosystem-based Approaches to Fisheries Conservation and LMEs	ID2474	IW	\$ 0.995	\$ 0.740	\$ 1.735	CEO approved 4/15/04	UNEP/ IOC
INVESTMENT FUND STRATEGIC PARTNERSHIPS-GEF, World Bank, Investment Banks for Regional Development								
REGIONAL -IF- Sub-Saharan Africa	Strategic Partnership for a Sustainable Fisheries Investment Fund in the Large Marine Ecosystems of Sub-Saharan Africa, Tranche 3	ID2574	IW	\$ 20.000	\$ -	\$ 20.000	Pipeline	IBRD World Bank
REGIONAL -IF- Sub-Saharan Africa	Strategic Partnership for a Sustainable Fisheries Investment Fund in the Large Marine Ecosystems of Sub-Saharan Africa, Tranche 2	ID2573	IW	\$ 10.000	\$ -	\$ 10.000	Pipeline	IBRD World Bank
REGIONAL -IF- Sub-Saharan Africa	Strategic Partnership for Sustainable Fisheries Investment Fund in the Large Marine Ecosystems of Sub-Saharan Africa (Tranche 1, Installment 2)(from November 05 WP)	ID2986	IW	\$ 12.000	\$ 75.000	\$ 87.000	Pipeline	IBRD World Bank
REGIONAL -IF- Sub-Saharan Africa - 5 LMEs, 34 countries	Strategic Partnership for a Sustainable Fisheries Investment Fund in the Large Marine Ecosystems of Sub-Saharan Africa (Tranche 1, Installment 1)	ID2093	IW	\$ 13.670	\$ 75.000	\$ 88.670	Council Approved- 11/10/05	IBRD World Bank
REGIONAL -IF- Black Sea LME & Danube R.	Strategic Partnership for Nutrient Reduction in the Danube River and Black Sea LME-World Bank-GEF Nutrient Reduction Investment Fund: Tranche 3	ID2044		\$ 12.480	\$ 242.410	\$ 254.890	Council Approved- 5/16/03	IBRD - World Bank
REGIONAL -IF- Black Sea LME & Danube	Danube/Black Sea Strategic Partnership - Nutrient Reduction Investment Fund: Tranche 2	ID1661	IW	\$ 4.850	\$ 74.800	\$ 79.650	Council Approved- 5/17/02	IBRD - world Bank
14 countries	Belarus, Bosnia-Herzegovina, Bulgaria, Croatia, Czech Republic, Georgia, Hungary, Moldova, Russian Federation, Slovak Republic, Slovenia, Turkey, Ukraine, Romania							
REGIONAL -IF- Black Sea LME	Strengthening the Implementation Capacities for Nutrient Reduction and Transboundary Cooperation in the Danube River Basin (Tranche 2)	ID2042	IW	\$ 12.000	\$ 12.878	\$ 24.878	CEO endorsed. 5/16/03	

Table 1. continued

GEF-LME Funded Foundation Grants and Investment Fund Supported Projects-4								
GEF Projects: Country, Regional, Global	Project Name	GEF project #	GEF Focal Area	GEF Grant (US\$m)	Co- financing amount, US\$m	Project cost, US\$m	GEF status	Impl. Agency
REGIONAL-IF- East Asia LMEs	Strategic Partnership for a Land- Based Pollution Reduction Investment Fund for the LMEs of East Asia, Tranche 3	ID2576	IW	\$ 20.000	\$ -	\$ 20.000	Pipeline	IBRD - World Bank
REGIONAL- IF-- East Asia LMEs	Strategic partnership for a Land- Based Pollution Reduction Investment Fund for the LMEs of East Asia, Tranche 2	ID2575	IW	\$ 25.000	\$ -	\$ 25.000	Pipeline	
REGIONAL- IF-- East Asia LMEs	World Bank/GEF Partnership Investment Fund for Pollution Reduction in the Large Marine Ecosystems of East Asia (Tranche 1, Installment 2) (from November 05 WP)	ID3025	IW	\$ 10.000	\$ 206.643	\$ 216.643		
Regional-IF- East Asia LMEs	World Bank/GEF Partnership Investment Fund for Pollution Reduction in the Large Marine Ecosystems of East Asia (Tranche 1 of 3 tranches)	ID2454	IW	\$ 20.700	\$ 486.800	\$ 507.500	Council Approved- 11/10/05	IBRD - world Bank
8 countries, 6 LMEs	Gulf of Thailand LME, South China Sea LME, Sulu-Celebes Sea LME, Indonesian Sea LME, East China Sea LME and the Yellow Sea LME. Countries included are: Asia/Pacific, Cambodia, China, Indonesia, Lao PDR, Malaysia, Philippines, Thailand, Vietnam							
REGIONAL -IF- Mediterranean Sea LME	World Bank-GEF Investment Fund for the Mediterranean Sea Large Marine Ecosystem Partnership (Phase III)	ID2712	Multi- focal Area	\$ 20.251	\$ 27.427	\$ 47.678	Pipeline	IBRD - World Bank
17 countries	Albania, Algeria, Bosnia & Herzegovina, Bulgaria, Croatia, Egypt, Lebanon, Libya, Macedonia, Morocco, Serbia & Montenegro, Syria, Tunisia and Turkey. Palestinian Authority will also participate.							
REGIONAL -IF- Mediterranean Sea LME	World Bank-GEF Investment Fund for the Mediterranean Sea Large Marine Ecosystem Partnership (Phase II)	ID2711	Multi- focal Area	\$ 30.000	\$ -	\$ 30.000	Pipeline	IBRD - World Bank
REGIONAL -IF- Mediterranean Sea LME	World Bank-GEF Investment Fund for the Mediterranean Sea Large Marine Ecosystem Partnership, Tranche 1	ID2601	Multi- focal Area	\$ 10.000	\$ 90.000	\$ 100.000	Council Approved- 8/28/06	IBRD - World Bank
Σ Grants + Co-financing = project costs =						\$ 1,800.059		

2. The Global Environment Facility and LMEs

Since 1995, the Global Environment Facility (GEF) has been partnering with national and international agencies to assist developing coastal countries in meeting ecosystem-related targets. Following a 3-year pilot phase, the GEF was formally launched to forge cooperation and to finance actions in the context of sustainable development—actions that address critical threats to the global environment from biodiversity loss, climate change, degradation of international waters, ozone depletion, and persistent organic pollutants. The geographic area of the LME, its coastal area, and contributing basins constitute the place-based area for assisting countries to understand linkages among root causes of degradation and to integrate needed changes in sectoral economic activities. The LME areas serve to initiate capacity-building and bring science to pragmatic use in improving the management of coastal and marine ecosystems. The GEF Operational Strategy recommends that nations sharing an LME begin to address coastal and marine issues by jointly undertaking strategic processes for analyzing factual, scientific information on transboundary concerns and their root causes and for setting priorities for action on these transboundary concerns. This process has been referred to as a Transboundary Diagnostic Analysis (TDA), and it provides a useful mechanism for fostering participation at all levels. Countries then determine the national and regional policy, legal and institutional reforms, and investments needed to address the priorities in a country-driven Strategic Action Program (SAP). This allows sound science to become the basis for policy making within a geographic location where an ecosystem-based approach to management can be developed and, more importantly, can be used to engage stakeholders so that they contribute to the dialogue and in the end support the ecosystem-based approach that can then be pragmatically implemented by the communities and governments involved. The science-based approach encourages transparency through joint monitoring and assessment processes, including joint cruises for countries sharing an LME, to build trust among nations over time.

GEF assistance is presently provided to 16 LME projects (Table 2) that are implemented by UN agencies including the United Nations Development Programme (UNDP), the United Nations Environment Programme (UNEP), the Food and Agriculture Organization (FAO), and the United Nations Industrial Development Organization (UNIDO). Countries have approached the GEF and these UN implementing agencies for technical and scientific assistance in restoring and protecting their large marine ecosystems.

Table 2. List of 16 LME projects funded by the GEF

• Agulhas Current LME	• Caribbean Sea LME	• Mediterranean Sea LME
• Baltic Sea LME	• Guinea Current LME	• Somali Current LME
• Bay of Bengal LME	• Gulf of Mexico LME	• South China Sea LME
• Benguela Current LME	• Gulf of Thailand LME	• Yellow Sea LME
• Black Sea LME	• Humboldt Current LME	
• Canary Current LME	• Indonesian Sea LME	

The GEF assists developing countries in adopting a science-driven, ecosystem-based approach to the management of human activities affecting marine ecosystems and linked freshwater basins (Duda and Sherman 2002). In its strategic operational guidance for 2007-2010, the GEF continues to recommend the use of LMEs as the geographic focus for ecosystem-based strategies to recover depleted fisheries, reduce coastal pollution, and restore damaged

habitats. Agreements have been reached between GEF and the World Bank to provide investment funds and long-term loans to countries participating in GEF-LME projects that support implementation of all five LME modules, to serve as foundation projects to which investment funds can be applied by individual countries addressing national concerns while contributing to the recovery and sustainability of LME goods and services. The foundation project concept follows the model developed for the Guinea Current LME and is aimed at improving the entire marine ecosystem through the five-module LME approach. The GEF strategy for the fourth replenishment (2007-2010) in the focal area International Waters (IW) proposes to allocate additional support to LME Foundation Projects engaged in assessment and management efforts to restore depleted fish stocks, reduce and control nutrient overenrichment, and adapt to the effects of ice melt in Arctic ecosystems and high latitude glacial ecosystems. Additional financial support is being allocated to IW from other focal areas of the GEF (e.g., biodiversity, climate change, and persistent organic pollutants), which will be engaged in cross-cutting activities with IW. LMEs targeted for future investment in the GEF fourth replenishment period include the Guinea Current, Benguela Current, Agulhas and Somali Currents, Canary Current, Caribbean Sea, Gulf of Mexico, Yellow Sea, and South China Sea. Initial estimates for the total foundation project and investment funds in support of LME project participating countries could reach US\$3 billion by 2010.

3. LME Indicators Contribute to Climate Change Assessments

The Northeast Fishery Science Center (NEFSC) of NOAA has the longest continuous time-series of US data and information on ecosystem changing states. It is in the US Northeast Continental Shelf Large Marine Ecosystem, extending over 260,000 km² from the Gulf of Maine southward to Cape Hatteras, NC, where NEFSC scientists, economists, and other marine specialists have been applying ecosystem-based methods for assessing living marine resources and their environments—methods that have served as the principal prototype for the GEF-LME projects. Included in the suite of indicators for productivity are measurements of photosynthetic activity, zooplankton biodiversity and biomass, and oceanographic variability. The fish and fisheries model is based on the results of trawl surveys for demersal species and acoustic surveys for pelagic species. The indicators of pollution and ecosystem health are based on the NOAA–Environmental Protection Agency (EPA) model used to monitor changes in condition of US coastal waters and the socioeconomics and governance modules that have evolved from information needs of US regional fishery management councils and other commercial, recreational, conservation, and economic interests and stakeholders. Indicators for each of the five modules are listed in Figure 1.

Productivity Module Indicators

Primary productivity can be related to the carrying capacity of an ecosystem for supporting fish resources (Pauly and Christensen 1995). It has been reported that the maximum global level of primary productivity for supporting the average annual world catch of fisheries has been reached and that further large-scale increases in biomass yields from marine ecosystems are likely to be at trophic levels below fish in the marine food web (Beddington 1995). Measurements of ecosystem productivity can be useful indicators of the growing problem of

coastal eutrophication. In several LMEs, excessive nutrient loadings of coastal waters have been related to harmful algal blooms implicated in mass mortalities of living resources, emergence of pathogens (e.g., cholera, vibrios, red tides, and paralytic shellfish toxins), and explosive growth of nonindigenous species (Epstein 1993).

Modular Assessments for Sustainable Development

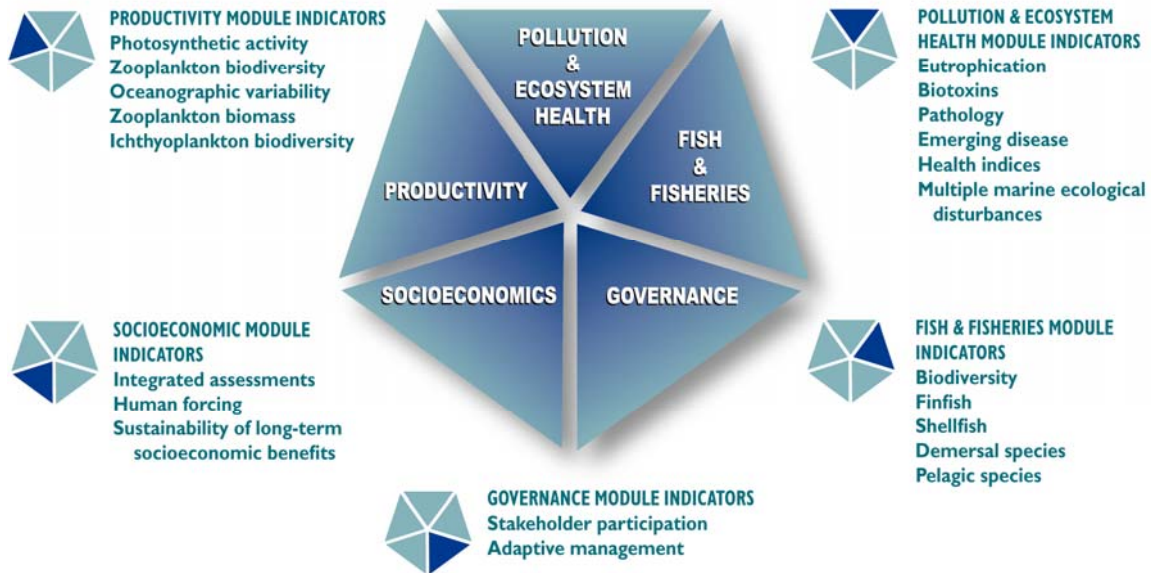


Figure 1. LME modules as suites of ecosystem indicators (Sherman 2005).

The ecosystem parameters measured and used as indicators of changing conditions in the productivity module are zooplankton biodiversity and species composition, zooplankton biomass, water-column structure, photosynthetically active radiation, transparency, chlorophyll-*a*, nitrite, nitrate, and primary production. Plankton can be measured over decadal time scales by deploying continuous plankton recorder systems such as the Mariner Shuttle (Figure 2A) monthly across ecosystems from commercial vessels of opportunity. Advanced plankton recorders can be fitted with sensors for temperature, salinity, chlorophyll, nitrate, nitrite, petroleum, hydrocarbons, light, bioluminescence, and primary productivity, providing the means for in situ monitoring and for calibrating satellite-derived oceanographic data (Figure 2B). Properly calibrated satellite data can provide information on ecosystem conditions including physical state (i.e., surface temperature), nutrient characteristics, primary productivity, and phytoplankton species composition (Aiken et al. 1999; Berman and Sherman 2001; Melrose et al. 2006).

Fish and Fisheries Module Indicators

Changes in biodiversity and species dominance within fish communities of LMEs have resulted from excessive exploitation, naturally occurring environmental shifts caused by climate change, and coastal pollution. Changes in biodiversity and species dominance in a fish community can move up the food web to apex predators and cascade down the food web to plankton components of the ecosystem. The fish and fisheries module includes both fisheries independent bottom-trawl surveys and pelagic-species acoustic surveys to obtain time-series information on changes in fish biodiversity and abundance levels (AFSC 2006; NEFSC 2002; NEFSC 2006). Standardized sampling procedures, when employed from small calibrated trawlers, can provide important information on changes in fish species (Sherman 1993). Fish catch provides biological samples for stock identification, stomach content analyses, age-growth relationships, fecundity, and coastal pollution monitoring for possibly associated pathological conditions, as well as data for preparing stock assessments and for clarifying and quantifying multispecies trophic relationships. The survey vessels can also be used as platforms for obtaining water, sediment, and benthic samples for monitoring harmful algal blooms, diseases, anoxia, and changes in benthic communities.



Figure 2A. Northeast Fisheries Science Center Systematic measurements are made of the LME by using towed bodies such as the Mariner Shuttle, depicted here (Lord 1998).

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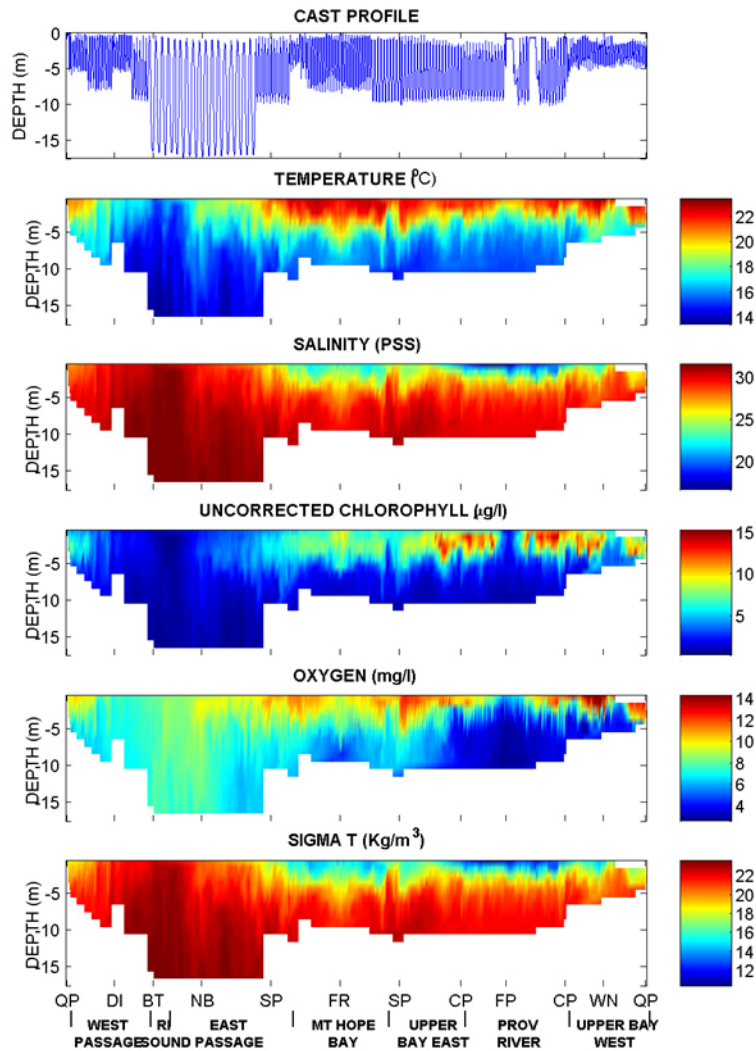


Figure 2B. The electronically produced outputs from Mariner Shuttle sensors showing vertical profiles of depth, temperature, salinity, chlorophyll, oxygen, sigma T (density) based on undulating continuous sampling (Berman and Sherman 2001).

A list of fish and fisheries surveys for demersal and pelagic indicators is given in Figure 3 (general indicators for each of the five LME modules are listed in Figure 1). Figure 4 shows African scientists gathered to board the *R/V Dr. Fridtjof Nansen* prior to departing for a productivity, fisheries, and oceanographic assessment survey for the Guinea Current LME project. Fisheries are also important in the Benguela Current LME Project, where the project leaders are especially keen to adopt advanced oceanographic forecasting methods for applications to a fisheries forecasting system, as described by Shannon et al. (2006).

The Guinea Current Large Marine Ecosystem

Surveys for Fish and Fisheries stock indicators

- Demersal species surveys
- Pelagic species surveys
- Ichthyoplankton surveys
- Invertebrate surveys (e.g. shrimp, octopus)

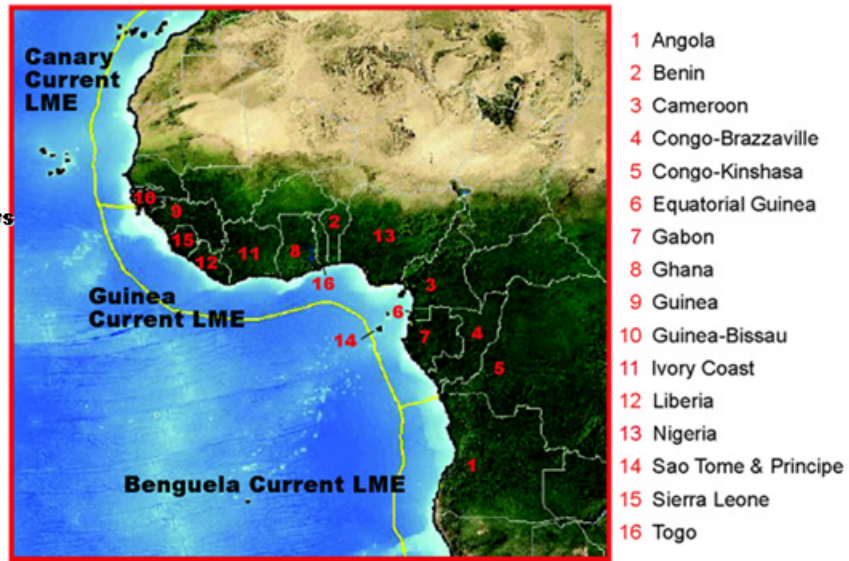


Figure 3. Surveys for Fish and Fisheries stock indicators for the 16-country Guinea Current LME project (Celone and Sherman 2002).



Figure 4. African scientists before boarding the R/V Dr. Fridtjof Nansen, Guinea Current LME project (Celone and Sherman 2002).

The growing number of fishery scientists and marine specialists participating in GEF-LME projects is now linked via an electronic network organized by the American Fisheries Society (AFS) with a grant from the GEF. The Global Fisheries Ecosystem Management Network (GFEMN) includes 42 participating countries.

Pollution and Ecosystem Health Module Indicators

In several LMEs, pollution and eutrophication have been important driving forces of change in biomass yields. Assessment of the changing status of pollution and health in an entire LME requires multiple-state comparisons of ecosystem resilience and stability. To be healthy and sustainable, an ecosystem must maintain its metabolic activity level and its internal structure and organization, and it must resist external stress over time and space scales relevant to the ecosystem (Costanza 1992).

The pollution and ecosystem health module measures pollution effects on the ecosystem through the monitoring strategy of the USEPA; its pathobiological examination of fish and fish tissue; and estuarine and nearshore monitoring of contaminants and contaminant effects in the water column, substrate, and selected groups of organisms. Where possible, bioaccumulation and trophic transfer of contaminants are assessed, and critical life history stages and selected food web organisms are examined for indicators of exposure to and effects from contaminants, effects of impaired reproductive capacity, organ disease, and contaminant-impaired growth. Assessments are made of contaminant impacts at both species and population levels. Implementation of protocols to assess the frequency and effect of harmful algal blooms, emergent diseases, and multiple marine ecological disturbances (Sherman 2000) are included in the pollution module.

In the United States, the EPA has developed a suite of five coastal condition indices: water quality, sediment quality, benthic communities, coastal habitat, and fish tissue contaminants (Figure 5) as part of an ongoing collaborative effort with NOAA, the US Fish and Wildlife Service, the US Geological Survey, and other agencies representing states and tribes. The 2004 *National Coastal Condition Report II* includes results from the EPA's analyses of coastal condition indicators and NOAA's fish stock assessments by LMEs aligned with the EPA's national coastal assessment regions (USEPA 2001; USEPA 2004). The EPA and NOAA are jointly introducing this approach to the international GEF supported LME projects, along with a methodology for nutrient assessment.

Nitrogen overenrichment has been reported as a coastal problem for two decades. In European LMEs, recent nitrogen flux increases have been recorded ranging from 3-fold in Spain to 4-fold in the Baltic Sea to 11-fold in the Rhine River basin draining to the North Sea LME. Howarth et al. (2000) and Duda and El-Ashry (2000) described the origin of this disruption of the nitrogen cycle from the Green Revolution of the 1970s, as the world community converted wetlands to agriculture, utilized more chemical inputs, and expanded irrigation to feed the world. For the Gulf of Mexico LME, much of the large increase in nitrogen export is from agricultural inputs, both from the increased delivery of fertilizer nitrogen as wetlands were converted to agriculture and from concentrations of livestock. Industrialized livestock production during the last two decades increased the flux, the eutrophication, and the oxygen depletion even more, as reported by the National Research Council (NRC 2000). Significant contributors to eutrophication are sewage from drainages of large cities and atmospheric deposition from automobiles and agricultural activities, with the amounts depending on proximity of sources.

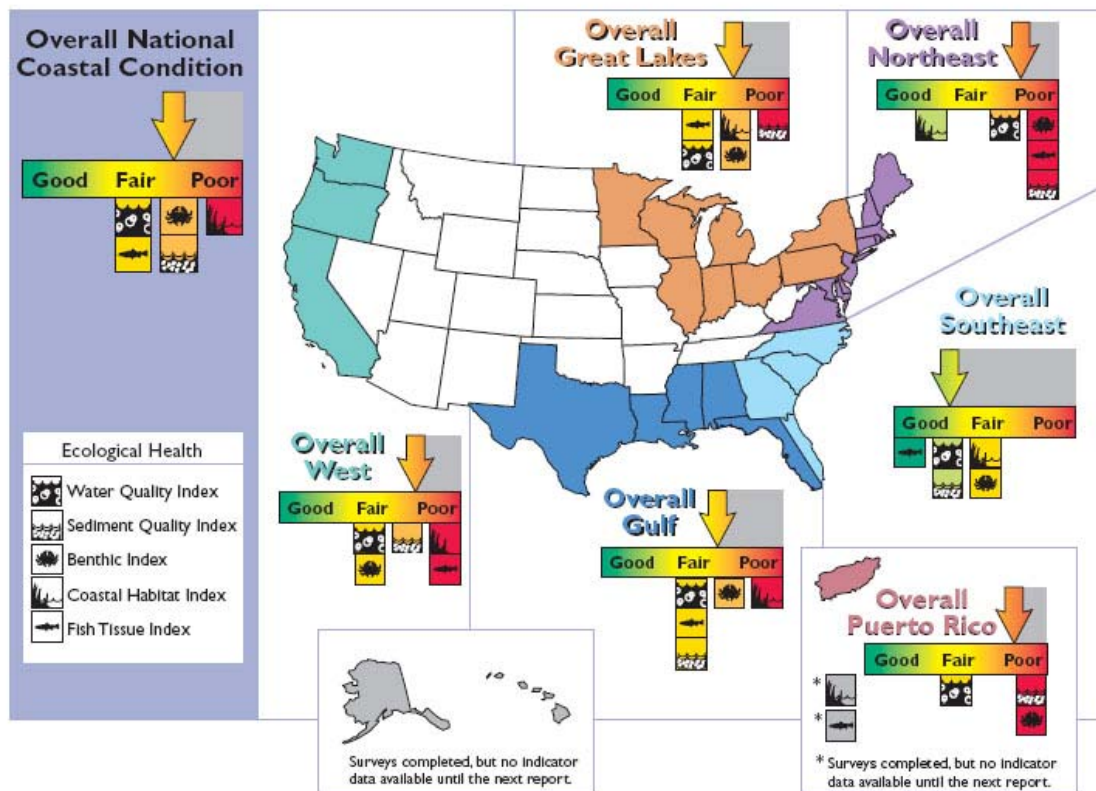


Figure 5. The Environmental Protection Agency's (EPA) five pollution and ecosystem health indicators for seven areas in the United States coinciding with LMEs, and stop-light assessments of the indicators (USEPA 2004).

GEF is frequently asked by countries to help support the agreed-upon incremental cost of actions to reduce such nitrogen flux. Actions range from assisting in: (1) development of joint institutions for ecosystem-based approaches for adaptive management, as described in this paper; (2) on the ground implementation of nitrogen abatement measures in the agricultural, industrial, and municipal sectors; and (3) breaching of floodplain dikes so that wetlands recently converted to agriculture may be reconverted to promote nitrogen assimilation. The excessive levels of nitrogen contributing to coastal eutrophication constitute a new global environment problem that is cross-sectoral in nature. Excessive nitrogen loadings and oxygen depletion events causing significant mortalities among marine resource species have been identified as problems in the following LMEs that are receiving GEF assistance: Baltic Sea, Black Sea, Adriatic portion of the Mediterranean Sea, Yellow Sea, South China Sea, Bay of Bengal, Gulf of Mexico, and Plata Maritime Front/Patagonia Shelf.

Preliminary global estimates of nitrogen export from freshwater basins to coastal waters were assembled by Seitzinger and Kroeze (1998). Their model predicts a doubling of nitrogen to coastal waters by 2050 (Figure 6). These preliminary estimates of global freshwater basin nitrogen export are alarming for the future sustainability of LMEs. Given the expected future increases in population and in fertilizer use, without significant nitrogen mitigation efforts, LMEs will be subjected to a future of increasing harmful algal bloom events, reduced fisheries, and hypoxia that further degrades marine biomass and biological diversity.

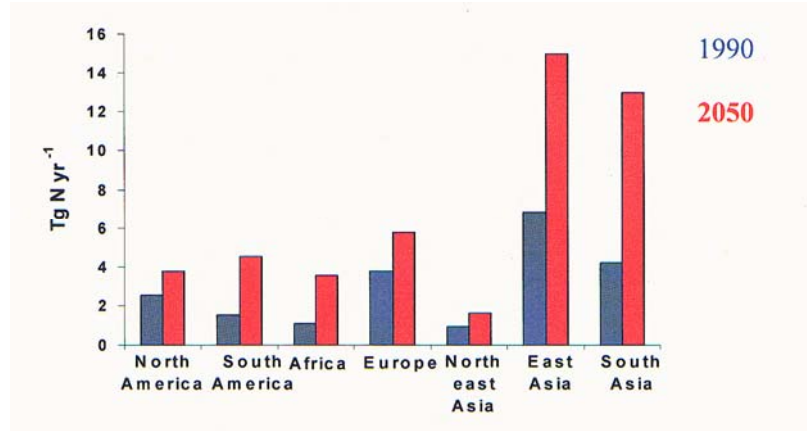


Figure 6. Model-predicted dissolved inorganic nitrogen (DIN) export by rivers to coastal systems in 1990 and 2050. (Predictions are based on a business-as-usual (BAU) scenario. Adapted from an image provided courtesy of S.P. Seitzinger, see further (Kroeze and Seitzinger 1998).

Socioeconomic Module Indicators

The LMEs annually contribute US\$12.6 trillion to the global economy (Costanza et al. 1997). The socioeconomic module emphasizes the practical application of scientific findings to managing LMEs and the explicit integration of social and economic indicators and analyses with all other scientific assessments to assure that prospective management measures are cost-effective. Economists and policy analysts work closely with ecologists and other scientists to identify and evaluate management options that are both scientifically credible and economically practical with regard to the use of ecosystem goods and services. In order to respond adaptively to enhanced scientific information, socioeconomic considerations must be closely integrated with science. This component of the LME approach to marine resources management has recently been described as the human dimensions of LMEs. A framework has been developed by the Department of Environmental and Natural Resource Economics at the University of Rhode Island for monitoring and assessment of the human dimension of LMEs and for incorporating socioeconomic considerations into an adaptive management approach for LMEs (Sutinen 2000). One of the more critical considerations, a method for economic valuations of LME goods and services, has been developed by using framework matrices for ecological states and economic consequences of change (Hoagland and Jin 2006; Hoagland et al. 2005; Olsen et al. 2006).

Governance Module Indicators

The governance module is evolving, based on demonstration projects now underway in several ecosystems, such that ecosystems will be managed more holistically than in the past. In LME assessment and management projects supported by the GEF for the Guinea Current and Benguela Current LMEs, agreements have been reached among the environmental, fisheries, energy, and tourism ministers of the countries bordering these LMEs to enter into joint transboundary, international resource assessment and management commissions. An example of this cooperation can be seen in the Cape Town Declaration (Appendix 1). Elsewhere, the Great

Barrier Reef and Antarctic LMEs are also being managed from an ecosystem perspective, the latter under the Commission for the Conservation of Antarctic Marine Living Resources. Governance profiles of LMEs are being explored to determine their utility in promoting long-term sustainability of ecosystem resources (Juda and Hennessey 2001). In each of the LMEs, governance jurisdiction can be scaled to ensure conformance with existing legislated mandates and authorities (Olsen et al. 2006). An example of multiple governance-related jurisdictions is shown in Figure 7 for the Northeast US Continental Shelf LME. The 260,000 km² spatial extent of the ecosystem encompasses multiple levels of marine management (governance) jurisdiction. The fisheries are managed in the New England area of the ecosystem by the New England Fishery Management Council, and the fisheries in the Mid-Atlantic area of the ecosystem, by the Mid-Atlantic Fishery Management Council. The estuaries and near-coastal areas within 3 miles of the coast are under jurisdiction of the coastal states from Maine to North Carolina where the USEPA provides grants to the states for monitoring changing ecological conditions using the 5 LME pollution and ecosystem health indicators. Other governance/management units are the National Estuarine Research Reserve System (NERRS), several marine fisheries protected areas and management sites, and a national marine sanctuary.

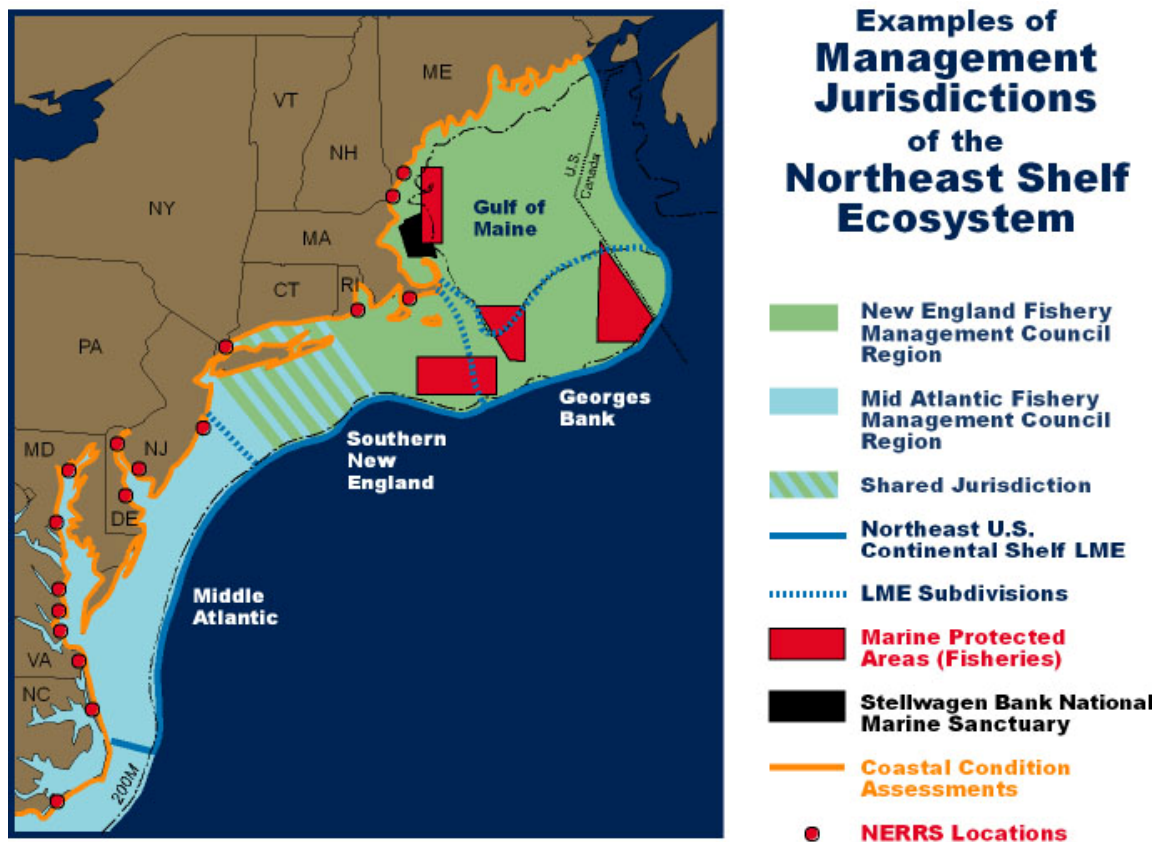


Figure 7. Example of multijurisdictional Large Marine Ecosystem governance. Included are: jurisdictions covered by the New England and Mid-Atlantic Fishery Management Councils, LME subareas, marine protected areas and the boundaries of the Stellwagen Bank National Marine Sanctuary, near-coastal areas assessed for “condition” determinations by the Environmental Protection Agency, and locations of National Estuarine Research Reserve System (NERRS) sites (Sherman et al. 2004).

4. Opportunities to link LMEs with GEOSS, GOOS, and IOOS: LME Indicators contribute to climate change assessments

Link the Global Marine Assessment and Global Earth Observation System of Systems.

Through international cooperation, the Global Earth Observation System of Systems (GEOSS) will collect and disperse data and information from terrestrial, atmospheric, climate, and ocean observations. The Global Marine Assessment (GMA), under discussion since the World Summit on Sustainable Development, will seek to establish a regular, comprehensive process of reporting and assessment of the state of the global marine environment. The Administration supports both efforts, and will actively seek to create international links between the two processes. (US Ocean Action Plan, page 37).

The ecosystem objectives of the Global Earth Observation System of Systems (GEOSS), Global Ocean Observing System (GOOS), and Integrated Ocean Observing Systems (IOOS) are to improve the management and protection of coastal and marine ecosystems. LME assessments can be combined with GEOSS, GOOS, and IOOS to develop place-based environmental information of value to the public and to enhance research to address issues relating to fisheries, aquaculture, urbanization and coastal communities, coral reefs, invasive species, protection and restoration of habitats, and protected species. Temperature increases in the world's LMEs have significant ecological impacts. For example, in the East Bering Sea LME, these include ecosystem productivity change, loss of sea ice, coastal response to sea-level rise, and nutrient-climate interactions (Overland et al. 2005). The ecosystem indicators developed through the LME modular approach are important sources of data and information for IOOS and GEOSS. Examples of the productivity indicators compatible with IOOS, GOOS, and GEOSS (Figure 2) are programmed for inclusion in the Guinea Current LME and Benguela Current LME projects.

4.1. Africa GOOS

The 16 GEF-supported LME projects through funding from the GEF are acquiring new instruments for monitoring changing states of LMEs and are providing input data for the IOOS/GOOS/GEOSS. LME projects in Africa are operationalizing the five-modular approach in the Mediterranean Sea LME, the Canary Current LME, the Guinea Current LME, and in the Agulhas-Somali Current LMEs. In keeping with NOAA efforts to encourage partnerships with countries and scientific organizations to share earth observations and develop and strengthen data networks (NOAA 2007), LME projects in Africa are developing strong links with GOOS. Several Africa-GOOS workshops were organized by the Benguela Current LME Project and by the Intergovernmental Oceanographic Commission (IOC) of the United Nations Educational, Scientific, and Cultural Organization (UNESCO). The workshops discussed operational oceanography and the uses of remote sensing in Africa. In addition, a pan-African LME forum was attended by African ministers who on November 13, 2006 issued a Cape Town Declaration

supporting the advances made by the African LME projects (see Appendix 1). There has been GOOS–Africa–IOC participation in the planning of the Canary Current LME project and involvement in the preparation of the Agulhas-Somali Current project document. LME observation systems in Africa are being used both for monitoring changing conditions in fisheries, offshore oil and gas, shipping and trade, mining, integrated coastal zone management, seaside tourism, and public safety and health and for developing early warning systems for floods, droughts, and sea level rise.

Both GOOS and LMEs have a regional focus and are intended to be permanent, with sustainable funding by national institutions. LME programs operate in countries most in need of assistance in capacity building. The LME Program is expediting actions for linking IOOS, GOOS, and GEOSS with ongoing projects in Africa to augment data and information pertinent to fisheries, aquaculture, coastal zone management, and earth observations.

5. LME Program Collaboration

NOAA and other marine resource stewardship agencies are collaborating in the planning and implementation of GEF supported LME projects in 110 developing countries. The NOAA LME Program is providing US assistance to the 16 LME projects listed in Table 2. Profiles of selected LME foundation projects can be found in Appendix 5. “In kind” technical and scientific assistance is being provided to LME projects in the developing countries of Asia, Africa, Latin America, and the Caribbean, as well as in Eastern Europe. Countries in these LME projects are moving 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) to: achieve substantial reductions in land-based sources of pollution; introduce an ecosystems approach to marine resource assessment and management by 2010; designate a network of marine protected areas by 2012; and maintain and restore fish stocks to maximum sustainable yield levels by 2015. While it is unlikely that these targets will be met, significant progress is being made toward each of the targets by a growing number of countries participating in the NOAA-GEF supported global LME initiative. One hundred and ten participating countries, supported by US\$1.8 billion and a network of 2,500 people, are focusing a major effort on making strides towards the WSSD targets.

Within the global LME Program, NOAA and marine stewardship agencies from other countries can 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. Expertise in science and technology, ecosystems applications, and international participation in GOOS and GEOSS is being provided by NMFS, NOS, NESDIS, OAR, and NWS. Closer integration between NOAA’s observation activities and the new start-up activities of the GEF-LME projects will allow for significant global advances in the spatial and temporal application of ocean and atmospheric monitoring from satellites, buoys, in situ sensors, and ship based measurements. The joint activity will improve assessments of the effects of climate change and physical forcing of biological systems on LMEs through the use of ecosystem indicators in productivity, fish and fisheries, pollution and ecosystem health, socioeconomics, and governance.

5.1. Opportunities for Scientific and Technical Assistance to GEF-LME Projects (FY 2007-2010)

In 2007-2010, GEF is expanding opportunities for increasing the scope of LME Foundation Projects. The need has increased for scientific and technical assistance aimed at the four ocean-related WSSD targets. NOAA faces the challenge to improve integration of LME observations into a system of data and information processing for applications to GOOS, IOOS, and GEOSS in collaboration with NESDIS, NOS, OAR, NWS, NMFS, and other agencies. One of the opportunities sought by GEF recipient countries is access to and training in advanced applications of satellite remote sensing for linking in situ subsurface chlorophyll and temperature data with surface data as depicted in Figure 8.

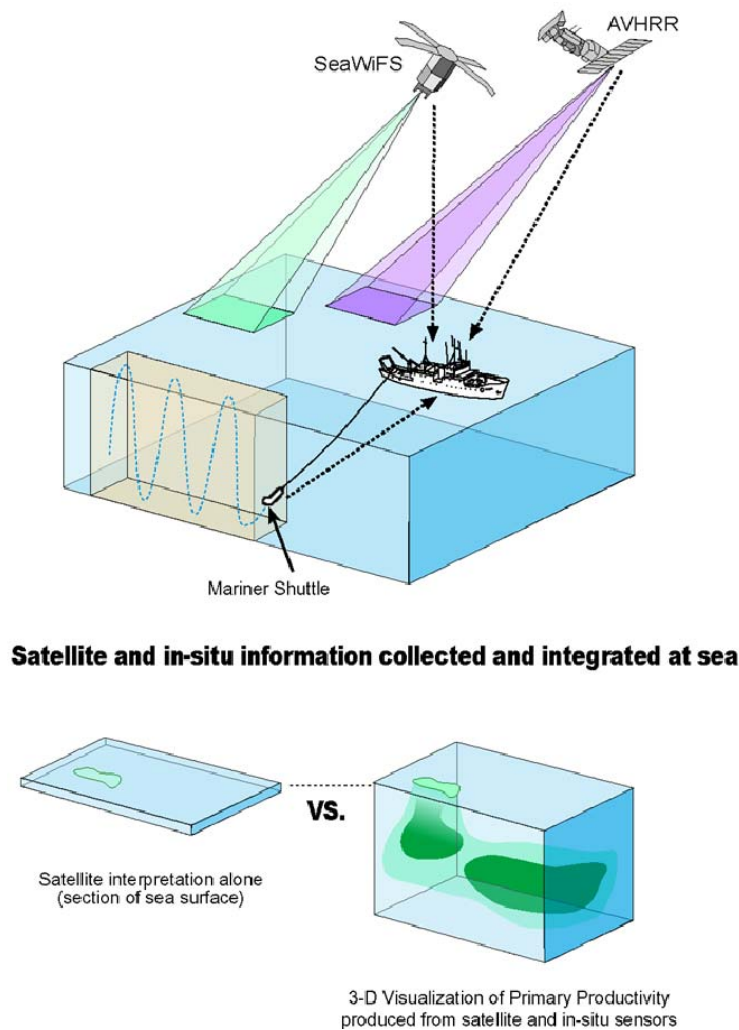


Figure 8. Schematic illustrating the electronic integration of the Sea-viewing Wide Field-of-view Sensor (SeaWiFS) Chlorophyll data and AVHRR Sea Surface Temperature (SST) data with in-situ subsurface data. In-situ sensors add depth to the relatively shallow section of sea surface interpreted remotely from satellite sensors.

Countries participating in GEF-LME Projects have requested scientific and technical assistance from NOAA and other ocean agencies in the operationalization of the modular approach to LME assessments, including: productivity-oceanography-climatology assessments; fish and fisheries assessments in support of the precautionary approach to accelerate fisheries recovery; a resolution of conflicts between artisanal and industrial fisheries; a reduction and control of the harmful effects of nutrient overenrichment on LME goods and services; and the development of strategies for adapting to global warming, in order to maintain and further develop the socioeconomic benefits from LME goods and services. The type of in-kind, scientific and technical support that can be provided by NOAA and other marine stewardship agencies includes: (1) training in the use and delivery of satellite-derived oceanographic products and advanced survey technology for primary productivity measurements; (2) training in the use of advanced methodologies for assessing fish and fisheries stocks, demographics, and the development and use of indicators of ecosystem carrying capacity for sustainable fishery yields and ecosystem health; and (3) scientific and technical training in the use of new technologies and models for cost effective modeling and measuring indicators of ecosystem level changes effecting socioeconomics and governance of LMEs. Examples are the training workshops for plankton analysis (Figure 9).

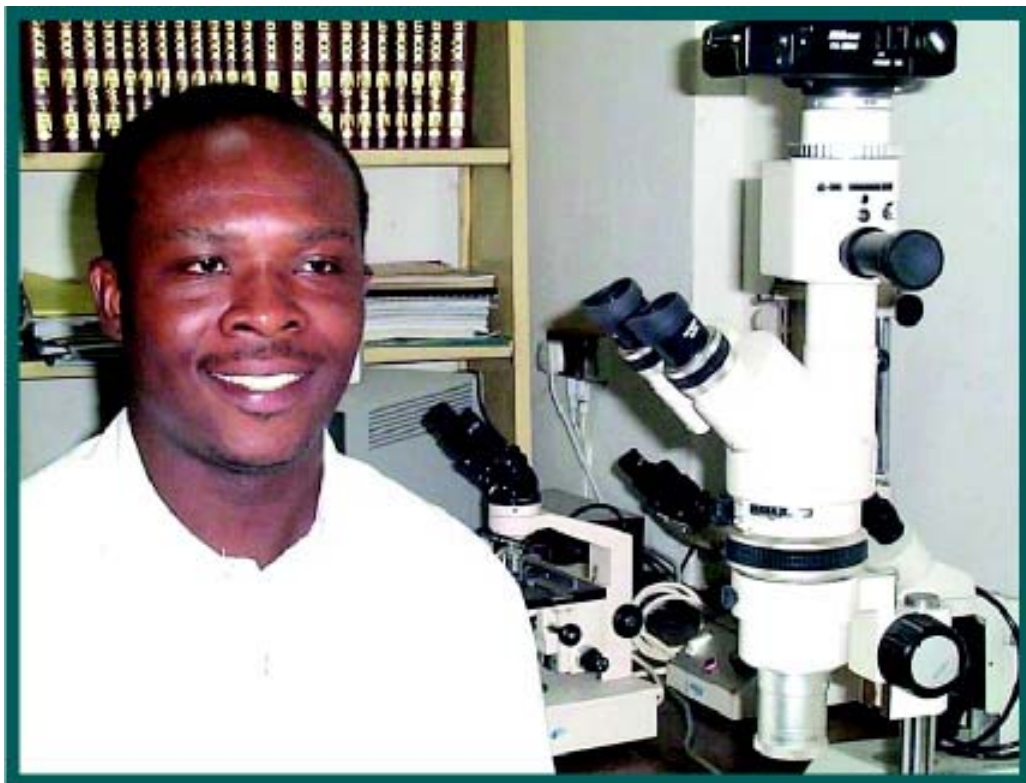


Figure 9. Dr. George Wiafe, scientist and Professor at the University of Ghana. For his Ph.D. research, he analyzed samples collected from the Guinea Current Large Marine Ecosystem (GCLME). Dr. Wiafe attended training workshops for plankton analysis, some of which took place at the Sir Alister Hardy Foundation for Ocean Science in Plymouth, England. He contributed to the first assessment of variability in plankton productivity across the LME and has prepared a manual on the identification of zooplankton in the Gulf of Guinea.

A complete listing of LME projects and activities programmed for 2007-2010 is given in Table 4. Among the new opportunities for NOAA participation is assistance needed by developing countries in the reduction of nutrient loading in LMEs, the establishment of a network of marine protected areas, and the improved management of coastal zones, consistent with NOS activities. NOAA's International Affairs (IA) office supports an LME activity with the Arctic Council that offers a good opportunity for collaboration with OAR and NWS in a new initiative to assist countries in adapting to climate change and ice melt conditions affecting Arctic LMEs and high altitude glacial ecosystems. In addition, there is an emerging ecosystem-based approach to the assessment and management of marine resources within the APEC nations. The key contact for the Arctic at IA is Elizabeth McLanahan. The key contact for APEC is Elaine Denning at IA. The key contact at NOAA-Fisheries for IOC-UNESCO interactions is Ned Cyr. For LME foundation projects and investment fund project coordination, the key contacts are Kenneth Sherman, Marie-Christine Aquarone, and Sally Adams at the LME Program Office in Narragansett, RI. In addition, Jay O'Reilly of the Office of Marine Ecosystem Studies (OMES, NEFSC) is providing scientific and technical assistance for the productivity module to the LME projects along with Mark Berman and Chris Melrose. Initial development of international LME project oriented Integrated Ecosystem Assessments (IEAs) is being headed up by Kevin Friedland of OMES, Narragansett, RI. Collaboration is encouraged for NESDIS assistance in linking subsurface measurements of chlorophyll and primary productivity with sea-surface products pertinent to IOOS, GOOS, and GEOSS.

PART II. CRITICAL INTERNATIONAL PARTNERS OF THE LME PROGRAM

1. UN Partners

There is an ongoing effort to coordinate scientific and technical assistance to the developing countries engaged in GEF-LME projects, in collaboration with NOAA's International Affairs Office and the director of NOAA's Ecosystem Goal Team through the services of the NOAA Office of Science and Technology and the LME Program Office. As the international Ecosystem Goal Team continues the long-term development of an ecosystem-based approach to the assessment and management of marine resources and their environments, focus will be on: identifying indicators of changing ecosystem states in relation to fish stock recovery, providing scientific advice, meeting stakeholder needs for ecosystem information at the international level, providing technical and scientific assistance for management programs that have an ecosystem-based framework, and offering strategies to assist LME project implementation. The NEFSC Office of Marine Ecosystem Studies and the LME Program Office in Narragansett, RI will continue to assist developing countries in achieving GEF-LME project objectives and in applying lessons learned from the advanced stages of several projects engaged in applying ecological time series to management decisions for the recovery and sustainability of LME goods and services. Coordination is ongoing with the five agencies of the UN system (UNIDO, UNDP, FAO, IOC/UNESCO, and UNEP), in providing support to the 16 GEF-LME projects.

1.1. UNIDO

The United Nations Industrial Development Organization (UNIDO) is the technical UN agency which brings together skills and expertise on industrial development and environmental protection. UNIDO provides knowledge-based expertise and transfer of environmentally sound technologies for water treatment, waste management, cleaner production, and methodologies for reducing Persistent Organic Pollutants (POPs) in the environment. It partners with the LME program in several International Waters projects supported by GEF. These LME projects include one that addresses coastal area degradation and living resources depletion in the Guinea Current LME through regional actions (16 countries); a Regional Latin America Integrated Management Project for the Humboldt Current LME (2 countries); and a regional Latin America integrated assessment and management project for the Gulf of Mexico LME (2 countries).

1.2. UNDP

The United Nations Development Programme (UNDP) addresses poorly managed and uncoordinated human activities across sectors that are threatening shared international water resources and the livelihoods of people who depend on them. Major threats include sea and land-based pollution, depletion of freshwater resources, habitat loss, introduction of exotic species, and over-harvesting of living and nonliving aquatic resources. Addressing these threats, UNDP-GEF projects in the International Waters focal area aim at achieving a comprehensive, ecosystem-based approach to the sustainable management of international waters and to incorporate both developmental and ecological needs. Much of the global marine resources are shared by two or more countries bordering each of the 64 LMEs, where 80% of the world's fish are caught. The LME projects implemented by the UNDP include the Guinea Current LME (with UNIDO), the Benguela Current LME, the Yellow Sea LME, the LMEs of East Asia (Gulf of Thailand, South China Sea, Sulu-Celebes Sea, Indonesian Sea LMEs), and the Black Sea LME.

1.3. FAO

The Food and Agriculture Organization (FAO) of the United Nations leads international efforts to defeat hunger and assist developing countries and countries in economic transition to improve fisheries practices. FAO has focused special attention on LME projects such as the Bay of Bengal LME, the Canary Current LME, and the Yellow Sea LME. An agreement was reached in 2005 with the Norwegian government and FAO for making the *RV Nansen* available at reduced operational costs to LME projects in West Africa. The Canary Current, Guinea Current, and Benguela Current LME projects are conducting joint surveys wherein operations are providing assessment data to implement the modules of productivity, fish and fisheries, and pollution and ecosystem health in the three West Africa LME projects. These surveys will be extended to the Agulhas Current and Somali Current LMEs along the East African coast, beginning in late 2007. The resulting data and information constitute an important contribution to GOOS and GEOSS.

1.4. IOC-UNESCO

The Intergovernmental Oceanographic Commission (IOC) of UNESCO advances research and new ideas from the oceanographic community and supports oceanic investigations needing to be undertaken by several nations at once. The IOC hosts the annual LME Consultative Committee Meeting. This 2-day meeting brings together the worldwide network of LME scientists and policy-makers for an annual review of LME projects and activities around the globe. Reports have been published and distributed by the IOC and are available online from the UNESCO document website at www.ioc-unesco.org (search for the phrase 'IOC Consultative Reports' to be taken from the IOC Consultative Large Marine Ecosystem Meeting Reports list).

1.4.1. The IOC Medium-Sized Project (MSP) Entitled “Promoting LME Approaches to Fisheries Conservation” (US\$1.7 million)

The IOC is supporting a Medium-Sized Project (MSP) for promoting ecosystem-based approaches to fisheries conservation and LMEs. The MSP has six components: (1) training by colleagues from the University of British Columbia (UBC) in the application of Ecosim and Ecopath modeling for 64 LMEs; (2) a fisheries ecosystem capacity building project, which is an electronic network for members of international fisheries societies conducted by the American Fisheries Society; (3) training in the application of nitrogen flux models to all 64 LMEs under the direction of Dr. Sybil Seitzinger, NEFSC/Rutgers University; (4) the development and expansion of an information portal for LMEs by the University of Rhode Island; (5) training on modeling focused on biological particle size spectra as potential indicators of ecosystem condition, under the direction of Princeton University, the University of California-Berkeley, the International Center for Theoretical Physics (ICTP), the International Institute for Applied Systems Analysis (IIASA), and NOAA; and (6) a project by UBC to rearrange 2001-2005 FAO global capture statistics into LMEs.

The MSP is funded by the GEF, implemented by the IOC, and coordinated by NOAA. GEF direct support is US\$995,000. The components coordinated by the LME Program Office include the Eutrophication Project (US\$430,000, with a NOAA in-kind contribution of US\$100,000). This project proposes to fill the gaps in nitrogen loading forecasts for LMEs. Disruption of the nitrogen cycle is occurring worldwide with the conversion of wetlands to agriculture, the use of more chemical inputs, the expansion of irrigation, and the contribution of sewage to eutrophication. Scientists from developing countries and countries with economies in transition will be trained through the IOC Eutrophication Network in the methods and application of a nitrogen-based model used to forecast eutrophication conditions in coastal waters of selected LMEs. Forecasts will be based on a new and innovative Nitrogen Export from Watersheds (NEWS) model. The Modeling Project (US\$140,000, with a NOAA in-kind contribution of US\$70,000) focuses on the use of a methodology with a training component on “The ecological use of the size spectrum of organisms in the sea (the ‘Sheldon Spectrum’), in the large marine ecosystem context”; workshops on carrying capacity (US\$335,000) provide training and application of the Ecosim/Ecopath model to the 64 LMEs. The Project on Geographic Information System (GIS) training in assessment and management of LMEs (US\$45,000, with a NOAA in-kind contribution of US\$10,000) focuses on “The geospatial data foundation for large marine ecosystems: a seamless architecture within and among LMEs.” The FAO catch statistics

updates project (US\$50,000, with a NOAA in-kind contribution of US\$10,000) completes and disseminates 64 LME time-series depicting trends in fish biomass levels. The American Fisheries Society and World Council of Fisheries Societies project (US\$45,000) develops an extensive database of ecosystem oriented fisheries management practices and experts. An e-network provides for communications and information exchanges among GEF-LME projects around the globe.

1.5. NOAA Partnership with the United Nations Environment Programme (UNEP)

The United States will promote, within the United Nations Environment Programme's Regional Seas programs and by international fisheries bodies, the use of the large marine ecosystems (LME) concept as a tool for enabling ecosystem-based management to provide a collaborative approach to the management of resources within ecologically bounded transnational areas (USOAP 2004, p. 36-37).

1.5.1. UNEP Global Programme of Action (GPA)

Some 80% of the pollution load in the oceans originates from land-based activities (municipal, industrial, and agricultural wastes; run-off; and atmospheric deposition). These contaminants affect the most productive areas of the marine environment, including estuaries and near-shore coastal waters. The health, and in some cases the very survival, of coastal populations depend upon the health and well-being of coastal systems such as estuaries and wetlands. In response to intense pressures put on coastal systems, 108 governments and the European Commission adopted the 1995 Washington Declaration to establish a Global Programme of Action (GPA) for the Protection of the Marine Environment from Land-based Activities, to be administered by UNEP. In 2005, NOAA partnered with UNEP's GPA in The Hague to assist developing nations in restoring and sustaining the goods and services of the world's LMEs. In keeping with NOAA's 2005 Memorandum of Understanding with UNEP, significant steps forward were taken in assisting countries in planning and implementing LME projects for achieving the objectives of the GPA.

The Beijing Declaration of October 2006 (Appendix 3) furthered the implementation of the GPA by outlining national, regional, and international actions needed to apply ecosystem approaches, to value the social and economic costs and benefits of the goods and services that oceans and coasts can provide, and to strengthen the implementation of the GPA through the UNEP Regional Seas Programme and other regional mechanisms. The application of the five LME module indicators of changing ecosystem conditions (productivity, fish and fisheries, pollution and ecosystem health, socioeconomics, and governance) provide useful baseline information from which to measure progress by governmental stewardship agencies toward the recovery of depleted fish stocks, restoration of degraded habitats, and reduction of coastal pollution. These suites of indicators are consistent with measurements needed to quantify progress in the implementation of the ecosystem-based approach to the UNEP GPA and to the UNEP Regional Seas Programme.

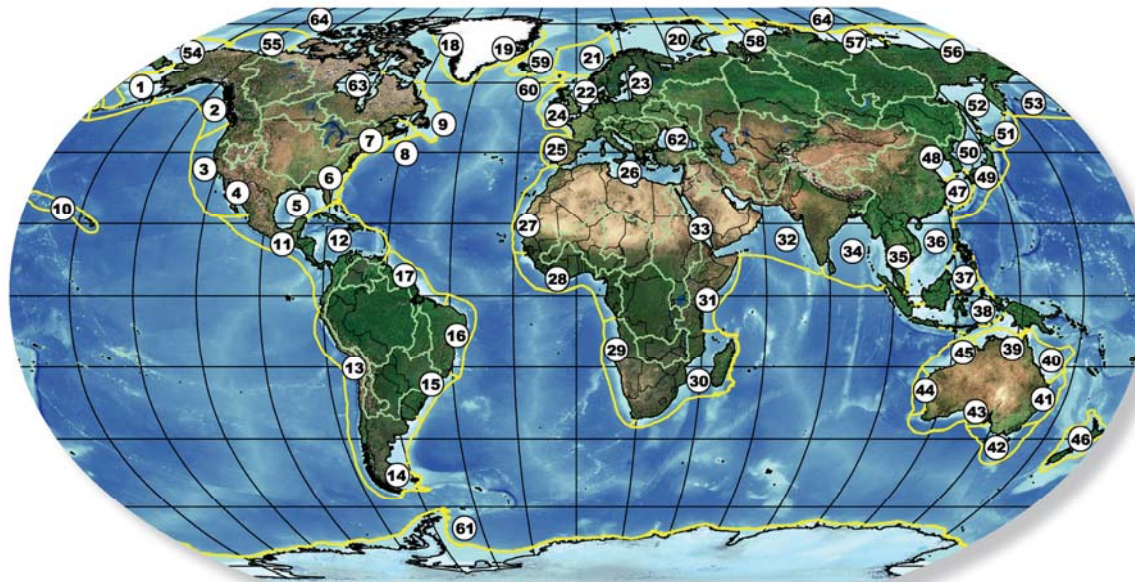
1.5.2. UNEP Regional Seas Programme

The sixth global meeting of the UNEP Regional Seas Conventions was held in 2004 and adopted a resolution to incorporate NOAA's LME approach and to use LMEs as operational/management units for translating Regional Seas programs into concrete actions. The ensuing partnership linked the Regional Seas Programme and the GEF-LME projects, focusing on the assessment and management of LMEs located in the Regional Seas areas (Figures 10A and 10B). Proposed outcomes are concrete proposals to improve Regional Seas Programme performance and to promote an ecosystem-based approach in Regional Seas projects. The US Ocean Action Plan supports this initiative (US Ocean Action Plan in relation to LME activities, Appendix 4).



Figure 10A. Map of LMEs within and external to Regional Seas (Sherman and Aquarone 2004).

Large Marine Ecosystems of the World and Linked Watersheds



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

Figure 10B. Map of the 64 Large Marine Ecosystems of the world and their linked watersheds (Sherman et al. 2004).

The outcomes of the Regional Seas/LME partnership have included: a table of GEF-LME projects within the Regional Seas areas; an 8-page brochure describing the NOAA-UNEP partnership in Regional Seas; and several contracts between UNEP-Regional Seas and the University of Rhode Island and the Marine Policy Center at the Woods Hole Oceanographic Institute for frontal maps and temperature series for all 64 LMEs, as well as improved estimates of goods and services for selected LMEs within Regional Seas.

1.5.3. UNEP LME Report

NOAA and UNEP have agreed to collaborate on the preparation and publication of an initial assessment of the changing conditions of the world's 64 LMEs. The planned UNEP LME report will profile conditions in LMEs located within the Regional Seas. Each of the 64 descriptions will include time series trends and patterns of Sea Surface Temperatures (SST) (Igor Belkin, University of Rhode Island); fronts circulation (Igor Belkin, University of Rhode Island); chlorophyll and primary production (J. O'Reilly, Office of Marine Ecosystem Studies, NOAA-NMFS); fish and fisheries yields, fish values, and marine trophic indices (D. Pauly and V. Christensen, University of British Columbia); DIN, nutrient loading, and eutrophication (S.

Seitzinger, Rutgers University); pollution and ecosystem health (Group of Experts on Scientific Aspects of Marine Environmental Protection); socioeconomics (P. Hoagland, Woods Hole Oceanographic Institution and J. Sutinen, University of Rhode Island); and governance descriptions (L. Juda and T. Hennessey, University of Rhode Island). The NOAA LME report is scheduled for publication by UNEP in 2008.

1.5.4. TIWAS (UNEP-Nairobi)

A proposed Transboundary International Waters Assessment (TIWAS) medium-sized project (MSP) is presently being developed by UNEP-Nairobi. The LME Program Office is collaborating with UNEP to design a scientifically robust methodology for comparative assessment of priority transboundary concerns, their causes and socioeconomic impacts in the world's transboundary groundwater systems, surface water systems, LMEs, and selected open ocean areas. The MSP will establish a global methodology around the LME concept. The methodology is to be completed within the next 12 months through the deliberations of a consortium of senior scientists and marine policy experts from Princeton University (S. Levin); UC Berkeley (T. Powell); the International Institute for Applied Systems Analysis (IIASA, Vienna); the International Centre for Theoretical Physics (ICTP, Trieste); the University of New Hampshire (Charles Vorosmarty); GESAMP (Robert Duce); the LME Program Office (Narragansett, RI); University of Kalmar, Sweden; GEF-LME international project staff; and UNEP-Nairobi. The fourth replenishment of GEF is providing funds to support the application of an acceptable methodology for the transboundary international waters assessment.

1.6. *Protection of the Arctic Marine Environment (PAME)—LME actions in the Arctic*

The 17 Arctic LMEs (Figure 11) are diverse and dynamic systems under stress from global warming and the melting of sea ice. Marine species are few, but each species has high numbers. 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 ice melt conditions 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 reviewed and accepted a working map of 17 Arctic LMEs (Figure 11) to guide the 2006 to 2008 work plan (see PAME website at: <<http://www.pame.is>>). Experts from Arctic countries are reviewing suites of LME indicators for assessing the changing states of 17 Arctic LMEs. The indicators will be tested and evaluated during a pilot project focused on the West Bering Sea LME. A project proposal for the GEF is in preparation by the United States (NOAA) and the Russian Federation (Murmansk Marine Biological Institute). 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. 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.

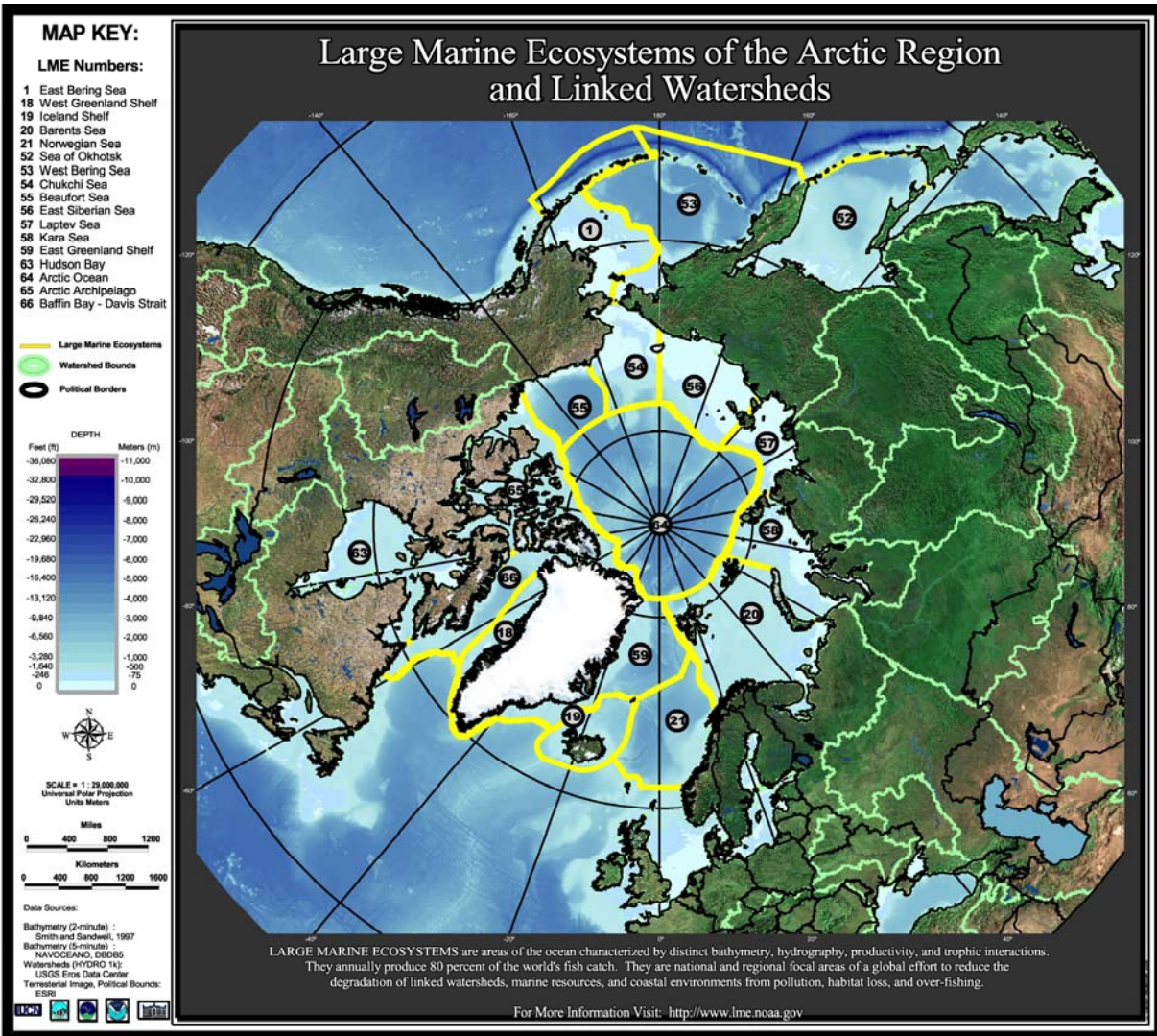


Figure 11. Map of the 17 LMEs of the Arctic.

1.7. Asia-Pacific Economic Cooperation (APEC)

The Asia-Pacific Economic Cooperation (APEC) project takes initial steps toward examining LMEs in the Asia-Pacific region. 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 ensure sustained production potential for the goods and services of the region. Workshops were undertaken in 2007 to agree on the science based criteria to be used in the identification of LMEs, to agree on a set of indicators, and to create 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. In total, 23 Pacific Ocean LMEs are involved in the project.

2. Nongovernmental Organizations (NGOs)

2.1. The IUCN

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 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.

2.2. World Wildlife Fund

The World Wildlife Fund (WWF) is included in the World Bank Partnership Investment Fund, together with the GEF, the Global Program on Fisheries (PROFISH), and other bilateral and multilateral donors in the funding of country-level activities on a country-by-country basis. The Partnership Investment Fund is advised by a strategic partnership of stakeholders in the region who, at the regional level, facilitate the exchange of information and lessons learned among LME projects and monitor and evaluate program progress. In Africa, for example, a Regional Advisory Committee (RAC) chaired by the African Union will include representatives of UN implementing agencies for the LME Programs (and staff from those agencies), regional fisheries bodies, civil society organizations, the World Bank, WWF, and other donors and organizations. After the first tranche, FAO will provide secretarial services to the RAC and its chair. The RAC secretariat will provide assistance to countries for the preparation of proposals and communications; assist in the coordination and exchange of information and lessons learned; disseminate to countries, stakeholders, potential co-financiers, and other relevant parties, the objectives and requirements of the strategic partnership; and prepare annual reports, progress reports, work plans, and budgets. The WWF and the FAO will provide early support in communications, awareness building, and information dissemination of the strategic partnership. In addition, WWF is active in the Global Programme of Action in the Baltic Sea, and in the Mediterranean Sea LME Program.

3. The LME Commissions

During the 10-year period between the United Nations Conference on Environment and Development (UNCED) in 1992 and WSSD in 2002, advances were made in introducing ecosystem-based assessment and management of natural resources and their environments. A significant milestone in the marine ecosystem assessment and management movement was achieved in the mid 1990s by the Ecological Society of America Committee on the Scientific Basis for Ecosystem Management. The Committee concluded that the overarching principle for guiding ecosystem management is to ensure the intergenerational sustainability of ecosystem goods (e.g., fish, trees, petroleum) and ecosystem services or processes including productivity cycles and hydrological cycles (Christensen et al. 1996). From a fisheries perspective, the National Research Council (NRC 1999; NRC 2000) concluded that sustaining fishery yields will require maintaining the ecosystems that produce the fish. These reports are supportive of a paradigm shift from the highly focused, single-species or short-term sectoral thematic approach in general practice today to a broader, more encompassing, multithematic ecosystem-based approach that moves spatially from smaller to larger scales and from short-term to longer-term management practices. Included in this approach is a movement away from the management of commodities toward maintaining the sustainability of marine resources to ensure benefits from ecosystem goods and services for the future.

3.1. Paradigm Shift to Ecosystem-based Management

The paradigm shift depicted in Table 3 is presently emerging in the applications of ecosystem-based assessment and management policies within the geographic boundaries of LMEs. On a global scale, 64 LMEs produce 80% of the world's annual marine fishery biomass yield. Most of the global coastal ocean pollution and marine habitat alteration also occur within the boundaries of LMEs.

Table 3. Movement toward ecosystem based management (from Lubchenco 1994)

<i>From</i>	<i>To</i>
Individual species	Ecosystems
Small spatial scale	Multiple scales
Short-term perspective	Long-term perspective
Humans: Independent of ecosystems	Humans: Integral parts of ecosystems
Management divorced from research	Adaptive management
Managing Commodities	Sustaining production potential for goods and services

In 1995, the GEF Council included the concept of LMEs in its GEF Operational Strategy as a vehicle for promoting ecosystem-based management of coastal and marine resources in the International Waters focal area within a framework of sustainable development. The report of the second meeting of the UN open-ended informal Consultative Process on Oceans and the Law of

the Sea (UN General Assembly 2001) recognized the contribution of the GEF in addressing LMEs through its science-based and ecosystem-based approach. Since the mid-1990s, developing countries have approached the GEF in increasing numbers for assistance in improving the management of LMEs shared with neighboring nations. Processes being undertaken as part of GEF projects are focusing on LMEs to foster country-driven commitments to policy, legal, and institutional reforms for changing the way human activities are conducted in the economic sectors that place stress on coastal ecosystems. LMEs serve as place-based, ecologically-defined areas for which stakeholder support for integrating essential national and multicountry reforms and international agency programs can be mobilized into a cost-effective, collective response to an array of conventions and programs. Site-specific ocean concerns, those of adjacent coastal areas, and of linked freshwater basins are being addressed in LMEs through GEF assistance. Operation of joint management institutions is being supported and tested in order to restore biomass and diversity to sustainable levels to meet the increased needs of coastal populations and to reverse the precipitous declines in ecosystem integrity currently being caused by overfishing, habitat loss, and nitrogen overenrichment. At risk are renewable goods and services valued at US\$12.6 trillion per year to the global economy. The geographic area of the LME, including its coastal area and contributing basins, constitutes the place-based area for countries to understand linkages among root causes of degradation and for integrating needed changes in sectoral economic activities. The LME areas serve to initiate capacity building and to bring science to pragmatic use in improving the management of coastal and marine ecosystems.

3.2. The New LME Commissions for Ecosystem-based Management

The governance module is evolving based on demonstrations now underway to manage ecosystems from a more holistic perspective than generally practiced in the past. In two GEF supported projects—the Guinea Current LME and the Benguela Current LME—agreements have been reached by the environmental ministers, the fisheries ministers, the energy ministers, and the tourism ministers of the countries bordering each LME to support joint resource assessment and management activities and to establish commissions for advancing the assessment and management of the goods and services produced by the LMEs.

In the 1992–2002 decade between two major global environmental summits, UNCED and WSSD, significant advances in the scientific assessments of the oceans and on the effects of climate change, overfishing, decreased biodiversity, and coastal waters pollution and overenrichment convinced the political leadership of the global family of nations that the years 2002 to 2020 would be noted for actions taken to adapt civil society and socioeconomic sectors to climate change and, to the extent possible, mitigate its effects. With regard to the issues of overfishing and pollution, nations at the WSSD agreed to achieve substantial reductions in land-based sources of pollution; to introduce an ecosystems approach to marine resource assessment and management by 2010; to designate a network of marine protected areas by 2012; and to maintain and restore fish stocks to maximum sustainable yield levels by 2015. Ocean stewardship agencies and financial institutions during the post WSSD decades are far better prepared to assist developing countries to turn the corner on global environmental degradation and make real strides in reclaiming the full productive potential and sustainability of LME goods and services.

In August 2006 in Cape Town, South Africa, the ministers responsible for fisheries, the environment, tourism, and energy of South Africa and Namibia signed the document bringing into force the Benguela Current Commission. This action was followed by the initiation in Abuja, Nigeria, on 22 September 2006 of an Interim Guinea Current Commission. Both commissions agreed to use the Strategic Action Plan (SAP) for the GEF-LME projects (BCLME project SAP; GCLME project SAP) as the framework of commission deliberations. It is explicitly stated in the case of the Benguela Commission that the objective of the Commission is

to establish a formal structure for cooperation between the contracting states that will facilitate the understanding, protection, conservation, and sustainable use of the Benguela Current Large Marine Ecosystem by the Contracting States and to further the objectives recorded in the Strategic Action Programme. (BCC Interim Agreement 2006, Article 2. Objective. The complete 29 August 2006 text is available online at www.bclme.org, Interim Agreement).

The Abuja Declaration establishing the Interim Guinea Current Commission states that,

The GCLME Project Regional Coordination Unit (RCU) with its complement of staff will serve concurrently as the Executive Secretariat of the Interim Guinea Current Commission. The IGCC will eventually take leadership of the Project and its coordination. The IGCC will play the key role in completing the development of the Strategic Action Plan (SAP) as the Project is implemented and will be responsible for negotiating subsequent phases of the GCLME project and agreements with cooperating institutions (Appendix 2).

The Guinea Current LME and Benguela Current LME Commissions will be taking actions leading to the recovery and sustainability of goods and services provided by these ecosystems. Efforts will be directed to the addition and integration of ecological information obtained from the five-module indicator suites. The results of the integrated ecosystem assessment processes conducted by designated working groups of the commissions are adapted for recovery and sustainability of depleted fish stocks during the annual cycle of assessment and management as depicted in Figure 12.

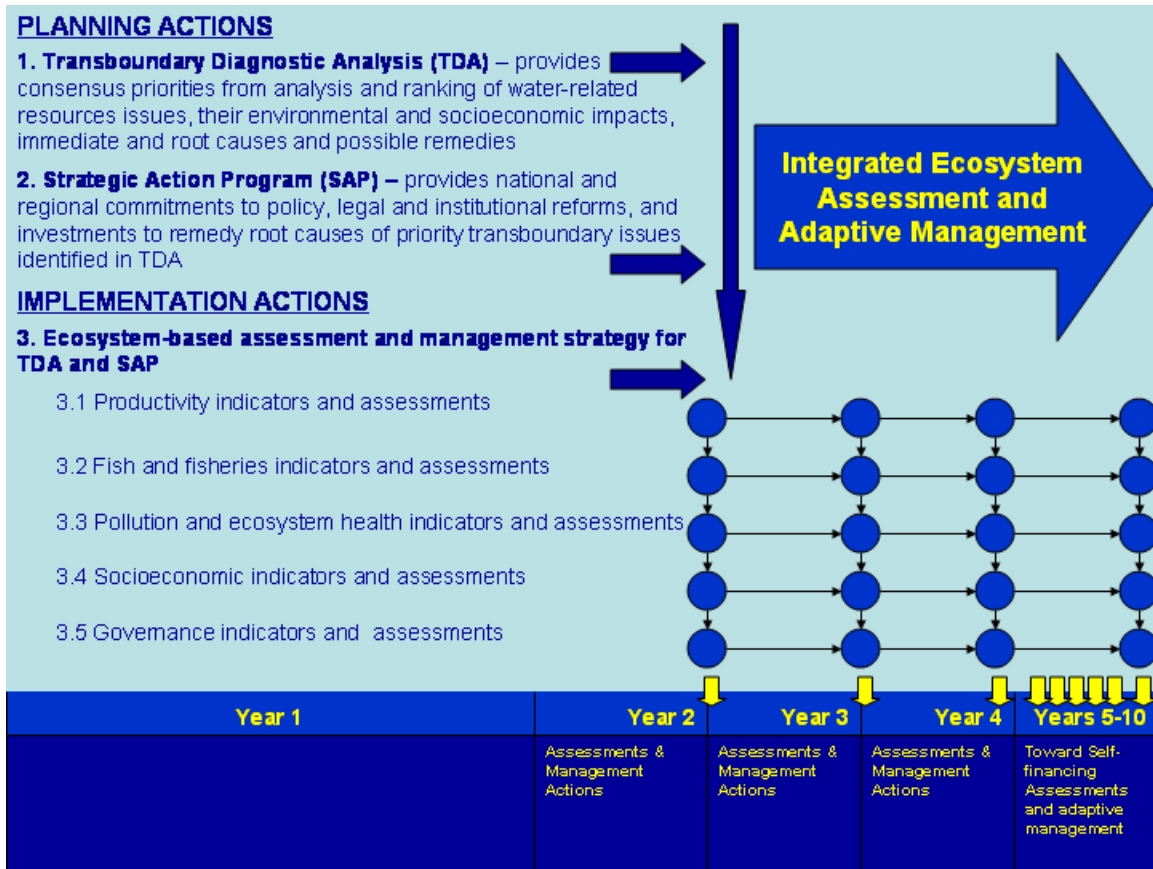


Figure 12. Large Marine Ecosystems Program planning and implementation process and schedule. The countries bordering an LME jointly prepare documents based on consensus that rank coastal resource issues, identify and prioritize transboundary problems, analyze socioeconomic impacts, outline root causes and advance possible remedies and actions for sustaining LME resources. The process to recover depleted fisheries, reduce coastal pollution and restore damaged habitats in an LME is funded by the Global Environment Facility and donor contributions over a period of 10 years. The Project is subsequently expected to self-finance (Sherman et al. 2004).

PART III. PLANNED ACTIVITIES OF THE LME PROGRAM (2007-2010)

A summary of programming activities and new initiatives for FY07-FY10 is provided in Table 4. 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 (Appendix 2), where 18 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 2006 Beijing meeting decided to follow the LME approach.

Table 4. Large Marine Ecosystems Program Activities 2007- 2010

TABLE OF LME PROGRAM ACTIVITIES 2007-2010					1
PROJECT TITLE	ACTIVITIES UNDERWAY	START		LME/L.O.s	U.N. AND OTHER AGENCIES
		UP	END		
ARCTIC AND PACIFIC INITIATIVES					
APEC 23 LMEs of the Pacific	Ecosystem-based approach to the assessment and management of marine resources: Asian countries of Pacific Demonstration Project		FY10	IA: E. Denning; LME APEC Program Office, M.C. Aquarone; NOAA S&T; L.O.s, NOAA Pacific FSC, J. Polovina, OAR	
	Convenor, Meeting in Qingdao, China (09/07)	FY07		LME Program Office, K. Sherman; Q. Tang, Yellow Sea Fisheries Institute	
	Ongoing APEC reports	FY07		LME Program Office, S. Adams, Technical Editor	
17 LMEs of the Arctic	Consensus of NOAA suite of indicators (Group of Experts; U.S. Chair, K. Sherman)	FY07	FY07	OAR, J. Calder; NWS; IA, E. McLanahan; LME Program Office, M.C. Aquarone, coordination	Arctic Council
	Initiate Arctic LME assessments with a pilot project in the West Bering Sea LME with the Russian Federation		FY10	L.O.s, OAR; NMFS, Alaska Fisheries Science Center	UNEP; MMBI, Mumansk
		TDA FY08 SAP FY09			
	Ongoing PAME reports	ongoing		LME Program Office, M.C. Aquarone & S. Adams	Arctic Council, PAME
AAAS volume on Arctic	Volume on changing states of 17 Arctic LMEs. Chapters based on AAAS Symposium in 2006 convened by K. Sherman and B. Gold	FY07	FY08	Skjoldal and Sherman eds.; LME Program Office, S. Adams, Technical Editor (to CRC used in publication)	

TABLE OF LME PROGRAM ACTIVITIES 2007-2010

2

PROJECT TITLE	ACTIVITIES UNDERWAY	START		LME/L.O.s	U.N. AND OTHER AGENCIES
		UP	END		
LME METHODOLOGY DEVELOPMENT					
Medium Size Projects					
MSP - Promoting Ecosystem Based Approaches to Fisheries Conservation and LMEs	6 components of project		FY08	LME Program Office, MC Aquarone, project coordinator; OAR and Geophysics Lab at Princeton (GDFL)	IOC-UNESCO
Assessment of Assessments	GEF Contribution to LME assessment methodology	FY07	FY08	LME Program Office; NOAA S&T; L.O.s	UNIDO, UNEP-Nairobi
U.N. mandated Global Assessment Prototype	Vienna meeting in Oct. 07	FY07		LME Program Office; NOS	UNIDO; UNEP-Nairobi
	Submit full MSP Methodology	FY08 FY09	FY10		
Development of 5 modules					
<i>Productivity Module:</i>	Productivity and chlorophyll for all 64 LMEs		FY07	NESDIS; OMES, Berman, Melrose, O'Reilly	
	Testing and evaluation of productivity module in Narragansett Bay	FY07	FY09	Narragansett Lab	
<i>Fisheries Module</i>	Ecopath/Ecosim reports ontrophic condition of fisheries	FY07	FY07		University of British Columbia (UBC)
<i>EPA indicators of Pollution and Ecosystem Health</i>	Application to Baltic Sea and other LME Projects	continuing		NOS; NMFS; LME Program Office, MC Aquarone and K. Sherman; NEFSC, T. Noji	EPA, K. Summers;
	Collaboration with EPA in Narragansett on sampling of coastal conditions, National Coastal Condition Report #3		FY07	OMES, Narrag. Lab	
<i>Socioeconomics Module:</i>	Contracts with UNEP, The Hague		FY08	NEFSC, P. Logan, S. Edwards	UNEP; WHOI, P. Hoagland, D. Jin; URI, J. Sutinen
<i>Governance Module</i>	2 Commissions instituted, Benguela Current and Guinea Current	FY07	FY10		WHOI; URI, L. Juda, T. Hennessey; LME Projects

TABLE OF LME PROGRAM ACTIVITIES 2007-2010					3
PROJECT TITLE	ACTIVITIES UNDERWAY	START UP	END	LME/L.O.s	U.N. AND OTHER AGENCIES
U.N. AGENCIES					
FAO	Fisheries and LME conservation MSP		FY08	OAR; GFDL Princeton	IOC
	Bay of Bengal Project	FY07	FY10	NOAA, E.Cyr	FAO, J. Csirke
IOC-UNESCO	Reports on LME consultative meetings (yearly)	ongoing		NOAA, K. Sherman, MC Aquarone, S. Adams	IOC, P. Bernal; IUCN, C. Lundin
	Fisheries and LME conservation MSP		FY08	OAR; GFDL Princeton	FAO
UNDP	Agulhas-Somali LME Project, Benguela Current LME Project, Black Sea, Caribbean Sea, Gulf of Mexico, Humboldt Current, Yellow Sea LMEs	continuing		LME Program Office; NOAA S&T; L.O.s	
UNEP	UNEP-LME Report on Changing States of 64 LMEs (650pp); K. Sherman and G. Hempel, editors		FY08	LME Program Office, MC Aquarone contributing author; S. Adams, Tech. Editor to CRC copy	LME Program Office; UNEP
	SST Time Series all LMEs Chlorophyll, primary productivity Fish yields, value & trophic level DIN, eutrophication, nutrient loads Pollution & ecosystem health Socioeconomics Governance			URI (Belkin) OMES (O'Reilly) UBC (Pauly & Christensen) Rutgers (Seitzinger) GESAMP WHOI & URI URI (Juda & Hennessey)	
	Completion of manuscript Printing and distribution		FY07 FY08		
UNEP-Nairobi	MSP, developing methodology for global assessments	FY07	FY09	LME Program Office, MC Aquarone, Coordinator; NESDIS, NWS	UNIDO
UNEP-Nairobi	TIWAS Proposal	FY07		LME Program Office	UNIDO
UNIDO	TIWAS Proposal	FY07		LME Program Office	UNEP-Nairobi
INTERNATIONAL AGENCIES					
IUCN	DVD booklet		FY08	LME Program Office	UNEP
IW:Learn	"Turning the Tide" DVD		FY08	LME Program Office	GEF

TABLE OF LME PROGRAM ACTIVITIES 2007-2010					4
PROJECT TITLE	ACTIVITIES UNDERWAY	START		LME/L.O.s	U.N. AND OTHER AGENCIES
		UP	END		
LME FOUNDATION PROJECTS STRUCTURED TO USE 5 MODULE, LME APPROACH TO ASSESSMENT AND MANAGEMENT					
<i>Agulhas & Somali Currents LMEs</i>	TDA/SAP	FY07	FY10	LME Program Office; NOAA S&T; L.O.s; NOAA Consultant B. Brown	UNDP
<i>Baltic Sea LME</i>	Phase 1	complete		LME Program Office	World Bank; EPA K.Summers; ICES; HELCOM
	Phase 2, SAP	FY07	FY10	NOAA S&T; L.O.s; NOS, Bricker; OMES, Berman, K. Sherman	
<i>Bay of Bengal LME</i>	Project startup	FY08		LME Program Office; S&T E. Cyr; OAR; NESDIS	FAO
	SAP	FY08	FY10	NOAA S&T, L.O.s	
<i>Benguela Current LME</i>	end of first phase	FY08		LME Program Office	UNDP; Angola, Namibia, S. Africa; BENEFIT
	second phase	FY09		NOAA S&T; L.O.s; NESDIS	
<i>Black Sea LME and Danube R.</i>	Investment Fund Project	ongoing		NOS, OAR	UNDP
<i>Canary Current LME</i>	end of Block B		FY07	LME Program Office; NOAA Consultant B. Brown; NOAA S&T; L.O.s, NESDIS	FAO; UNEP
	SAP	FY08		NOAA S&T; L.O.s; NESDIS	
<i>Caribbean Sea LME (WWW2BW)</i>	Block B	FY07	FY10	SEFSC and L.O.s	UNDP, UNEP
		ongoing			

TABLE OF LME PROGRAM ACTIVITIES 2007-2010					5
PROJECT TITLE	ACTIVITIES UNDERWAY	START UP	END	LME/L.O.s	U.N. AND OTHER AGENCIES
Foundation GEF- LME Projects continued					
<i>Guinea Current LME</i>	SAP, 2nd phase		FY10	LME Program Office; NOAA S&T; LOs, NESDIS; OAR Miami Lab. NOAA Consultant B. Brown	UNDP; University of Lagos, P. Nwilo
<i>Gulf of Mexico LME (WW2BW)</i>	TDA/SAP	FY07	FY10	SEFSC, J. Berkson; L.O.s: NOS, NESDIS, OAR Miami Lab	UNDP, UNIDO
<i>Gulf of Thailand LME</i>	Part of East Asian Sea LMEs Strategic Investment Fund Project	FY07	FY10	LME Program Office; NOAA S&T; L.O.s: NWS, OAR Seattle PMEL;	UNEP; World Bank, IBRD
	SAP	FY07	FY10		
<i>Humboldt Current LME</i>	SAP	continuing		LME Program Office; NOAA S&T; L.O.s: OAR (PMEL), NESDIS, NWS; SWFSC Lajolla, J. Phinney	UNIDO, UNDP
<i>Indonesian Sea LME</i>	Part of East Asian Sea LMEs Investment Fund Project			LME Program Office; NOAA S&T; LOs: NWS, OAR Seattle PMEL; NOAA S&T	UNEP; World Bank, IBRD
	SAP		FY10	NOAA S&T, L.O.s	
<i>Mediterranean Sea LME</i>	Strategic Partnership, Mediterranean LME Investment Fund Project		FY10	LME Program Office; NESDIS, NOS; NOAA S&T	UNEP/IBRD World Bank - GEF Investment Fund
	SAP	FY07	FY10	NOAA S&T, L.O.s LME Program Office	
<i>South China Sea LME</i>	within East Asian Sea LMEs Investment Fund Project	FY07	FY10	LME Program Office; NOAA S&T; L.O.s: NWS, OAR Seattle PMEL;	UNEP/IBRD World Bank - GEF Investment Fund
<i>Yellow Sea LME</i>	SAP		FY09	LME Program Office	UNDP
	2nd phase	FY10		NOAA S&T, L.O.s: NESDIS, NOS	

TABLE OF LME PROGRAM ACTIVITIES 2007-2010

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PROJECT TITLE	ACTIVITIES UNDERWAY	START UP	END	LME/L.O.s	U.N. AND OTHER AGENCIES
NEW LME PROJECTS					
West Bering Sea LME	Pilot Project	FY07		AFSC; PMEL Seattle; M. Sigler, P. Livingston, Loh-Lee Low; OAR, J. Overland; Ice Prediction; USG Arctic Climate Impact Assessment (ACIA)	
	PDF B TDA and SAP	FY07 FY08			
<i>East Asian Sea LMEs</i>	Strategic Partnership	FY07			UNEP/IBRD World Bank GEF Investment Fund UNEP
<i>Sulu-Celebes LME</i>	TDA/SAP Block B SAP	FY07 FY08			
Dead Zone Assessment: Global nutrient overenrichment		FY07		NOS; LME Program Office; NOS, Bricker	IOC; Rutgers Univ., S. Seitzinger
Linkage from LME Projects to GOOS - IOOS - GEOSS		FY07		LME Program Office; NESDIS NODC Data Center, S. Levitus; NOS	
Sea Truthing in BCLME, GCLME, YSLME, Satellite Remote Sensing products including SST in relation to subsurface Chlorophyll max		FY07		LME Program Office; OMES, NESDIS NODC Data Center, S. Levitus; NOS	IOC
LMEs and Climate Change		FY07		OAR, NOS, NESDIS, NWS, LME Program Office	URI, I. Belkin- SST analysis
LME WEBSITE OPERATIONS					
LME website at: http://www.lme.noaa.gov	Continue to develop website as primary source for LME data and information	FY07 ongoing			URI (Damon)

TABLE OF LME PROGRAM ACTIVITIES 2007-2010					7
PROJECT TITLE	ACTIVITIES UNDERWAY	START UP	END	LME/L.O.s	U.N. AND OTHER AGENCIES
EDUCATION					
<i>LME curriculum</i>	K to 12 Meeting with Rhode Island science teachers curriculum portfolio global distribution of these materials	FY07	FY08		UNEP
<i>DVD</i>	"Turning the Tide" Distribution Tested on school children elementary, middle and high schools	FY07 FY07	FY08 FY08	LME Program Office; schools in RI and in Ghana	IW:Learn
<i>DVD Guinea Current</i>		FY07	FY08	LME Program Office	UNEP; GCLME office, Dr.C. Ibe
Outreach training to Professional scientists in emergent trophic patterns	ECOPATH / ECOSIM	FY07	FY08		UBC, V. Christensen
Outreach training to Professional scientists in nitrogen overloading & eutrophication	DIN modelling	FY07	FY08		Rutgers, S. Seitzinger
LME VOLUMES, REPORTS and PUBLICATIONS					
Predicting the Benguela volume			FY06		
The UNEP Large Marine Ecosystem Report: A Perspective on Changing Conditions in LMEs of the World's Regional Seas. K Sherman & G. Hempel, editors. 650pp.	UNEP Regional Seas Reports and Studies No. 182	FY07		LME Program Office, UNEP MC Aquarone contributing author; S. Adams, Technical Editor to CRC for publication	
Arctic volume Based based on AAAS Symposium, St. Louis 2006. H.R. Skjoldal and K. Sherman, editors.		FY07	FY08	LME Program Office, Arctic S. Adams Technical Editor to CRC for publication	Arctic Council, PAME
Comparative Ecosystem Assessments in Relation to Climate Change volume , based on Qingdao Conference. K. Sherman contributing author and editor.		FY07	FY10	LME Program Office, S. Adams Technical Editor to CRC for publication	

TABLE OF LME PROGRAM ACTIVITIES 2007-2010					8
PROJECT TITLE	ACTIVITIES UNDERWAY	START UP	END	LME/L.O.s	U.N. AND OTHER AGENCIES
LME VOLUMES, REPORTS and PUBLICATIONS continued					
Indicators of Changing States of LMEs volume based on Conference in Narragansett on Indicators. K. Sherman contributing author and editor.		FY09	FY10	LME Program Office, S. Adams Technical Editor to CRC for publication	
IOC Consultative Meeting Reports		annual	report	LME Program Office, MC Aquarone and S. Adams	
PAME Reports		ongoing		LME Program Office, MC Aquarone and S. Adams	Arctic Council, PAME
GCLME Socioeconomics and Valuation		FY07	FY08	LME Program Office, S. Adams	WHOI, P. Hoagland; GCLME, Dr. C. Ibe
APEC Reports: LMEs of the Asian Pacific Economic Community		FY07	FY08	LME Program Office, MC Aquarone and S. Adams	
Handbook on Productivity Indicators for LMEs		FY07	FY08	LME Program Office, MC Aquarone and S. Adams	
"Turning the Tide" booklet to accompany the DVD		FY07	FY08	LME Program Office, S. Adams	IW Learn
"Variability of Large marine Ecosystems in response to global climate change" to submit for publication		FY07	FY07	LME Program Office;	URI, I. OMES, J. O'Reilly Belkin
TIWAS report		FY08	FY09	LME Program Office, S. Adams	UNEP-Nairobi
"Climate Change and Impacts on LMEs of the Arctic" --paper for publication based on the Arctic Coastal Zones at Risk Conference convened by IASC	author, K. Sherman	FY07		LME Program Office, S. Adams	
"Changing States of the LMEs of Russia" paper following the Conference being convened in Russia, October 2007	author, K. Sherman	FY07	FY08	LME Program Office, S. Adams	

TABLE OF LME PROGRAM ACTIVITIES 2007-2010					9
PROJECT TITLE	ACTIVITIES UNDERWAY	START UP	END	LME/L.O.s	OTHER AGENCIES
LME VOLS., REPORTS AND PUBLICATIONS continued					
invited paper for the UN Conference, the 5th Trondheim Conference on Biodiversity, 29 October - 2 November 2007	author, K. Sherman	FY07		LME Program Office, S. Adams	
CONFERENCES, WORKSHOPS, PRESENTATIONS and PRESENTED PAPERS					
UMASS-Dartmouth Seminar, presentation on the Large Marine Ecosystem Program, 17 May 2007	New Bedford Whaling Museum	FY07		LME Program Office, S. Adams, Tech.Ed.	
Gulf of Mexico LME Project Steering Committee Meeting, 21 May 2007	Houston, TX	FY07		LME Program Office, S. Adams, Tech.Ed.	
Caribbean LME Project, Regional Steering Committee Meeting, June 2007	Cartagena, Colombia	FY07		LME Program Office, S. Adams, Tech.Ed.	
GEF 4th Biennial International Waters Conference - 31 July - 3 August 2007	Cape Town, South Africa	FY07		LME Program Office, S. Adams, Tech.Ed.	
GCLME Valuation Workshop	Cape Town, S.A.	FY07		LME Program Office, S. Adams, Tech.Ed.	
IOC 9th Consultative Meeting, Paris, July 2007	Paris, France	FY07		LME Program Office, S. Adams, Tech.Ed.	
ICES September '07 presentation, "Variability of Large Marine Ecosystems in response to global climate change," K. Sherman, J. O'Reilly & I. Belkin	Helsinki, Finland	FY07		LME Program Office, S. Adams, Tech.Ed.	
2nd Global Conference on Large Marine Ecosystems 11-13 September 2007	Qingdao, P.R. China	FY07	FY08, vol.	LME Program Office, S. Adams, Tech.Ed.	

TABLE OF LME PROGRAM ACTIVITIES 2007-2010					10
PROJECT TITLE	ACTIVITIES UNDERWAY	START UP	END	LME/L.O.s	U.N. AND OTHER AGENCIES
CONFERENCES, WORKSHOPS, PRESENTATIONS continued					
APEC meeting, Marine Ecosystem Identification and Mapping in the Asia-Pacific Region - First Workshop- 14 September	Qingdao , P.R. China	FY07		LME Program Office, S. Adams, Tech.Ed.	
International Arctic Science Committee (IASC), with LOICZ and IHDP, "Arctic Coastal Zones at Risk" 1-3 October 2007, Invited Speaker, Climate Change and Impacts on People of the Arctic	Tromsø, Norway	FY07		LME Program Office, S. Adams, Tech.Ed.	
IUCN World Conservation Congress 5-14 October	Barcelona, Spain	FY07		LME Program Office, S. Adams, Tech.Ed.	
LMEs of Russia 10-13 October	Mumansk, Russia	FY07		LME Program Office, S. Adams, Tech.Ed.	
UNIDO Expert Group Meetings (2) - 15-19 October	Vienna, Austria	FY07		LME Program Office, S. Adams, Tech.Ed.	
Norway/ UN Conference, the 5th Trondheim Conference on Biodiversity, 29 October 2 November 2007	Trondheim, Norway	FY07		LME Program Office, S. Adams, Tech.Ed.	
Arctic Council, PAME. Group of Experts, U.S. Chair, K. Sherman	Copenhagen, DK	ongoing		LME Program Office, S. Adams, Tech.Ed.	Arctic Council, PAME

In 2007-2010, a wide scope of LME activities will advance the implementation and operationalization of LME activities 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 UN 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 to maintain US and NOAA leadership in ecosystem assessment and management practices.

In FY 2007-2010, 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 fourth 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 NOAA LME office will continue to develop ecosystem management tools (LME Methodology Development) based on ecosystem indicator methodologies and the five-modular approach (productivity-oceanography-climatology, fish and fisheries assessments, pollution and ecosystem health assessments, socioeconomic activity, and governance models). The NOAA-LME Program will continue to partner with the EPA in assessing the condition of US coastal waters. The EPA National Coastal Condition Report III, containing coastal condition methodology with five indicators of coastal ecosystem condition, is in preparation. This report will include Our Living Oceans fisheries assessments by LMEs produced by the LME Office. Kevin Summers of EPA continues to represent EPA/NOAA at workshops relating to pollution and ecosystem health, offering scientific and technical assistance in the introduction of five indicators of coastal ecosystem condition. EPA-Narragansett is extending the coastal conditions indicator sampling and assessments from the estuaries to the Northeast US Continental Shelf LME by participating in NOAA cruises and ecosystem monitoring surveys. 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 UN agency partners, such as the IOC, UNIDO, UNEP, UNDP, and FAO, and with other international partners (GEF, IUCN, and the International Waters Learning Exchange and Resource Network [IW:Learn]). As a result of GEF's new operational strategy, a number of LME Foundation Projects with a full, five-modular approach are to be supported with projects focused on fisheries recovery, reduction and control of nutrient overenrichment, and adaptation to climate change at a GEF estimated replenishment level of US\$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, described in Appendix 4. 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 Seas 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 in preparation for the Qingdao, China meeting on global LMEs. In the area of education, a new LME curriculum is being developed in partnership with elementary, middle school, and high school teachers and students in Rhode Island and in Ghana, on the basis of the reactions of school children to the viewing of the DVD "Turning the Tide," on global LMEs and the LME concept. It is a curriculum structured along the five modules. There are planned events to launch the DVD and new curriculum. A new DVD on the Guinea Current LME project is presently in preparation.

The LME Program will continue publishing works on the LME approach to ocean management (LME volumes, papers, and reports). Conferences, meetings, and workshops both in the United States 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). A major meeting, the 2nd Global Conference on Large Marine Ecosystems, convened in Qingdao, China, on 11-13 September 2007. The Russian Academy of Sciences, the Russian Ministry for Science and Technology, and the Murmansk Marine Biological Institute convened an international conference on the LMEs of Russia in the epoch of global changes (climate, resources, management) in October 2007 in Rostov-on-Don, Russia.

APPENDIX 1. THE CAPE TOWN DECLARATION

In LME assessment and management projects supported by the GEF in Africa, agreements have been reached among the environmental, fisheries, energy, and tourism ministers of the countries bordering these LMEs to enter into joint transboundary, international resource assessment and management commissions. A pan-African LME forum was attended by African ministers who on November 13, 2006 issued the following Cape Town Declaration supporting the advances made by the African LME projects.

Pan African LME Forum

DECLARATION

The Pan African Forum is a major African event that brings together the leadership of marine and coastal areas of the countries of sub-Saharan African LME Programmes.

Through the establishment of the Benguela Current Commission and the Guinea Current Commission, the Ministers responsible for fisheries, environment, energy, mining and tourism have committed their countries to the recovery of depleted fish stocks, restoration of degraded habitats, and reduction and control of coastal pollution. These are the first two LME Commissions worldwide to focus on reducing risks to the sizeable contributions from the goods and services these LME make to the African GDP.

The most recent collapse of fisheries in the Benguela Current ecosystem is understood as the combination of over-fishing, and climate change. They call for immediate joint action predicated on, and supported by, science – based assessments, and on the concerns of socio-economic stakeholders and governments.

The African LME Programmes require improved mechanisms for funding from financial institutions and donors in order to rebuild fish stocks, restore marine ecosystems and move towards an ecosystem approach to management and development. With the assistance of the Global Environmental facility (GEF) and other donors, major progress has already been made by the concerted efforts of the countries. In pursuance of these objectives, the Pan African LME Forum recommends action to:

- Strengthen strategic partnerships amongst African coastal states, regional and international organisations and agencies, aimed at recovery of the degraded African Large Marine Ecosystems
- Adopt best practices and examples of approaches to the recovery and sustainability of LME transboundary goods and services.

- Foster closer cooperation and partnerships between civil society, maritime industries and the LME Programmes of Africa, in collaboration with GOOS Africa and other international efforts, to monitor and assess global environmental conditions.
- Promote the LME modular approach of productivity, fish and fisheries, pollution, ecosystem health, socio-economics and governance as a means to increase the benefits provided by African LMEs.
- Initiate a co-ordinated assessment of African LMEs in relation to adaptation mechanisms for mitigating the effects of Climate Change.
- Develop and strengthen co-operation between African LME programmes to advance recovery of depleted fisheries resources and recover and sustain marine ecosystems.
- Mobilise financial resources to support the mitigation of ecological and socio-economic disruptions of the LMEs caused by Climate Change.
- Develop a harmonised approach to support NEPAD policies on fisheries and environment, and cooperation with existing regional governance mechanisms including the Abidjan and Nairobi conventions, regional fisheries bodies and river basin authorities.
- Promote implementation of the WSSD and UN Millennium Goals through integrated management and sustainable development of the African LMEs.
- Strengthen efforts to support African countries in enhanced benefits capture from LME fisheries through improved regulation of access, MCS, combating IUU and other measures.

13th November 2006

Cape Town, South Africa

APPENDIX 2. BENGUELA CURRENT AND GUINEA CURRENT COMMISSIONS

The 3 countries of the Benguela Current LME and 16 countries of the Guinea Current LME have endorsed the establishment of governance Commissions. Both commissions have agreed, as outlined below, to use the Strategic Action Plan (SAP) for their GEF-LME project as the framework for Commission deliberations.

Benguela Current Commission

South Africa, Namibia and Angola Sign Marine Management Pact

South Africa, Angola and Namibia signed an agreement in August 2006 to formally establish the Benguela Current Commission, allowing for their joint management of the Benguela Current's marine resources.

The Benguela Current extends from east of Port Elizabeth, South Africa and north to Angola's Cabinda province. Government Ministers from South Africa, Namibia and Angola launched an institutional structure that will link the three countries in the management of the Benguela Current Large Marine Ecosystem (LME), one of richest and most productive marine ecosystems on earth. The Benguela Current Commission is the culmination of over 10 years of efforts by scientists from Angola, Namibia and South Africa who began to share their knowledge and understanding of this rich stretch of ocean in 1995. The three countries will collectively manage transboundary environmental issues such as shared fish stocks and will work together to mitigate the impacts of marine mining and oil and gas production on the marine environment. With the support of the Global Environment Facility (GEF), which finances environmentally sustainable projects, and the implementing agency, the United Nations Development Programme (UNDP), this collaborative effort has now resulted in the Benguela Current Commission, the first of its kind in the world. The objective of the agreement is to facilitate the understanding, protection, conservation, and sustainable use of the Benguela Current LME by Angola, Namibia, and South Africa. This action by the three countries establishes a governance precedent.

Now in its fifth year, the Benguela Current Large Marine Ecosystem Program has already allocated more than US\$10 million in support of 75 scientific and economic research projects in the region. One of the concrete results of the scientific collaboration is the implementation of early warning systems to monitor the effects of climate change on the LME, which are seen in increased storm activity and the gradual migration of fish stocks. For the past few years, fisheries scientists have noticed a marked shift eastwards to several species endemic to the continent's west coast, including rock lobsters and sardines, as well as several bird species, which are now breeding hundreds of miles further east than they did several years ago. Global climate change is being looked at as a possible cause behind this migration, which has potentially devastating consequences not only for marine and bird life but for the west coast fishing industries that support thousands of jobs.

Note: Benguela Commission 2006 is announced at <http://www.bclme.org/news/mediaflash_bcc.aspnews/mediaflash_bcc.asp>

Guinea Current Commission

The Abuja Declaration

We, the Ministers of Environment of Angola, Benin, Cameroon, Congo, Côte d'Ivoire, Democratic Republic of Congo, Equatorial Guinea, Gabon, Ghana, Guinea, Guinea Bissau, Liberia, Nigeria, Sao Tome and Principe, Sierra Leone and Togo, gathered in Abuja, Nigeria, 21 – 22 September, 2006 on the occasion of the First Meeting of Ministers responsible for the implementation of the Guinea Current Large Marine Ecosystem (GCLME) Project;

- Conscious of the fundamental importance of the health of the Guinea Current Large Marine Ecosystem, including its coastal areas and contiguous drainage basins to the well being of the coastal populations, the economies and food security of the coastal states and the socio-cultural life of the Guinea Current Region;
- Noting the degrading state of the coastal and marine environment in the GCLME Region caused by severe depletion of shared resources and the ensuing loss of biodiversity, pollution from land and sea-based activities, the physical destruction of sensitive habitats including the effects of coastal erosion, etc,
- Aware of the direct correlation between ecological degradation and escalating poverty, galloping food insecurity and deteriorating health of our coastal populations,
- Noting the trans-boundary nature of the environmental and resource management issues/problems and reaffirming our commitment to resolving the challenges arising from the identified issues/problems at both national and sub-regional levels, based on the Large Marine Ecosystem Approach which seeks to create an ecosystem-wide assessment and management framework for the sustainable use of living and non-living resources,
- Recognizing the imperative of achieving sustainable development through, *inter alia*:
 - o Integration of environmental concerns in planning, accounting and budgeting processes;
 - o Capacity building, accentuated stakeholders' participation, public awareness and outreach campaigns;
 - o Management of trans-boundary water bodies and forests and biodiversity conservation;
 - o Development of environmental information management and decision support systems and the promotion of information and data exchange;
- Further recognizing the need to sustain these initiatives through increased networking and regional co-operation.
- Conscious of the need to attain the objectives of the Abidjan Convention (1981), implement the Coastal and Marine Environment component of the NEPAD Environmental Action Plan, and achieve the WSSD Goals in the region
- Recalling the Accra Ministerial Declaration (10 July, 1998) by the Environment Ministers of the Pilot Phase countries which endorsed a regional approach to the

Environmentally Sustainable Development of the Coastal and Marine Environment of the West and Central Africa.

- Further recalling Decision II of the Brazzaville Declaration (26 May, 2006) of the African Ministerial Conference on Environment calling on African government to support the LME Projects in Africa as tools for revitalization and successful implementation of both the Abidjan and Nairobi Conventions (1981 and 1985 respectively).

Acknowledging the remarkable progress made by the project since its inception in January 2005, is the completion of the Trans-boundary Diagnostic Analysis process and especially in strengthening regional coordination mechanisms for consultation and joint actions,

- Applauding GEF, UNDP, UNEP, UNIDO, US-NAOAA, NEPAD, FAO, IMO, WWF and other international and national NGOs, as well as other stakeholders including the Private Sector, for their contributions to the positive evolution of the project towards its defined objectives and goals;

Do hereby agree as follows:

1. To institutionalize regional cooperation at the technical level through the creation of an Interim Guinea Current Commission (IGCC) in the framework of the Abidjan Convention (1981) as provided in paragraph 37 of the approved Guinea Current LME Project Document signed by all the participating countries;
2. The IGCC will build capacity for the successful implementation of the West and Central African Action Plan of the Abidjan Convention including the development of appropriate Protocols, afford a vantage platform for the execution of the Coastal and Marine Environment Component of the NEPAD Environmental Action Plan and drive the attainment of the World Summit on Sustainable Development (WSSD) Goals in the region;
3. The GCLME Project Regional Coordination Unit (RCU) with its complement of staff will serve concurrently as the Executive Secretariat of the Interim Guinea Current Commission. The IGCC will eventually take leadership of the Project and its coordination. The IGCC will play the key role in completing the development of the Strategic Action Plan (SAP) as the Project is implemented and will be responsible for negotiating subsequent phases of the GCLME project and agreements with cooperating institutions;
4. The functioning of the IGCC would be assured largely from project funds. However, member countries should provide adequate and timely material and financial support, beyond those already pledged, for the expansion and consolidation of project activities;
5. A permanent Guinea Current Commission (GCC) would be constituted and adopted by the countries at Summit (Heads of State and Government) level, to serve as the highest decision making organ during the process of completion and implementation of the full SAP by 2009.

6. The institutional, legal and financial arrangements, including a financial mechanism for the longer term sustainability of the GCC (and its sub-Commission for Fisheries) would be further negotiated by the countries and other stakeholders during the present project life (2005 - 2009) and in particular during the Donors' Conference to be hosted by the African Development Bank (ADB) in 2008 as part of the implementation of the full SAP for the 16 countries.
7. Invite international cooperating partners including specialized donor agencies and the Private Sector to assist the GCLME countries and the IGCC in addressing identified and emerging priority environmental issues and their root causes.
8. Call on the countries and all other stakeholders to pursue with vigour the implementation of this Declaration.

Adopted in Abuja, 22nd September, 2006

Note: Guinea Current Commission 2006 Ministerial signing of the Abuja Declaration is announced at <http://www.unep.org/GC/GC24/download.asp?ID=88> >, p.12

APPENDIX 3. 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, outlined below, 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.

Beijing Declaration on Furthering the Implementation of the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities

We the representatives of 104 governments and the European Commission, with the valued support and concurrence of delegates from international financial institutions, international and regional organizations, the private sector, non-governmental organizations, other stakeholders and major groups,

Having met in Beijing from 16 to 20 October 2006 at the second session of the Intergovernmental Review Meeting on the Implementation of the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities,

Acknowledging that people are dependent on the oceans and coasts and their resources for their survival, health and well-being, that a significant number of people derive their food security and economic livelihood from the coastal and marine environment and that many of those areas, in particular low-lying coastal areas and small island developing States, are vulnerable to the rise in the sea level and climate-related natural disasters as well as effects on the marine environment of ocean acidification resulting from land-based activities,

Noting the steady urbanization of coastal areas, with close to 40 per cent of the world's population living within 100 kilometres of the coast, and concerned about the findings of the United Nations Environment Programme's Global Marine Assessment and its report "The state of the marine environment: trends and processes", in particular as regards the severe and increasing occurrence of nutrient overenrichment of coastal waters, the continuing and projected increase in the discharge of untreated municipal, industrial and agricultural wastewater, and the substantial increase of atmospherically transported emissions,

Recognizing the growing damage that those trends are causing to people and the environment, including stress on marine ecosystems, loss of corals and wetlands, contamination of marine sources of human food and prejudice to the amenity of beaches and the health of bathing waters,

Noting the continuing need for improved monitoring to identify threats at regional, national and local levels and to assess the impact and effectiveness of measures to address such problems,

Recognizing that the Global Programme of Action is an effective tool for integrating

environmental concerns into development planning and strategies at the regional and national levels and that, as such, it contributes substantially to the achievement of the internationally agreed development goals², including those contained in the Millennium Declaration¹ and those highlighted in Agenda 21⁴, the Barbados Programme of Action³, the Johannesburg Plan of Implementation⁴ and the Mauritius Strategy for the Sustainable Development of Small Island Developing States⁵,

Emphasizing the importance of the Global Programme of Action in addressing the interaction of land and ocean and integrating freshwater with coastal and marine management approaches, thereby protecting human health and livelihoods while fostering the application of ecosystem approaches,

Noting that the need for sufficient financial resources and for capacity-building are major challenges faced by developing countries for the successful implementation of the Global Programme of Action,

Recognizing the important contribution of the United Nations Environment Programme Regional Seas Programme, the Global Environment Facility and international financial institutions in implementing the Global Programme of Action and concurrently recognizing the financial constraints faced in such implementation and the consequent need for resource mobilization and support,

Noting the progress made by some countries in building institutional capacity and developing legislative frameworks and environmental policies regarding the sustainable management of the marine and coastal environment,

Supporting the Bali Strategic Plan for Technology Support and Capacity-building, adopted by the Governing Council of the United Nations Environment Programme/Global Ministerial Environment Forum at its twenty-third session, in view of the fundamental role of capacity-building in the implementation of the Global Programme of Action,

Acknowledging the important contribution of multi-stakeholder partnerships, including those concluded at the current session of the Intergovernmental Review Meeting on the Implementation of the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities, to the implementation of intergovernmental commitments to advance action on internationally agreed and recognized goals,

Recognizing the successful results and achievements in the progression from planning to implementation of the Global Programme of Action in the period 2002–2006 and, in particular, the contribution of the United Nations Environment Programme's Global Programme of Action Coordination Office,

Resolve:

1. To recommit ourselves to the Global Programme of Action as a flexible and effective tool for the sustainable development of oceans, coasts and islands;
2. To commit ourselves to furthering the implementation of the Global Programme of Action in 2007–2011:
 - (a) By applying ecosystem approaches;
 - (b) By valuing the social and economic costs and benefits of the goods and services that coasts and oceans provide;
 - (c) By establishing partnerships at the national, regional and international levels;
 - (d) By cooperating at the regional and interregional levels;
 - (e) By mainstreaming the Global Programme of Action into national development planning and budgetary mechanisms;
 - (f) By supporting the United Nations Environment Programme Global Programme of Action Coordination Office in undertaking its task of facilitating, furthering and promoting the implementation of the Global Programme of Action;
3. To express appreciation for the efforts of the United Nations Environment Programme in helping to advance the agenda with respect to the sustainable development of oceans, coasts and islands and invite it to strengthen its support to the further implementation of the Global Programme of Action through increased contributions from its Environment Fund, enhanced cooperation and coordination with multilateral environmental agreements and improved cooperation with all stakeholders and relevant organizations, including multilateral development banks, at the global and regional levels;

National actions

4. To strengthen efforts to develop and implement our regional and national programmes of action and mechanisms for the protection of the marine environment from land-based pollution sources and activities, in concert with the relevant implementing legislation and financing, and to mainstream the objectives of the Global Programme of Action into development planning and implementation, including the United Nations country level programmes, the United Nations Development Assistance Framework, poverty reduction strategy papers, common country assessments and country assistance strategies, to reduce and manage the risks and impacts of coastal and marine pollution;
5. To commit to the continued currency and relevance of the Global Programme of Action as a fundamental framework for the protection of the coastal and marine environment and to commit ourselves to taking the Global Programme of Action's objectives and to mainstreaming them across our governments, and also to advancing them, as appropriate, in the relevant intergovernmental organizations and in the various multilateral environmental agreements to which we are Parties and in which we participate;
6. To promote the effective implementation of international and regional conventions, agreements and protocols to which we are Parties, relevant to the achievement of the goals of the Global Programme of Action;
7. To improve cooperation and coordination at all levels in order to deal with issues related to watersheds, coasts, seas and oceans in an integrated manner and to incorporate the integrated management and sustainable use of river basins, seas and oceans into relevant national policies and programmes, in particular by implementing integrated approaches to water resources management, to coastal zone management and coastal area management, to coastal area and river basin management, and to physical alteration and destruction of habitats;

8. To develop and implement national plans of action for the Global Programme of Action, in close coordination with the national integrated water resources management and water efficiency plans, as set forth in the Johannesburg Plan of Implementation;

9. To further the application of ecosystem approaches to watershed, coast, oceans and large marine ecosystem and island management, and to strengthen national, regional and global cooperation to help achieve increased application by 2010 of the ecosystem approach, as set forth in the Johannesburg Plan of Implementation;

10. To increase our efforts to integrate and mainstream economic valuation of the goods and services that oceans, coasts and watersheds provide into our accounting and decision-making, taking full account of all services that the environment provides, including their direct and indirect value to societies and ecosystems;

11. To devote additional effort, finance and support to address point and non-point source nutrients, including municipal, industrial and agricultural wastewater, as major and increasing source categories directly affecting human health, well-being and the environment, including marine ecosystems and their associated watersheds;

12. To develop and implement durable mechanisms to ensure the long-term financial sustainability and implementation of regional and national programmes of action and mechanisms for the protection of the marine environment from land-based pollution sources and activities;

13. To improve monitoring systems at all levels so as to enable governments, major groups and the public to contribute to building a common understanding and knowledge of the damage being done to the marine environment and the measures needed to protect it and for the follow-up of the implementation of the Global Programme of Action;

14. To actively promote the involvement and participation of local and regional authorities, communities and other relevant stakeholders in the development and implementation of programmes of action and strategies, in particular at the local level, for the implementation of the Global Programme of Action;

Regional actions

15. To strengthen the United Nations Environment Programme regional seas conventions and programmes, as well as other regional conventions, agreements and programmes for the protection of the marine and coastal environment, to serve as effective mechanisms to further the implementation of the Global Programme of Action and the protection and sustainable use of the marine environment, through means such as the development and implementation of protocols addressing land-based pollution sources and activities;

16. To work through the United Nations Environment Programme regional seas programmes and other regional and interregional bodies and processes to apply ecosystem approaches to watershed, coast, ocean and large marine ecosystem and island management, and to develop and strengthen strategic partnerships and improve interregional action, cooperation, scientific understanding, environmental education, exchange and sharing of knowledge, technology and experience;

International actions

17. To call upon United Nations agencies, United Nations inter-agency groups, such as UN-Oceans and UN-Water, the United Nations Development Group, the International Maritime

Organization, and multilateral environmental agreements, in particular the Ramsar Convention on Wetlands of International Importance especially as Waterfowl Habitat, the Convention on Biological Diversity and the Stockholm Convention on Persistent Organic Pollutants, to increase the integration of the Global Programme of Action into their policies, plans and programmes, consistent with their mandates;

18. To call upon international and regional financial institutions and donor countries to continue to support the implementation of the Global Programme of Action at the appropriate levels and to increase their contribution to ensuring its long-term sustainability through financial and technical support and by building the capacity of developing countries, particularly small island developing States, to develop and implement their national programmes of action;

19. To welcome the national, regional and international partnerships, discussed during the second session of the Intergovernmental Review Meeting on the Implementation of the Global Programme of Action, aimed at mainstreaming the work and objectives of the Global Programme of Action into their respective workplans, activities, policies and programmes at the appropriate levels and to welcome the creation of new partnerships with all sectors of civil society and the strengthening of existing ones, as critical mechanisms for the successful implementation of the Global Programme of Action;

20. To support the continuity and the mainstreaming of the Global Programme of Action into the major fields of global development activity and promote it as a means to create the integrated processes, intellectual leadership and partnerships that are necessary to achieve global goals and strategies in linked watershed, coastal and ocean areas through ecosystem-based approaches;

21. To improve the implementation of the Global Programme of Action through cooperating with other international initiatives, in order to develop joint activities around the integrated management of watersheds;

22. To invite the States that have not done so, to consider becoming Parties to international and regional conventions, agreements and protocols, as appropriate, relevant to the achievement of the goals of the Global Programme of Action.

United Nations Environment Programme actions

23. To endorse the Global Programme of Action programme of work for the period 2007–2011, commend it to the United Nations Environment Programme Governing Council/Global Ministerial Environment Forum and encourage the Governing Council/Global Ministerial Environment Forum to devote greater financial resources to its implementation, particularly at the regional level;

24. To welcome the “Guidance to the Implementation of the Global Programme of Action for 2007–2011” produced by the United Nations Environment Programme’s Global Programme of Action Coordination Office, as a tool aimed at supporting implementation of the Global Programme of Action in a manner consistent with emerging issues in the international environment and sustainable development context;

25. To request the United Nations Environment Programme Governing Council/Global Ministerial Environment Forum to endorse the present Declaration and the outcome of the second session of the Intergovernmental Review Meeting on the Implementation of the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities as valuable contributions to the implementation of Agenda 21 and other internationally agreed development goals, including those contained in the Millennium Declaration and the

Johannesburg Plan of Implementation;

26. To request the Executive Director of the United Nations Environment Programme to convene the third session of the Intergovernmental Review Meeting on the Implementation of the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities in 2011, in collaboration with the relevant organizations and institutions, and to seek the support of the United Nations Environment Programme in organizing the meeting and implementing its outcome;

27. To express special gratitude and appreciation to the Government and people of the People's Republic of China for hosting the second session of the Intergovernmental Review Meeting on the Implementation of the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities.

¹ See General Assembly Resolution 55/2.

² Report of the United Nations Conference on Environment and Development, Rio de Janeiro, 3-14 June 1992 (United Nations publication, Sales No. E.93.I.8 and corrigenda), vol. I: Resolutions adopted by the Conference, resolution 1, annex II.

³ Report of the Global Conference on the Sustainable Development of Small Island Developing Status, Bridgetown, Barbados, 25 April-6 May 1994 (United Nations publication, Sales No. 4.94.I.18 and corrigenda), chap. 1, resolution 1, annex II.

⁴ Plan of implementation of the World Summit on Sustainable Development (Report of the World Summit on Sustainable Development, Johannesburg, South Africa, 26 August-4 September 2002 (United Nations publication, Sales No. E.03.II.A.1 and corrigendum), chap. I, resolution 2, annex.

⁵ Report of the International Meeting to Review the Implementation of the Programme of Action for the Sustainable Development of Small Island Developing Status, Port Louis, Mauritius, 10-14 January 2005 (United Nations publication, Sales No. E.05.II.A.4 and corrigendum), chap. I, resolution 1, annex II.

APPENDIX 4. OVERVIEW OF OCEAN POLICY AND THE LME APPROACH

The US Ocean Action Plan (OAP) of the United States was released on 17 December 2004. The OAP is a response to the US Commission on Ocean Policy report, which was the result of a 3-year review of national ocean policies of the past 35 years (US Commission on Ocean Policy 2004). The commission was mandated by the US Congress and carried forward by 16 members appointed by the president. The commission held public meetings, made site visits, and based their recommendations on advice received from hundreds of people across the country. The commission's final report highlights the progress that has been made while also identifying key recommendations for advancing ocean, coastal, and Great Lakes policy. The report emphasizes ecosystem assessment and management. In Chapter 3, "Setting the Nation's Sights," sustainability, stewardship, ocean-land-atmosphere connections, ecosystem-based management, multiple use management, and other general policies are recommended. Further, in the section entitled, "Translating Principles into Policy," we read under the subheading, "Ecosystem-based Management" that,

sound ocean policy requires managers to simultaneously consider the economic needs of society, the need to protect the nation's oceans and coasts, and the interplay among social, economic, and ecological factors. These factors are closely intertwined, just like the land, air, sea, and marine organisms. Activities that affect the oceans and coasts may take place far inland. For example, land-based sources of pollution, such as runoff from farms and city streets, are a significant source of the problems that plague marine ecosystems. Ocean policies cannot manage one activity, or one part of the system, without considering its connections with all the other parts. Thus, policies governing the use of US ocean and coastal resources must become ecosystem-based, science-based, and adaptive (US Commission on Ocean Policy 2004).

In the introduction to the OAP, the administration clearly states that it "will continue to work toward an ecosystem-based approach in making decisions related to water, land and resource management." These policy statements are in keeping with the 20-year development of the LME approach to the assessment and management of marine resources and their environments both within the waters of the United States and in partnerships with UN agencies and developing nations in Africa, Asia, Latin America, and Eastern Europe. The LME approach consists of a five module strategy for measuring changes in ecosystem (1) productivity, (2) fish and fisheries, (3) pollution and ecosystem health, (4) socioeconomics, and (5) governance. Information on the changing states of LMEs is used by governments to improve marine resources management practices for moving toward restoration of degraded habitats, reduction of coastal pollution, and recovery of depleted fish stocks. This background paper on the LME approach is focused on a global movement for introducing and practicing ecosystem-based management of marine resources in partnerships with the GEF as a funding mechanism, the IUCN, and several UN organizations as executing and implementing agencies.

The ecosystem-based management strategy of the US Commission on Ocean Policy is emphasized in the US Ocean Action Plan where, under the section on Advancing International

Oceans Science, the LME approach to the assessment and management of marine resources is supported (US Commission on Ocean Policy 2004):

Advance the Use of Large Marine Ecosystems. The US will promote, within the United Nations Environment Program's regional seas programs and by international fisheries bodies, the use of the Large Marine Ecosystems (LME) concept as a tool for enabling ecosystem-based management to provide a collaborative approach to management of resources within ecologically bounded transnational areas. This will be done in an international context and consistent with customary international law as reflected in 1982 UN Convention on the Law of the Sea. (USOAP 2004)

APPENDIX 5. PROFILES OF SELECTED LME FOUNDATION PROJECTS

1. Gulf of Mexico LME Project

Support a regional partnership in the Gulf of Mexico (page 5); monitor and share data on ocean currents in the Gulf of Mexico through Mineral Management Service of the Interior Department (US Commission on Ocean Policy 2004, page 13).

A workshop taking place in August 2006 identified and prioritized a list of transboundary issues for the Gulf of Mexico LME. The participating countries of Mexico and the United States began to scientifically characterize the LME and to identify its most pressing transboundary issues. The issues identified were 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 GEF-supported Gulf of Mexico LME project is on restoring and sustaining fisheries and fish stocks and on reducing and controlling nutrient overenrichment to safe ecosystem health levels. These actions will be supported by appropriate legal, policy, and institutional reforms, and investments to address the priority transboundary issues will be identified. The two countries will apply the five-module approach to LME assessment and management. They will identify the key information gaps in fisheries, eutrophication, pollution assessment, biodiversity, socio-economic conditions, legal/regulatory review, stakeholder analysis, hot spots, and contaminant levels in order to establish an ecosystem approach to LME management.

The project 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 nontarget species interaction, bycatch, and discards. It will investigate the commercial aspects of shrimp, reef fish, blue crab (*Callinectes sapidus*), red snapper (*Lutjanus campechanus*), mackerel (spp.), herring (*Clupea harengus*), sardines (spp.), and anchovy (spp.) fisheries. In addition it will assess ecosystem-wide nutrient overenrichment 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.

2. A Large Marine Ecosystem Strategy for the Assessment and Management of the Caribbean Sea LME

Partner creation: White Water to Blue Water Initiative (US Commission on Ocean Policy 2004, page 35)

As part of the White Water to Blue Water Initiative, the Caribbean Sea LME project provides opportunities to promote the application of watershed and marine ecosystem management techniques, to provide training to Caribbean stakeholders, and to establish linkages with the adjacent Gulf of Mexico GEF-LME Project. The Caribbean Sea LME is a semienclosed tropical sea bounded by North, Central, and South America, and the Lesser Antilles chain of islands. The area includes 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 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. The focus has been on fishery resources with very limited information on trophic linkages and the environment. 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. While oceanwide large pelagics are assessed by the International Commission for the Conservation of Atlantic Tuna (ICCAT), the status of pelagics within the LME is unknown.

The Caribbean Sea LME project builds upon and complements already existing projects and initiatives that emphasize the technical and institutional aspects of sustainable living marine resource use, focusing on governance, science, and institutional issues in a transboundary marine context. The overall goal of the 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. The specific objectives of the LME project are: (1) to identify, analyze, and reach consensus on major issues, root causes, and actions required to achieve sustainable management of the shared living marine resources of the Caribbean Sea LME; (2) to improve the shared knowledge base for sustainable use and management of the transboundary living marine resources; (3) to implement legal, policy, and institutional reforms and to achieve sustainable transboundary management of the living marine resources; and (4) to develop mechanisms for LME-level monitoring, evaluation, and reporting.

The first Steering Committee Meeting took place in August 2006, followed by a Transboundary Diagnostic Analysis workshop in September 2006 to address transboundary issues and monitoring and assessment needs. The Caribbean Sea LME project will explore the suitability of various governance mechanisms to sustainably manage key resources such as: large

pelagics, shrimp, flying fish, lobster, conch, coral reef fisheries, coral reef resources, seabirds, and marine invasive species. Pilot programs will provide the opportunity to explore regional and subregional governance mechanisms, supported by sound science-based information.

3. The Baltic Sea LME Project and Eutrophication

Eutrophication has been identified as a major threat to the Baltic Sea LME, caused by nutrient loading from land, atmospheric deposition, and internal nutrient loading through biological and geochemical pathways. The Helsinki Commission (HELCOM) contracting parties routinely monitor nutrient discharges to the Baltic Sea, estimate the magnitude of nutrient losses to watercourses in the drainage area, and identify nutrient sources, although agreement on a common methodology among participants has not yet been reached. The GEF/LME nutrient workshop report, available on the web at www.edc.uri.edu/lme, summarizes the calculations made to arrive at estimates of dissolved inorganic nitrogen (DIN) export from Baltic Sea catchments and the implications for management. Agriculture is the dominant nitrogen source for the Baltic Sea. Soil properties influence the spatial distribution of nitrogen export, with export levels lower in the loamy areas of Poland and southern Sweden and higher in other catchments like southern Finland. 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). Both nitrogen and phosphorus loads affect the environmental quality of the Baltic Sea LME. The Swedish MARE project is developing a system to achieve cost efficient nutrient abatement without undesired side-effects, like changing the distribution of cyanobacteria blooms. The earlier 50% reduction goal is being replaced by scientifically justifiable targets that are also cost efficient for participating countries. Approximately 20% of phosphorus loads originate from point sources and can be reduced simply through improved waste water treatment. The socio-economic costs of nutrient load reduction are region-specific. 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. It is expected that the “good ecological quality” target will not soon be met in many areas of the Baltic Sea LME. Spatial models already in use in several Baltic Sea countries could help to identify sensitive areas on which to focus abatement measures.

The Baltic Sea LME has a large catchment area, with land use activities having a strong effect on water quality. 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. A new Continuous Plankton Recorder (CPR) survey is to be conducted by Poland between Gdynia (PL) and Karlskrona (SE). For reports and presentations on the Baltic Sea LME Project, see www.ices.dk/

4. Benguela Current LME

The Benguela Current LME Programme is designed to improve the structures and capacities of Namibia, Angola, and South Africa to deal with the environmental problems occurring across national boundaries in order that the Benguela Current LME may be managed as a whole. These transboundary issues include the migration or straddling of valuable fish stocks, the introduction of invasive species via the ballast water of ships moving through the region, and pollutants or harmful algal blooms that can be advected by winds and currents from the waters of one country into another. A Benguela Current Commission (BCC), with a secretariat and ecosystem advisory committee, has been established by the three countries bordering the Benguela Current LME (Angola, Namibia, and South Africa). The Benguela Current Commission agreement was signed in Cape Town on August 29, 2006, an event marking the first time a commission has been established for the assessment and management of LME goods and services. Application for GEF funds relate mainly to building institutional capacity within the newly formed BCC. The commission will encourage national policy reform and build long term capacity to implement an ecosystem approach to Benguela Current LME governance and conservation.

The Benguela Current LME is characterized by environmental variability and extreme events, including five Benguela Niños, harmful algal blooms, low oxygen events, sulphur eruptions, and catastrophic fish mortalities. A continuous plankton recorder is to be deployed in the Benguela Current LME; an early warning system for monitoring outbreaks of harmful algal blooms through monitoring buoys is already in place. Significant shifts, both human and climate driven, have occurred in the area of fisheries. The ecosystem approach investigates fisheries management through transboundary fish stock assessments, the monitoring of top predators as indicators of ecosystem change, and trends in fish catches (1950-1999). The sardine and rock lobster collapse in the 1960s and 1970s and the recent migration of pelagic fish and rock lobster in the southern Benguela Current had major socio-economic impacts: a decimated processing and canning industry and job losses. Regarding pollution and ecosystem health, a key policy action of the Benguela Current LME Programme is the assessment of environmental variability and ecosystem impacts and the improvement of predictability in this complex and variable ecosystem. Permanent, continuously operating, real-time regional ocean prediction systems such as the Global Ocean Observing System (GOOS) are increasingly required to support the variety of critical activities outlined above.

5. The Guinea Current LME and the LME Approach

Coastal monitoring is underway and making progress in the 16 West African countries of the Guinea Current LME. A range of activities is needed to provide managers with information about ecosystem conditions, for tracking perturbations and resources at risk. Given the abundant stressors on the Guinea Current LME, the LME approach has already helped address the need to standardize and make comparable data heretofore spatially and temporally fragmented. Currently, data are obtained from time series assessments based on the five modules. These methodologies are leading to a management system that will include regulatory, institutional, and decision-making aspects.

Regarding the fish and fisheries module, two fish assessment surveys have been completed with the *R/V Nansen*. Historical data from non-African countries are being accessed

and are becoming part of a regional data base. While fisheries regulation is still in its early days of implementation, progress is being made on establishing maximum sustainable yield levels, improved identification of target species of commercial fisheries, and an ecosystem-wide precautionary approach to distant water fishing. Licenses are no longer being issued except for tuna. As a conservation measure, Angola has stopped all horse mackerel fishing. A coordinated monitoring and surveillance program is being developed to control illegal fishing operations, recognizing that a healthy ecosystem is a resource for healthy economies. Efforts have been initiated to improve the quality of degraded habitats. Common effluent standards for pollution monitoring have been adopted, and a regional oil spill plan is being developed. A mangrove reserve has been established in southeastern Nigeria, and others are soon to follow in Cameroon and Angola. Integrated Coastal Area Management (ICAM) efforts are progressing with zoning restrictions to preserve habitat. A setback line is being implemented to deal with coastal erosion. The Guinea Current LME website provides additional information at: <<http://gclme.org>>.

At the institutional levels of the Guinea Current LME Programme, the Regional Coordination Unit (RCU) is fully functional, with an effective Steering Committee governing the project in place, and a Council of Ministers. Regional Activity Centers have been established as hubs for the technical programs. To move these institutions and instruments towards sustainability, the host countries for the RCU and the local Coordination Units must supply location and utilities. Host countries are to support the Regional Activity Centers. Regional scientific and technical advisory committees and national inter-ministerial committees at a high level are to provide decision-making support. The project has evolved from the Gulf of Guinea LME pilot programme (1995-1999), to the Accra Declaration (1998), and to a ministerial level meeting of all 16 countries of the Guinea Current LME in Abuja, Nigeria in September 2006 that endorsed the establishment of an Interim Guinea Current Commission (IGCC). Already the ministerial committee has issued several reports, on the fish species *Sardinella*, on biodiversity and erosion in the Republic of Congo, on erosion in Gabon, and on mangrove and pollution in Angola. The IGCC is mandated to act on behalf of the countries and has authority to receive relevant data on FAO fisheries, International Maritime Organization (IMO) data on ballast water, and on the GPA (UNEP). The establishment of the IGCC is providing a solid path to socioeconomic and human development (see Appendix 2).

6. Bay of Bengal Large Marine Ecosystem (BOBLME)

The BOBLME includes the coastal areas of eight countries: Bangladesh, India, Indonesia, Malaysia, Maldives, Myanmar, Sri Lanka, and Thailand. Some 400 million people live in the catchment and coastal areas, 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 (BOBLME) 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 (*Rastrelliger Kanagurta*) and hilsa (*Tenualosa ilisha*) 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 cofunding (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.

7. Yellow Sea LME

After more than a decade of planning and negotiation, the Yellow Sea LME Project, "Reducing Environmental Stress in the Yellow Sea Large Marine Ecosystem" was initiated in 2005 with GEF funding support. The goals are to reverse the decline of the Yellow Sea ecosystem, restore food fish for the sustenance of growing populations, and conserve the integrity of the ecosystem. The Yellow Sea LME Project aims to develop ecosystem-based, environmentally sustainable management practices for the Yellow Sea and its watershed; to prepare a Transboundary Diagnostic Analysis (TDA), National Yellow Sea Action Plans (NYSAPs), and a Strategic Action Plan (SAP); and to establish a regional framework for cooperation. Four components were developed for the Yellow Sea LME project. The first component, "Regional Strategies for Sustainable Management of Fisheries and Mariculture," addresses the need for sustainable fisheries management and fisheries recovery plans, agreed to on a regional basis. Since the 1990s, the proportion in Chinese fishery yields is 45% capture fisheries versus 55% aquaculture, with the cultivation of scallops, oysters, crabs, shrimp, seaweed, and fish. The second component, "Effective Regional Initiatives for Biodiversity Protection," addresses the need for regional coordination to preserve globally significant biodiversity. The third, "Actions to Reduce Stress to the Ecosystem, Improve Water Quality and Protect Human Health," develops management practices based on an understanding of ecosystem behavior. The fourth, "Development of Regional Institutional and Capacity Building," focuses on national and regional institutions, the preparation of investment portfolios, and project coordination. Five regional working groups are focusing on fisheries, biodiversity, the ecosystem, pollution, and investment.

Activities in 2005-2006 included two steering committee meetings, two regional technical meetings, ten meetings of the regional working groups, and one special technical meeting to plan for cooperative study cruises. A parliamentary conference was held in March 2006 in Qingdao, China. The project is reviewing marine fisheries production and the species composition of mariculture in the Yellow Sea LME, decadal analyses of spring species composition in biomass yields, biomass changes in the central and southern part of the Yellow Sea, changes in wintering stock biomass and annual landings of anchovy, with decadal changes

in age structure and size structure (1986 – 2005), the trophic level of important species and their decline, fluctuations in herring abundance, and the 36-year cycle of wetness oscillation in eastern China. There are seasonal changes in the nutrient condition of Yellow Sea waters, including low oxygen areas. The project hopes to establish an ecosystem-based monitoring and assessment program and to plan for cooperative study cruises that will provide basin-wide data to be added to existing data bases and will contribute to the preparation of a Yellow Sea TDA. The project has been successful in obtaining additional funding for process-oriented research. Additionally, a study of LME goods and services will be included, with contributions from China-Global Ocean Ecosystem Dynamics (GLOBEC) studies on ecosystem dynamics and the sustainable use of marine living resources. The Chinese government has agreed to host the second global Conference on LMEs, to be held in Qingdao, China in September 2007. Information is available at: www.imber.info/jobs-announcements/LMEs_second_announcement.pdf.

8. Black Sea LME

The Black Sea LME project is now winding down phase 2 (2004-2007) of a 15 year GEF-LME Project. The six countries bordering the Black Sea LME are Bulgaria, Georgia, Romania, Russia, Turkey, and Ukraine. 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. The present project builds on the cooperation already established between the Black Sea Commission and the International Commission for the Protection of the Danube River, extending this further to include a proposed Dnipro River Basin Commission. Attention is also being given to transboundary contamination by hazardous substances. The work undertaken has been far-reaching and has involved the cooperation of national and local governments, regional organizations, donors, the private sector, and NGOs. A key partner has been the Commission on the Protection of the Black Sea Against Pollution (Bucharest convention). A TDA and an SAP were first developed in 1996. The TDA was updated in 2006, with the gathering and interpretation of information on environmental impacts and the socioeconomic consequences of each identified issue. The reformulation of the SAP, completed in 2007, includes a review of the long-term vision, selects environmental indicators, and sets priority actions for improving and sustaining the health of the Black Sea LME.

Capacity-building activities, environmental monitoring, pilot projects, best fishing practices, and community actions are critical. A key activity of the Black Sea Ecosystem Recovery Project (BSERP) is an assessment program that will determine the current status and dynamics of the Black Sea LME and measure the progress made by the end of the project's phase 2 (2004-2007). These activities are coordinated by a specially-established study group led by regional and international scientists. The program includes an impact study of the Danube River input into the Black Sea LME; 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. There are missing data on primary productivity and fish. The project is at the tail end of a 15 year long support by GEF. The results of the research undertaken in 2003-2006 show clear signs that the Black Sea LME is recovering, although at a rather slow rate. There is a slow recovery of biodiversity in the northern part of the LME. However, the recovering ecosystem is still very vulnerable, and if issues are not properly addressed, the positive dynamics could be reversed.

9. 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 involved in the project are Morocco, Mauritania, Senegal, the Gambia, Guinea-Bissau, Guinea, and Cape Verde. The project goal is 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 been established on the basis of national consultation, resulting in the preparation of 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 the LMEs extending from Morocco to South Africa.

10. Agulhas Current LME and Somali Current LME

The project document 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 final project document was prepared so that it could be signed by the eight countries involved: Comoros, Kenya, Madagascar, Mauritius, Mozambique, Seychelles, South Africa, and Tanzania.

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