Ocean & Coastal Management 90 (2014) 38–49

Contents lists available at ScienceDirect

Ocean & Coastal Management

journal homepage: www.elsevier.com/locate/ocecoaman

Adaptive management institutions at the regional level: The case of Large Marine Ecosystems

Kenneth Sherman

NOAA National Marine Fisheries Service, Narragansett, Rhode Island 02882, United States

ARTICLE INFO

Article history:
Available online 3 August 2013

ABSTRACT

A global effort is underway by scientists, stakeholders, resource managers, and multisectoral ministerial representatives (e.g. fisheries, transportation, mining, energy, tourism, environment) from 110 economically developing countries to implement ecosystem-based management at the Large Marine Ecosystem scale. The effort is supported with $3.1 billion in financial assistance from the Global Environmental Facility and World Bank to assess and manage goods and services of Large Marine Ecosystems (LMEs) along the coasts of economically developing countries in Africa, Asia, Latin America and eastern Europe. Through a systematic spatial and temporal scaling across multiple jurisdictions (e.g. community, municipal, regional, national, and international) a generic suite of indicators is applied to monitor the annual changes in LME productivity, fish and fisheries, pollution and ecosystem health, socioeconomics, and governance. Ecosystem-based governance practices are being implemented by Commissions that serve as institutional frameworks for restoring and sustaining transboundary LME goods and services. Under activities guided by LME Commissions, the suites of indicators are analyzed in relation to drivers of change and the results are applied to adaptive management regimes to reduce coastal pollution, restore damaged habitats, recover depleted fisheries conserve biodiversity, control nutrient over-enrichment and ocean acidification, and mitigate and adapt to the effects of climate warming. Application of ecosystem-based adaptive management practices presently underway by the People's Republic of China and the Republic of Korea are discussed for the Yellow Sea LME.

1. The Large Marine Ecosystem approach

Large Marine Ecosystems (LMEs) are regions of ocean space of 200 000 km^2 or greater, encompassing coastal areas from river basins and estuaries out seaward to the break or slope of the continental shelf or out to the seaward extent of a well-defined current system along coasts lacking continental shelves. The World's LMEs are defined by ecological criteria including (1) bathymetry, (2) hydrography, (3) productivity, and (4) trophically linked populations (Sherman, 1993b; Duda and Sherman, 2002).

The LMEs continue to be degraded by unsustainable fishing practices, habitat degradation including loss of sea grasses, mangroves and corals; eutrophication, toxic pollution, aerosol contamination, ocean acidification; and emerging diseases. The scale and severity of risks to LME goods and services associated with depletion and degradation of near coastal oceans is well documented (Sherman et al., 2005; Lubchenco and Petes, 2010). The coastal waters of LMEs contribute an estimated $12.6 trillion annually to the global economy (Costanza et al., 1997). An estimated 80% of the world's annual marine fisheries catch is produced in 64 LMEs (Fig. 1).

The LME approach to the management of coastal and marine resources operates at multiple scales, within the boundaries of LMEs, and harnesses stakeholder support for integrated adaptive management in both Northern and Southern countries (Duda and Sherman, 2002; Duda, 2009). The LME approach to the assessment and management of coastal ocean goods and services includes a pragmatic application of natural and social sciences in support of adaptive management informed by time-series measurements of key ecosystem indicators of changing ecosystem conditions. The LME approach is based on five modules for measuring changing states in LMEs including (i) productivity, (ii) fish and fisheries, (iii) pollution and ecosystem health, (iv) socioeconomics, and (v) governance. Analyses of time-series measurements from the modular suites of indicators provide the basis for developing and implementing management actions to recover and sustain LME goods and services (Fig. 2).

E-mail address: Kenneth.Sherman@noaa.gov.

0964-5691/$ – see front matter © 2013 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.ocecoaman.2013.06.008

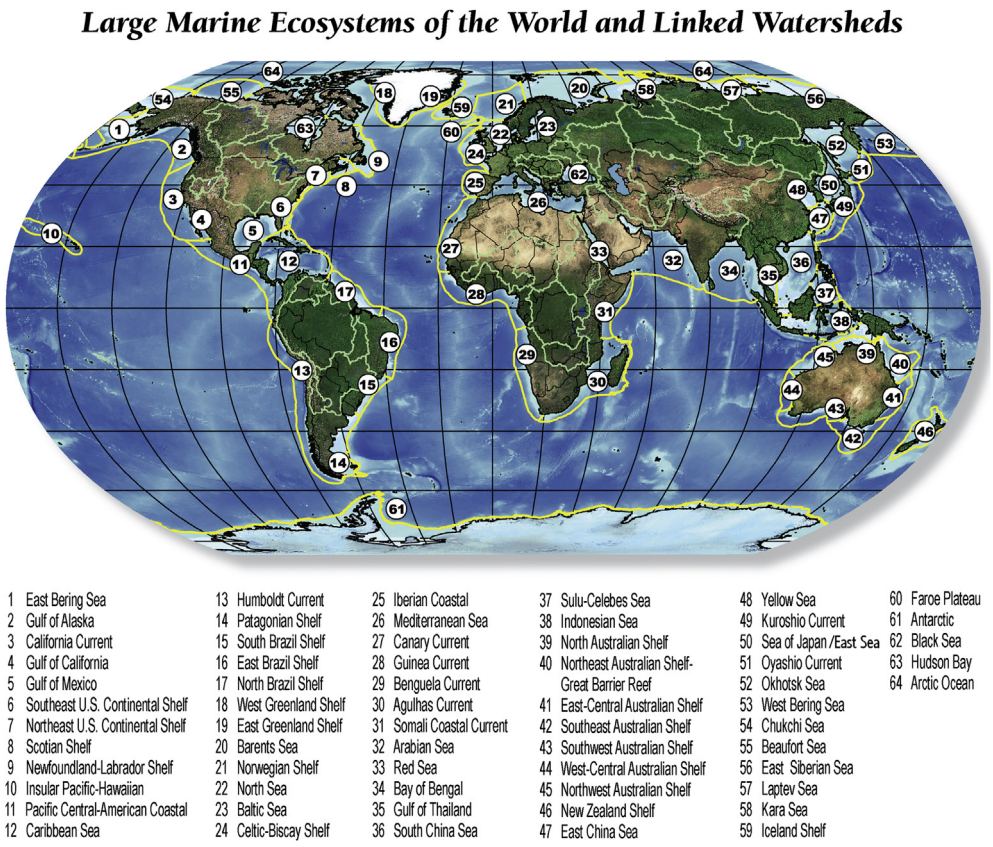

Fig. 1. Map of the 64 Large Marine Ecosystems of the world and their linked watersheds.

1.1. Productivity module indicators

Primary productivity can be related to the carrying capacity of an ecosystem for supporting fish resources (Pauly and Christensen, 1995; Christensen et al., 2009). Measurements of ecosystem productivity are also useful indicators of the growing problem of coastal eutrophication. In several LMEs, excessive nutrient loadings to 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 non-indigenous species (Epstein, 1993; Sherman, 2000).

The ecosystem parameters used as indicators of changing conditions in the productivity module are: photosynthetically-active radiation, transparency, chlorophyll *a*, primary productivity, nitrogen, sea surface temperature, water column structure, and ocean fronts (Aiken et al., 1999; Berman and Sherman, 2001; Melrose et al., 2006; Belkin et al., 2009; Sherman et al., 2009a).

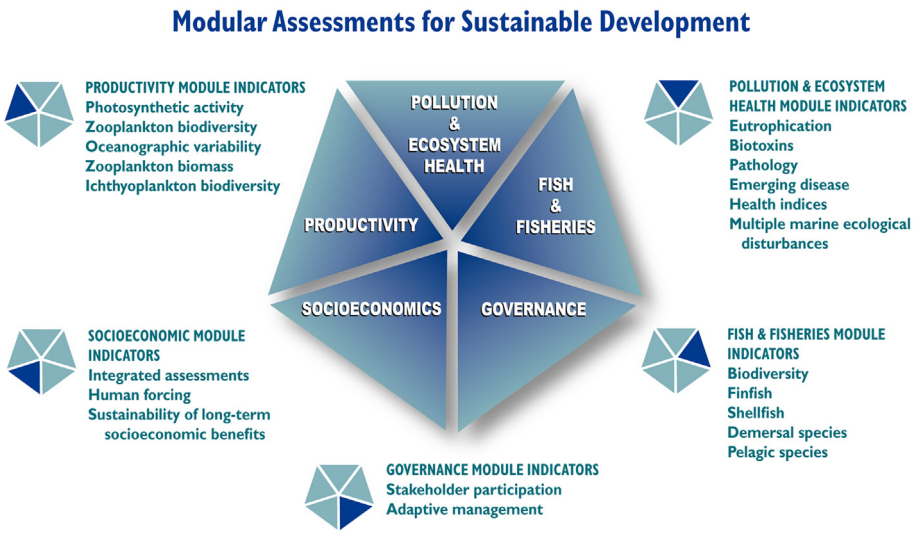

Fig. 2. LME modules as suites of ecosystem indicators.