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Large Marine Ecosystems of the World: An Annotated Bibliography

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U.S. Department of Commerce
National Oceanic and Atmospheric Administration
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Table of Contents

Introduction

Large marine ecosystems (LMEs) are areas of coastal oceans delineated on the basis of ecological characteristics—bathymetry, hydrography, productivity, and trophically linked populations (Sherman and Alexander, 1986). LMEs cover large areas on the order of 200,000 km^2 and greater. Their ecologically defined boundaries generally transcend national political boundaries and encompass coastal ocean domains of two or more countries, thereby fostering international cooperation among countries working towards implementation of ecosystem-based management (EBM) of LME goods and services. The 66 LMEs of the world annually produce 80% of the global marine fisheries biomass yield (Pauly et al., 2008) and contribute an estimated $12.6 trillion (USD) in goods and services annually to the global economy (Costanza et al., 1997). LMEs also include global centers of marine tourism, shipping, mining, and energy production. For example, the Gulf of Mexico LME supports offshore gas and oil energy production, extensive commercial and recreational fisheries, and extensive tourism sectors of the U.S. economy. These ecosystems, and the services they provide, threatened by overfishing, pollution, habitat degradation, eutrophication, the loss of biodiversity, acidification, and the effects of climate change.

The LME approach to the assessment, monitoring, and management of coastal marine resources is multidisciplinary and multisectoral, built on the need to link natural sciences with social sciences to achieve a more holistic management strategy for addressing human and environmental threats. This approach was introduced in the 1980s by Dr. Kenneth Sherman of NOAA and Dr. Lewis Alexander of the University of Rhode Island (Sherman and Alexander, 1986). The LME approach was further developed through a series of symposia with the American Association for the Advancement of Science and workshops with the Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific and Cultural Organization (IOC-UNESCO) and the National Oceanic and Atmospheric Administration (NOAA) of the United States (Sherman 1993, 2016). The outcome of these workshops was the five-module assessment framework of both natural-science- and social-science-based suites of indicators for monitoring changing conditions in LMEs. There are three natural-science-based suites: (i) productivity, (ii) fish and fisheries, and (iii) pollution and ecosystem health; and two social science suites focused on the human dimensions of LMEs: (iv) socioeconomics and (v) governance. In 1995, the Global Environmental Facility (GEF), an international financial institution for supporting sustainable development of natural resources, adopted the LME assessment and management approach for planning and implementing the coastal and marine projects of their International Waters focal area. Since then, the GEF has catalyzed $3.15 billion in financial assistance to 110 developing countries across the globe to support the implementation of EBM of coastal and marine resources in 22 LMEs (Sherman, 2014).

The LME approach has also received notable recognition in recent years. NOAA has recognized the LME approach as one of the 10 major scientific breakthroughs since the beginning of the agency and the establishment of the Coast Survey by President Thomas Jefferson in 1807 (see http://celebrating200years.noaa.gov/breakthroughs/ecosystems/welcome.html). In 2010, the Interagency Ocean Policy Task Force of the White House Council on Environmental Quality issued their final recommendations document, which designates LMEs as coastal ocean domains for implementing ecosystem-based management practices (United States, 2010). In 2015, the GEF published a report for distribution to the Conference of Parties (COP21) meeting in Paris, describing the LME approach as "the cornerstone of the GEF strategy for ocean and coastal conservation and the GEF is the leading global funding source for transboundary water systems" (GEF, 2015).

The sound scientific foundation for the LME approach to EBM has developed through a large body of literature. Since the publication of the seminal volume *Variability and Management of Large Marine Ecosystems* (Sherman and Alexander, 1986), a total of 14 LME volumes with contributions from 450 authors have been published by AAAS, Blackwell Science, and Elsevier Science. An additional four LME volumes have been published by IUCN (2009, 2010) and jointly by UNDP and GEF (2012, 2013). In addition to the volumes, the LME approach has provided a common basis for a growing number of comparative studies published in scientific journals. Since 1983, LMEs have been mentioned in 392 journal articles and served as the basis of specific case studies or as comparative LME studies in 304 of them. This work has continued in 2016 with the IOC-UNESCO Transboundary Waters Assessment Program (TWAP), which produced a global assessment of the ecological conditions of the world's 66 LMEs based on a 2-year study sponsored by the GEF. In April 2016, a theme volume of Elsevier Science's journal *Environmental Development*, titled "Ecosystem based management of Large Marine Ecosystems," was published as Volume 17, Part 1 (Sherman and Hamukuaya, 2016).

As described in this document, the LME published literature has grown significantly since the early 1980s. To provide a reliable source for the widely disseminated LME literature, an electronic search effort was undertaken by NOAA Fisheries in 2015. The present annotated bibliography is a result of this effort. The literature search included more than120 journals, 18 published LME volumes, and 38 reports.

Methodology

A. Literature Search for Journal Publications

Searches for peer-reviewed journal articles were conducted in 2015, using the Web of Science database, the Duke University online databases, and the Google Scholar search engine. Keyword search results (listed later) for each database/search engine were first screened based on exclusion criteria (listed later). If the keyword searches passed, the full text was opened in Adobe Acrobat Pro, and the *Find* tool was used to check the entire document for keywords. Documents with at least one keyword were imported into EndNote, which was used to organize and compile the final list. In the spring of 2016, a search was run through one specific journal, *The African Journal of Marine Science*, and the same criteria were used to include articles in the EndNote literature database. Journal articles were also added on an ad hoc basis when available.

Keywords: (Large marine ecosystem) (Large marine ecosystems) (LME) (LMEs)
Key inclusion criteria: a) included keywords in the abstract, key words, or the full text of the document at least once, and b) published between 1983 and present day.
Key exclusion criteria: a) book chapter, b) dissertation/thesis not published in an academic journal, c) conference papers not published in an academic journal, and d) not in English.

After the literature was selected for inclusion in the collection, it was placed in one of five groups. The group criteria are explained next.

Group One – These journal articles at least mention the LME approach or a specific LME, but do not discuss either. Included in this group are papers that simply reference key LME works. Papers are also included where it is unclear whether the author(s) are referring to the LME approach/program or rather to marine ecosystems that are large. (50 entries)
Group Two – These journal articles include a discussion, sometimes abbreviated, of the LME approach or a specific LME, between a few sentences and a couple of paragraphs; however, LMEs and the LME approach are not a focus of the work. (38 entries)
Group Three – These papers are works that focus on an LME or the LME approach, but are not comparative studies. (83 entries)
Group Four – This group includes comparative LME studies; that is, studies that use LMEs as the study area. (122 entries)
Group Five – These are the key LME publications, which are works that discuss the LME approach and further develop the application of the approach. (99 entries)

B. Other Literature

The other, non-journal article literature included in this collection, such as the LME volumes, was gathered from online sources, including the Large Marine Ecosystems and IW:LEARN websites.

The Annotated Bibliography

A. LME Volumes

1. K. Sherman and L. M. Alexander (eds.). 1986. Variability and management of Large Marine Ecosystems. American Association for the Advancement of Science (AAAS) Selected Symposium 99, Westview Press. Boulder, CO. 319.
2. K. Sherman and L. M. Alexander (eds.). 1989. Biomass yields and geography of Large Marine Ecosystems. American Association for the Advancement of Science (AAAS) Symposium 111, Westview Press. Boulder, CO. 493.
3. K. Sherman, L. M. Alexander and B. D. Gold (eds.). 1990. Large marine ecosystems: Patterns, processes and yields. Large Marine Ecosystem Series. American Association for the Advancement of Science (AAAS) Symposium. Washington, DC. 242.
4. K. Sherman, L. M. Alexander and B. D. Gold (eds.). 1991. Food chains, yields, models, and management of large marine ecosystems. Large Marine Ecosystem Series. American Association for the Advancement of Science (AAAS) Symposium, Westview Press. Boulder, CO. 320.
5. K. Sherman, L. M. Alexander and B. D. Gold (eds.). 1993. Large Marine Ecosystems: Stress, Mitigation, and Sustainability. American Association for the Advancement of Science (AAAS) Washington, D.C. 376.
6. K. Sherman, N. J. and T. Smayda (eds.). 1996. The Northeast Shelf ecosystem: Assessment, sustainability and management. Blackwell Science. Cambridge, MA. 564.
7. K. Sherman, E. N. Okemwa and M. J. Ntiba (eds.). 1998. Large marine ecosystems of the Indian Ocean: Assessment, sustainability, and management. Blackwell Science. Malden, MA. 394.
8. H. Kumpf, K. Steidinger and K. Sherman (eds.). 1999. The Gulf of Mexico large marine ecosystem: Assessment, sustainability, and management. Blackwell Science. Malden, MA. 704.
9. K. Sherman and Q. Tang (eds.). 1999. Large marine ecosystems of the Pacific Rim: Assessment, sustainability, and management. Blackwell Science. Malden, MA. 465.
10. J. M. McGlade, P. Cury, K. A. Koranteng and N. J. Hardman-Mountford (eds.). 2002. Gulf of Guinea large marine ecosystem: Environmental forcing and sustainable development of marine resources. Elsevier Science. Amsterdam. 392.
11. K. Sherman and H. R. Skjoldal (eds.). 2002. Large marine ecosystems of the North Atlantic: Changing states and sustainability. Elsevier Science. Amsterdam. 449.
12. G. Hempel and K. Sherman (eds.). 2003. Large Marine Ecosystems of the world: Trends in exploitation, protection, and research. Elsevier Science. Amsterdam. 423.
13. T. Hennessey and J. G. Sutinen (eds.). 2005. Sustaining Large Marine Ecosystems: The Human Dimension. Elsevier Science. The Netherlands. 371.

14. Shannon, G. Hempel, P. Malanotte-Rizzoli, C. Moloney and J. Wood (eds.). 2006. Benguela: Predicting a large marine ecosystem. Elsevier Science. Amsterdam. 410.
15. K. Sherman, M. C. Aquarone and S. Adams (eds.). 2009. Sustaining the World's Large Marine Ecosystems. The International Union for the Conservation of Nature (IUCN). Gland, Switzerland. viii+140.
16. K. Sherman and S. Adams (eds.). 2010. Sustainable Development of the World's Large Marine Ecosystems during Climate Change: A commemorative volume to advance sustainable development on the occasion of the presentation of the 2010 Göteborg Award. International Union for the Conservation of Nature (IUCN). Gland, Switzerland. x+232.
17. K. Sherman and G. McGovern (eds.). 2012. Frontline Observations on Climate Change and Sustainability of Large Marine Ecosystems. United Nations Development Programme (UNDP) and Global Environment Facility (GEF). New York, NY. 203.
18. K. Sherman and S. Adams (eds.). 2013. Stress, Sustainability, and Development of Large Marine Ecosystems during Climate Change: Policy and Implementation. United Nations Development Programme (UNDP) and Global Environment Facility (GEF). New York, NY. 146.

B. Journal Publications

Group One

A. M. Ellison and E. J. Farnsworth. (1996). Anthropogenic disturbance of Caribbean mangrove ecosystems: past impacts, present trends, and future predictions. Biotropica, 28 (4): 549-565.

The 32 countries bordering the Caribbean LME (CLME) made up the study area for this article. The CLME fishery is also mentioned. The study itself focuses on the historical, current, and future impacts of anthropogenic disturbances (extraction, pollution, reclamation, and climate change) on Caribbean mangroves.

L. W. Botsford, J. C. Castilla and C. H. Peterson. (1997). The management of fisheries and marine ecosystems. Science, 277: 509-515.

This paper provides an overview of the management of fisheries and marine ecosystems, arguing that management has failed to achieve sustainability of the world's fisheries due to sociopolitical pressure for larger catches and a lack of data. LMEs are referenced as a new concept for ecosystem management. The authors suggest several changes that would improve fisheries management without having to change the scientific approach.

S. Chaturvedi. (1998). Common security? Geopolitics, development, South Asia and the Indian Ocean. Third World Quarterly, 19 (4): 701-724.

The goal of this paper is to examine the concept of “common security” using a geopolitical approach with a focus on the Indian Ocean. This paper discusses the Rio Earth Summit and references LMEs in this context. During negotiations, developing countries did not embrace the U.S. proposal to use LMEs as the major principle out of concern that their exclusive economic zone (EEZ) rights may be compromised.

P. B. Bridgewater and I. D. Cresswell. (1999). Biogeography of mangrove and saltmarsh vegetation: implications for conservation and management in Australia. Mangroves and Salt Marshes, 3: 117-125.

The LME concept is briefly referenced in this paper with regard to the segmentation of the Australian coastline for saltmarsh and mangrove ecosystems. The review examines the biogeography of mangrove and saltmarsh ecosystems, their importance as habitat to commercial species, the key threats to these systems, and options for conservation and management.

E. Ostrom, J. Burger, C. B. Field, R. B. Norgaard and D. Policansky. (1999). Revisiting the commons: local lessons, global changes. Science, 284: 278-282.

This review article revisits the topic of common pool resources and presents lessons learned in the past 30 years since Garrett Hardin's seminal paper on the tragedy of the commons. LMEs are referenced as large-scale resources that depend on international cooperation.

F. Carbone and G. Accordi. (2000). The Indian Ocean Coast of Somalia. Marine Pollution Bulletin, 41 (1-6): 141-159.

This paper provides an overview of the Indian Ocean coast of Somalia and introduces the man-made, large-scale alteration of this coast. The authors present the problem of inadequate conservation in this area and established an area of high conservation priority. The Somali Coastal Current LME is referenced in the description of the Somali coast.

R. Goni, N. V. C. Polunin and S. Planes. (2000). Comment: The Mediterranean: marine protected areas and the recovery of a large marine ecosystem. Environmental Conservation, 27 (2): 95-97.

This comment article refers just once to the Mediterranean as a “large marine ecosystem.” The main focus of the work is the use of marine protected areas (MPA) for the recovery the Mediterranean.

C. M. Marquette, K. A. Koranteng, R. Overa and E. B. D. Aryeetey. (2002). Small-scale fisheries, population dynamics, and resource use in Africa: the case of Moree, Ghana. Ambio, 31 (4): 324-336.

This paper argues that fisheries management policies in Moree, a small-scale fishing community in Ghana, must take into account numerous processes influencing fishery resources. These processes are biophysical (e.g., coastal upwelling) as well as economic (e.g., the nonlocal demands for fish). The paper references the GEF/United Nations Industrial Development Organization (UNIDO) Gulf of Guinea LME project as one of two recent stock surveys that assess stock quality and quantity near Moree.

R. van der Elst. (2003). Local solutions to challenges of West Indian Ocean fisheries development. Naga, WorldFish Center Quarterly, 26 (3): 14-17.

This paper discusses local solutions to the challenge of fisheries development in the West Indian Ocean. It first provides an overview of the region’s fisheries and resource management, and then presents three case studies of the challenges to resource management in this region: Mozambique, Somalia, and Tanzania. The Agulhas and Somali Coastal Currents LME (ASCLME) program is included in a list of fisheries research and management projects in the West Indian Ocean.

M. Marques, M. F. da Costa, M. I. Mayorga and P. R. Pinheiro. (2004). Water environments: anthropogenic pressures and ecosystem changes in the Atlantic drainage basins of Brazil. Ambio, 33 (1): 68-77.

The study area for this publication included three LMEs: the South Brazil Shelf, the East Brazil Shelf, and the North Brazil Shelf. Within these LMEs, productivity was briefly reviewed in a description of the physical dimension of the Atlantic drainage basins of Brazil. The focus of this paper was the anthropogenic pressures and ecosystem changes in these basins.

L. J. Shannon , K. L. Cochrane , C. L. Moloney and P. Fréon. (2004). Ecosystem approach to fisheries management in the southern Benguela: a workshop overview. African Journal of Marine Science, 26 (1): 1-8.

This paper summarizes the workshop held in Cape Town in December 2002, where the ecosystem approach to fisheries (EAF) management concept was introduced for application in the southern Benguela current in South Africa. LMEs are referenced once in the discussion on ECOPATH with ECOSIM.

A. S. Y. Mackie, G. Oliver, R. Darbyshire and K. Mortimer. (2005). Shallow marine benthic invertebrates of the Seychelles Plateau: high diversity in a tropical oligotrophic environment. Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences, 363: 203-228.

The benthic mollusk and polychaete worm assemblages of the shallow waters of the Seychelles were examined and compared with temperate and subtropical environments. The findings suggest that benthic fauna in the Seychelles is at least as diverse as that of tropical habitats. The ASCLME project is referenced because its contributions to benthic ecology have provided perhaps the most relevant comparative data at the time of publication.

S. Parsons. (2005). Ecosystem considerations in fisheries management: theory and practice. The International Journal of Marine and Coastal Law, 20 (3-4): 381-422.

This paper references LME projects as a mechanism for the implementation of ecosystem management on a global scale. The paper examines recent developments of ecosystem-based fisheries management (EBFM). The author argues that EBFM is not a replacement for the existing fisheries management approaches, but rather a slow development. He also argues that a reduction of the capacity of the world's fisheries is an essential component of EBFM.

R. M. Briones. (2006). Projecting future fish supplies using stock dynamics and demand. Fish and Fisheries, 7 (4): 303-315.

LMEs are referenced in this paper with regard to population models. The Gulf of Thailand LME is used as an example to contrast the fish types used in a trophic model and a supply–demand model. The focus of this paper is supply–demand models as applied to projections of future fish supplies. The authors argue these models ignore stock dynamics and instead present a prototype bioeconomic supply–demand model as a potential alternative.

R. Enever, A. Revill and A. Grant. (2007). Discarding the English Channel, Western approaches, Celtic and Irish seas (ICES subarea VII). Fisheries Research, 86 (2-3): 143-152.

This study presents the findings of the catch and discard data collection program of the Centre for Environment, Fisheries and Aquaculture Science (UK) in the ICES subarea VII. The authors also estimate the annual quantities of discards in this area between 2002 and 2005. The study references a Kelleher 2005 study presenting data for discards in the Celtic–Biscay Shelf LME. The results of this study suggest that Kelleher's findings may have underestimated discards in the Celtic–Biscay shelf by at least 50%.

J. M. Mesias, J. J. Bisagni and A. M. E. G. Brunner. (2007). A high-resolution satellite-derived sea surface temperature climatology for the western North Atlantic Ocean. Continental Shelf Research, 27 (2): 191-207.

This study worked with a monthly mean time series for the Northwest Atlantic Ocean from 1985 to 1999, calculating long-term, high-resolution, satellite-derived sea surface temperature (SST) fields and a daily climatology. The study region includes the Northeast U.S. Continental Shelf LME, although it is referred to only as one of 50 LMEs.

A. Bakun and S. J. Weeks. (2008). The marine ecosystem off Peru: What are the secrets of its fishery productivity and what might its future hold? Progress in Oceanography, 79 (2-4): 290-299.

This paper describes the productivity of coastal Peru, part of the Humboldt Current Large Marine Ecosystem; however, it refers to the HCLME only twice. The authors compare the productivity of this region to other LMEs, including the Benguela Current Large Marine Ecosystem, emphasizing the superior fisheries productivity of the HCLME. When making these regional comparisons, the paper discusses potential factors for the larger fisheries yield of coastal Peru and then explores the potential effects of global climate change on these factors.

W. J. Bolster. (2008). Putting the Ocean in Atlantic History: maritime communities and marine ecology in the Northwest Atlantic, 1500-1800. The American Historical Review, 113 (1): 19-47.

This paper in the American Historical Review examines the Northeast Shelf LME from the perspective of an historian. The paper charges historians studying colonial New England with having neglected the living sea. The paper further challenges them to historicize the ocean as part of human histories, laying the groundwork with this paper on the maritime communities and marine ecology in the Northwest Atlantic from 1500 to 1800.

S. R. Palumbi, K. L. McLeod and D. Grunbaum. (2008). Ecosystems in action: lessons from marine ecology about recovery, resistance, and reversibility. BioScience, 58 (1): 33-42.

This study references LMEs in the context of the Worm 2006 paper. The article itself focuses on data provided by marine ecologists on recovery, resistance, and reversibility of marine ecosystems following a disturbance.

C. Bas. (2009). The Mediterranean: a synoptic overview. Contributions to Science, 5 (1): 25-39.

This paper references the LME approach as it integrates human/social aspects; however, it mentions the concept only once. The focus of the article is the formation of the Mediterranean Sea, its geomorphological structure, and its oceanographic dynamics. There is an effort to consider the Mediterranean Sea ecosystem as a single large unit, including the role of humans. At the end of the overview, the LME approach is referenced in an effort to integrate the biophysical, socioeconomic, and human factors influencing the Mediterranean.

M. Lindegren, C. Möllmann, A. Nielsen and N. C. Stenseth. (2009). Preventing the collapse of the Baltic cod stock through an ecosystem-based management approach. Proceedings of the National Academy of Science of the United States of America, 106 (34): 14722-14727.

This study applies a stochastic food-web model to the Baltic Sea, which is described once as a large marine ecosystem, to reconstruct the history of a commercially important cod stock. The study demonstrates that the collapse of this stock could have been avoided by adapting fishing pressure to environmental conditions and food-web interactions. This ecological modeling is an advance for ecosystem-based fisheries management, which can prevent the collapse of fish stocks in the future.

W. T. Peterson. (2009). Copepod species richness as an indicator of long-term changes in the coastal ecosystem of the northern California Current. California Cooperative Oceanic Fisheries Investigations Reports, 50: 73-81.

This paper studied copepod richness as an indicator of long-term changes in the California Current LME. The study concludes that an index of changes in food-chain structure could be created based on a time series of species richness due to the significant correlations between copepod species richness and the survival of Coho salmon.

R. Young. (2010). Institutional dynamics: resilience, vulnerability and adaptation in environmental and resource regimes. Global Environmental Change, 20 (3): 378-385.

This study uses the socioecological systems framework to explore the conditions leading to changes in environmental or resource regimes. LMEs are mentioned once as a global-level environmental and resource regime.

K. Alexander, W. B. Leavenworth, S. Claesson and W. J. Bolster. (2011). Catch density: a new approach to shifting baselines, stock assessment, and ecosystem-based management. Bulletin of Marine Science, 87 (2): 213-234.

This article presents three case studies based on historical fisheries in the Gulf of Maine to test catch density as a new metric for examining fish concentration to standardize historical and modern catch by the area fished. The findings show that overall catch today is higher; however, catch density was higher in the past, and catch density can accurately reflect shifts in trophic levels. The LME approach is referenced as the focus of ecosystem-based fisheries management since the 1980s.

P. Christie. (2011). Creating space for interdisciplinary marine and coastal research: five dilemmas and suggested resolutions. Environmental Conservation, 38 (2): 172-186.

This review paper focuses on integrated coastal management, ecosystem-based management frameworks, and marine protected areas as management tools. The authors argue that ocean management should be approached as a societal activity, and theories and methods should conform to this perspective, informed by interdisciplinary information. The paper references the ecosystem-based management efforts of the Caribbean LME and the Benguela Current LME. It also mentions mandates to establish large marine ecosystem management systems, but argues that these evaluation efforts are frequently inappropriately scaled and ad hoc, using as examples Cochrane et al. (2009) and Fanning et al. (2009).

N. Daan, H. Gislason, J. G. Pope and J. C. Rice. (2011). Apocalypse in world fisheries? The reports of their death are greatly exaggerated. ICES Journal of Marine Science, 68 (7): 1375-1378.

This article addresses the technical and conceptual flaws of the Worm et al. (2006) prediction that by 2048 all commercially exploited fish stocks will have collapsed. In the discussion of technical flaws, the paper refers to LMEs once with regard to the Pauly 2008 paper on fisheries in LMEs.

A. Forest, J.-É. Tremblay, Y. Gratton, J. Martin, J. Gagnon, G. Darnis, M. Sampei, L. Fortier, M. Ardyna, M. Gosselin, H. Hattori, D. Nguyen, R. Maranger, D. Vaqué, C. Marrasé, C. Pedrós-Alió, A. Sallon, C. Michel, C. Kellogg, J. Deming, E. Shadwick, H. Thomas, H. Link, P. Archambault and D. Piepenburg. (2011). Biogenic carbon flows through the planktonic food web of the Amundsen Gulf (Arctic Ocean): A synthesis of field measurements and inverse modeling analyses. Progress in Oceanography, 91 (4): 410-436.

In this study, major pathways of biogenic carbon flow (C) through the planktonic food web of the Amundsen Gulf of the Arctic Ocean were resolved for the spring–summer of 2008. The authors conclude that an increase in the lower food web productivity, as caused by climate change influences on Arctic marine ecosystems, is unlikely to support new harvestable fishery resources. This paper references LMEs once with regard to the 2010 Conti and Scardi paper on fisheries yield and primary productivity in LMEs. The authors argue that the C transfer efficiency in the central Amundsen Gulf region is lower than the required production for sustaining commercial fish catches.

R. A. Kenchington and J. C. Day. (2011). Zoning, a fundamental cornerstone of effective Marine Spatial Planning: lessons learnt from the Great Barrier Reef, Australia. Journal of Coastal Conservation, 15 (2): 271-278.

This paper covers the topic of zoning as a management tool and its application on the Great Barrier Reef Marine Park (GBRMP), discussing some of the common misconceptions about zoning and lessons learned from the GBRMP. In the introduction, the Great Barrier Reef Region is described as a large marine ecosystem. It is unclear whether this term refers to the LME approach/program or simply means that this is a large marine ecosystem.

Munilla, J. M. Arcos, D. Oro, D. Alvarez, P. M. Leyenda and A. Velando. (2011). Mass mortality of seabirds in the aftermath of the Prestige oil spill. Ecosphere, 2 (7): 1-14.

This study documents the mass mortality of seabirds in the aftermath of the *Prestige* oil spill in the winter of 2002–2003, which spilled oil over the northern half of the Iberian Coastal Large Marine Ecosystem, the study area of this research. The study identified the most oiled species of seabirds and their mortality, finding that the estimated mortality was higher than expected. The study concludes that the authors' methodology should be included in contingency response plans to oil spills. The paper also references the Celtic–Biscay Shelf LME, arguing that there was an effect from the mass mortality on the demography of the population of at least one bird species located in this LME.

A. Bundy, E. C. Bohaboy, D. O. Hjermann, F. J. Meuter, C. Fu and J. S. Link. (2012). Common patterns, common drivers: comparative analysis of aggregate surplus production across ecosystems. Marine Ecology Progress Series, 459: 203-218.

This study applies a system-level surplus production modelling approach to fisheries in the Northern Hemisphere and found that the environment affects estimates of system-level maximum sustainable yield in each of the ecosystems studied. Water temperature was the most influential factor on productivity. LMEs were used as the geographical boundaries for computing annual mean chlorophyll-a concentration using NASA's SeaWiFS Project data.

P. Fidelman and J. A. Ekstrom. (2012). Mapping seascapes of international environmental arrangements in the Coral Triangle. Marine Policy, 36: 993-1004.

This paper examines the governance context of the Coral Triangle Initiative on Coral Reefs, Fisheries, and Food Security (CTI) through a network approach. The paper briefly discusses different ways to define areas for ecosystem-based management, including LMEs. The Indonesia Sea and Gulf of Mexico LMEs, as well as the California Current LME, are mentioned as examples.

H. Liu, M. J. Fogarty, S. M. Glaser, I. Altman, C. Hsieh, L. Kaufman, A. A. Rosenberg and G. Sugihara. (2012). Nonlinear dynamic features and co-predictability of the Georges Bank fish community. Marine Ecology Progress Series, 464: 195-207.

This study examined fishery-independent survey data from 1963 to 2008 for 26 fish species on the Georges Bank, exploring the evidence for nonlinear dynamics. The Northeast Continental Shelf LME is referenced once in this study in regard to the diet overlap of fish communities of this region.

G. Merino, M. Barange, J. L. Blanchard, J. Harle, R. Holmes, I. Allen, E. H. Allison, M. C. Badjeck, N. K. Dulvy, J. Holt, S. Jennings, C. Mullon and L. D. Rodwell. (2012). Can marine fisheries and aquaculture meet fish demand for a growing human population in climate change? Global Environmental Change, 22: 795-806.

This study investigates the feasibility of sustaining current and increased fish consumption with both marine fisheries and aquaculture, concluding that it is feasible, but only if the animal feed industry reduces its reliance on wild fish and if fish resources are managed sustainably. In the introduction, LMEs are referenced in the context of a 2006 study by Holt and James, which ran downscaling simulations of the physical–ecosystem model for LMEs.

I. Munoz, E. Garcia-Isarch, I. Sobrino, C. Burgos, R. Funny and M. Gonzalez-Porto. (2012). Distribution, abundance and assemblages of decapod crustaceans in waters of Guinea-Bissau (north-west Africa). Journal of the Marine Biological Association of the United Kingdom, 92 (3): 475-494.

This paper examined the distribution, abundance, and assemblages of decapod crustaceans in waters off Guinea-Bissau, identifying seven main assemblages and providing new information about the topic in an effort to lay the groundwork for future studies. The Canary Current LME and the Guinea Current LME (GCLME) are both referenced as framing the Guinea-Bissau study area.

H. O. Nwankwoala. (2012). Case studies on coastal wetlands and water resources in Nigeria. European Journal of Sustainable Development, 1 (2): 113-126.

This paper examines the potential impacts of climate change on Nigeria's wetlands and suggests efforts for sustainable wetlands and water resource management through strengthened regulations and restorative programs and policies. The Canary Current LME and the Gulf of Guinea LME are referenced briefly in a discussion on the distribution and extent of wetlands in the West/Central African Sahel.

U. Rojas-Nazar, C. F. Gaymer, F. A. Squeo, R. Garay-Fluhmann and D. Lopez. (2012). Combining information from benthic community analysis and social studies to establish no-take zones within multiple uses marine protected area. Aquatic Conservation: Marine and Freshwater Ecosystems, 22: 74-86.

The Humboldt Current LME is mentioned briefly in the conclusion of this study as a body of knowledge to which this study may further contribute. The focus of the paper was to use a decision-support tool to identify priority areas for conservation (e.g., the establishment of no-take zones). This analysis was based on both biological (benthic community analysis) and social information.

K. Kleisner, D. Zeller and D. Pauly. (2013). Using global catch data for inferences on the world's marine fisheries. Fish and Fisheries, 14: 293-311.

This paper from the Sea Around Us Project reviews stock status plots as alternatives to detailed stock assessments for assessing global fisheries. The Pauly et al. 2008 paper, which created stock status plots for LMEs, is discussed in this paper.

I. Machado, M. Barreiro and D. Calliari. (2013). Variability of chlorophyll-a in the Southwestern Atlantic from satellite images: seasonal cycle and ENSO influences. Continental Shelf Research, 53: 102-109.

This study assessed seasonal and interannual satellite chlorophyll-a variability in the southwestern Atlantic based on roughly a decade of data. The study references the South Brazil Shelf and Patagonian Shelf LMEs, arguing that their delineation is consistent with the study’s results. These results suggest that differences in ecosystem functioning north and south of 37°S could be a mechanism reinforcing the separation of biological communities across that area.

F. Melin, B. N. Holben and Y. Courcoux. (2013). Validation of aerosol products derived from ocean color in East African coastal waters. African Journal of Marine Science, 35 (3): 351-358.

This study supports the use of ocean color data through an assessment of aerosol products derived from the ocean color missions of SeaWiFS and MODIS with AERONET field measurements. The ASCLME includes the south-east Africa marine ecosystem study area and are referenced in the introduction.

A. J. Clemento, E. D. Crandall and J. C. Garza. (2014). Evaluation of a single nucleotide polymorphism baseline for genetic stock identification of Chinook salmon (*Oncorhynchus tshawytscha*) in the California Current large marine ecosystem. Fisheries Bulletin, 112 (2-3): 112-130.

This paper describes the development and evaluation of a new baseline of single nucleotide polymorphism baseline marker data for Chinook salmon (*Oncorhynchus tshawytscha*) in the California Current LME. The LME is mentioned only twice.

F. de Leo, P. P. Miglietta and S. Pavlinovic. (2014). Marine ecological footprint of Italian Mediterranean fisheries. Sustainability, 6: 7482-7495.

This study analyzes fisheries in Italy, conducting an indepth analysis of the Marine Ecological Footprint, which evaluates the marine ecosystem area supplying seafood to humans. The authors assess the interactions between the environment and Italian Mediterranean fisheries systems. The Mediterranean LME is referenced in the discussion section with regard to the primary production required to sustain fisheries landings.

B. S. Halpern, C. Longo, C. Scarborough, D. Hardy, B. D. Best, S. C. Doney, S. K. Katona, K. L. McLeod, A. A. Rosenberg and J. F. Samhouri. (2014). Assessing the health of the U.S. West Coast with a regional-scale application of the Ocean Health Index. PLoS One, 9 (6), e98995.

This paper on the application of the Ocean Health Index mentions the California Current Large Marine Ecosystem once. The main focus of the paper is to describe the application of the Ocean Health Index to assess the relatively data-rich U.S. West Coast region. This shows the usefulness of the index as a tool for evaluating various management scenarios, as well as for vetting underlying assumptions and decisions with stakeholders and decision-makers.

J. A. Hare. (2014). The future of fisheries oceanography lies in the pursuit of multiple hypotheses. ICES Journal of Marine Science, 71 (8): 2343-2356.

This paper reviews the contributions of Johan Hjort to fisheries oceanography, using examples from the Northeast U.S. Continental Shelf Large Marine Ecosystem to examine four of Hjort's hypotheses. The paper argues that fisheries oceanographers should focus on Hjort's approach, which is characterized as integrative, interdisciplinary, and having multiple hypotheses.

A. D. McKinnon, A. Williams, J. Young, D. Ceccarelli, P. Dunstan, R. J. W. Brewin, R. Watson, R. Brinkman, M. Cappo, S. Duggan, R. Kelley, K. Ridgeway, D. Lindsay, D. Gledhill, T. Hutton and A. J. Richardson. (2014). Tropical Marginal Seas: Priority Regions for Managing Marine Biodiversity and Ecosystem Function. Annual Review of Marine Science, 6: 415-437.

This paper reviews eleven tropical marginal seas (TMSs) and concludes that in order to support the effective multinational and transboundary ecosystem management of TMSs, a structured process must be developed to identify ecologically and biologically significant areas (EBSAs) using globally agreed criteria. In a discussion of the utility of an EBSA approach to the TMSs, the Indonesian Seas LME and the Caribbean Sea LME are referenced as examples of the conflicts and management failures that can occur regardless of the number of stakeholder nations.

R. Ramachandran, P. Ramachandran, K. Lowry, H. Kremer and M. Lange. (2014). Improving science and policy in managing land-based sources of pollution. Environmental Development, 11: 4-18.

This article is the result of a working group on land-based sources of pollution (LBSP), which examined the science–policy interface of more than 40 LBSP projects through the 2010 GEF-funded project “Enhancing the use of science in International Waters projects to improve projects results.” The LME context is briefly mentioned once in the descriptions of project features and impacts section.

E. Ramos, A. Puente, J. A. Juanes, J. M. Neto, A. Pedersen, I. Bartsch, C. Scanlan, R. Wilkes, E. Van den Bergh, E. A. Gall and R. Melo. (2014). Biological validation of physical coastal waters classification along the NE Atlantic region based on rocky macroalgae distribution. Estuarine, Coastal and Shelf Science, 147: 103-112.

This paper presents a methodology to classify rock shorelines based on rocky macroalgae distribution along the Northeast Atlantic. The LME approach is referenced in regard to the boundary between cold and temperate regions on the NE Atlantic Coast. The methodology presented in this paper puts the boundary further north than the LME boundary (between the Iberian Coastal LME and the Celtic–Biscay Shelf LME).

P. F. Sale, T. Agardy, C. H. Ainsworth, B. E. Feist, J. D. Bell, P. Christie, O. Hoegh-Guldberg, P. J. Mumby, D. A. Feary, M. I. Saunders, T. M. Daw, S. J. Foale, P. S. Levin, K. C. Lindeman, K. Lorenzen, R. S. Pomeroy, E. H. Allison, R. H. Bradbury, J. Corrin, A. J. Edwards, D. O. Obura, Y. J. Sadovy de Mitcheson, M. A. Samoilys and C. R. C. Sheppard. (2014). Transforming management of tropical coastal seas to cope with challenges of the 21st century. Marine Pollution Bulletin, 85 (1): 8-23.

The authors examine how changes in the demography of coastal populations are degrading coastal waters to sustain these populations. The authors argue for expanded use of marine spatial planning (MSP) to transform how countries manage their coastal resources. LMEs are referenced as large-scale, marine ecosystem management frameworks. However, the authors argue that such large-scale management efforts fail to generate critical support from local communities and stakeholders.

A. Schukat, H. Auel, L. Teuber, N. Lahajnar and W. Hagen. (2014). Complex trophic interactions of calanoid copepods in the Benguela upwelling system. Journal of Sea Research, 85: 186-196.

The study area for this article is the Benguela upwelling system, where the authors examined the lifecycle adaptations, dietary preferences, and trophic levels of calanoid copepods using lipid classes, marker fatty acids, and stable isotope analyses. Their conclusions emphasized the complex trophic roles of these copepods and their need to be accounted for during the development of coastal upwelling food-webs. The Benguela Current is referred to as an LME in the introduction where its productivity is referenced in comparison to that of the HCLME.

M. C. Brandao, C. A. E. Garcia and A. S. Freire. (2015). Large-scale spatial variability of decapod and stomatopod larvae along the South Brazil Shelf. Continental Shelf Research, 107: 11-23.

This study established the South Brazil Shelf LME as its study area, but only mentions it once as an LME. The study investigates the spatial distribution of a spring/summer community of decapod and stomatopod larvae and possible linkages with hydrographical processes and parental habitats.

T. W. Miller and R. D. Brodeur. (2015). Diets of and trophic relationships among dominant marine nekton within the northern California Current ecosystem. Fishery Bulletin, 105 (4): 548-559.

This article explored the diets and trophic relationships of nekton in the California Current LME. LMEs are mentioned only once.

Group Two

M. H. Belsky. (1985). Management of large marine ecosystems: developing a new rule of customary international law. Management of Marine Ecosystems, San Diego Law Review, 22 (4): 733-763.

This article explores how the historical legal framework for the management of oceans is actually a threat to coastal and marine ecosystems, in that this framework has hindered the movement towards integrated ecosystem-based management. The author argues that new international agreements are facilitating this important shift and recommends that the customary international law of the sea include total ecosystem management as a "basic tenet."

J. R. Morgan. (1991). Marine regions and Law of the Sea. Ocean & Shoreline Management, 15: 261-271.

This paper explores the issue of reconciling “natural” regions on the ocean, such as LMEs, with “legal” regions established by laws, such as UNCLOS. Morgan argues that solving this issue for the purpose of effective ocean management requires international cooperation.

T. L. Laughlin. (1993). Chapter 17 of Agenda 21: Implementing data and information aspects. Marine Policy: 557-560.

This article discusses LMEs within the context of UNCED commitments for the marine environment. The section on LMEs references the Gulf of Guinea LME and the Yellow Sea LME projects.

J. Ekpere. (1998). Pan-African ocean environment management programme. Marine Policy, 22 (6): 515-525.

In this paper, Ekpere describes a Pan-Africa program for sustainable ocean development and management led by member countries of the Organization of African Unity. Each African LME is listed with an emphasis on the abundance of both living and non-living marine resources in African waters.

O. R. Young. (1998). Institutional uncertainties in international fisheries management. Fisheries Research, 37 (1-3): 211-224.

This article discusses institutional uncertainties in fisheries management on an international scale. LMEs are a focus of the discussion. Young identifies some of the causes of these uncertainties but also argues that not all uncertainties are detrimental.

C. L. Dyer and J. J. Poogie. (2000). The Natural Resource Region and marine policy: a case study from the New England Groundfish Fishery. Marine Policy, 24: 245-255.

This article introduces the Natural Resource Region (NRR), a network of Natural Resource Communities connected through total capital flows and marine resources of LMEs on which they depend. The NRR is a policy tool for the management of this total capital flow and LME activities. The authors present the New England multispecies groundfish fishery as a case study of NRR.

E. J. Molenaar. (2002). Ecosystem-based fisheries management, commercial fisheries, marine mammals and the 2001 Reykjavik Declaration. The International Journal of Marine and Coastal Law, 17 (4): 561-595.

Within the context of ecosystem-based fisheries management, this paper discusses the recovery of some marine mammal species and the inevitable re-evaluation of the legal protection they currently have. The author argues that sufficient scientific research is critical to understand the effects of a marine mammal catch on commercial fisheries. LMEs are discussed in the context of the Convention on the Conservation of Arctic Marine Living Resources, the area that coincides with the Baltic Sea LME.

P. K. Probert. (2002). Ocean science and conservation—catching the wave. Aquatic Conservation: Marine and Freshwater Ecosystems, 12 (2): 165-168.

This editorial provides a brief yet broad overview of ocean science and conservation. It emphasizes the need for a more holistic and ecosystem-based approach to ocean management and an effective system of ocean governance. LMEs are briefly mentioned as a significant move toward a more integrated approach to ocean management.

S. A. Lourie and A. C. Vincent. (2004). Using biogeography to help set priorities in marine conservation. Conservation Biology, 18 (4): 1004-1020.

This article discusses the need for an understanding of spatial context, connections, and scales of processes for the determination of marine conservation priorities. The authors also explore how current projects incorporate biogeographic information. LMEs are referenced as an example of marine biogeographic divisions.

T. L. Laughlin, S. G. Dionne, N. A. Colmenares, F. McDonald and S. E. Smith. (2006). A New Wave in Caribbean Sustainable Development: The White Water to Blue Water Partnerships. Journal of International Wildlife Law and Policy, 9: 277-288.

This paper describes the White Water to Blue Water partnership initiative in the Wider Caribbean Region. The goal of the region is to create, reenergize, and expand partnerships to integrate watershed and marine ecosystem-based management in the region. The LME approach is introduced as the marine ecosystem theme of the Miami Conference for the White Water to Blue Water partnership.

E. F. B. Miclat, J. A. Ingles and J. N. B. Dumaup. (2006). Planning across boundaries for the conservation of the Sulu-Sulawesi Marine Ecoregion. Ocean & Coastal Management, 49 (9-10): 597-609.

The LME approach is described in the introduction of this paper. The South China Sea LME project and GEF IW project are also described. The Sulu-Celebes LME is redefined as the Sulu-Sulawesi Marine Ecoregion (SSME) and is the study area of this paper, which describes World Wildlife Fund for Nature (WWF) SSME Conservation Program.

E. J. Gregr and K. M. Bodtker. (2007). Adaptive classification of marine ecosystems: identifying biologically meaningful regions in the marine environment. Deep Sea Research Part I, 54 (3): 385-402.

This paper suggests a quantitative, adaptive, mesoscale marine ecosystem classification scheme. The authors apply their approach to the North Pacific Ocean. LMEs are referenced as a current system of marine classification using biological and physical features.

S. M. Garcia and A. T. Charles. (2008). Fishery systems and linkages: implications for science and governance. Ocean & Coastal Management, 51 (7): 505-527.

This article describes fishery systems and linkages, explaining why the problem of implementation persists despite knowledge of these systems and linkages. The authors offer new directions to overcome this challenge. LMEs are referenced twice in the paper: once in a discussion of scale and again when the authors argue that managing fisheries within complex systems (such as LMEs) simply makes the fisheries themselves more difficult to manage because they are now embedded in systems that are more difficult to predict and control effectively.

R. Mahon. (2008). Assessing governability of fisheries using the interactive governance approach: preliminary examples from the Caribbean. The Journal of Transdisciplinary Environmental Studies, 7 (1): 1-12.

This paper presents the Interactive Governance Approach, a framework for exploring and addressing fisheries governance. The paper explored this approach in the Caribbean Sea LME, also mentioning the Gulf of Mexico LME and the North Brazil Shelf LME.

M. J. Costello. (2009). Distinguishing marine habitat classification concepts for ecological data management. Marine Ecology Progress Series, 397: 253-268.

In this article, Costello reviews the definitions and classifications of marine habitats and biotopes so that they may be appropriately used in data management systems. LMEs are referenced as one approach to the delineation of coastal regions.

L. J. Shannon, M. Coll, D. Yemane, D. Jouffre, S. Neira, A. Bertrand, E. Diaz and Y.-J. Shin. (2009). Comparing data-based indicators across upwelling and comparable systems for communicating ecosystem states and trends. ICES Journal of Marine Science, 67 (4): 801-832.

This paper presents a suite of ecological indicators for communicating how fishing affects several upwelling ecosystems as well as other ecosystems in which small pelagic fish play important ecological roles. The article references the Coll et al. (2008) paper that used primary production required to sustain catches within each LME to compare the world's fished marine ecosystems. Within this context, the Humboldt Current, Mediterranean, Canary Current, Guinea Current, Benguela Current, and Iberian Coastal LMES are all mentioned.

J. L. Suarez de Vivero, J. C. R. Mateos and D. Florido del Corral. (2009). Geopolitical factors of maritime policies and marine spatial planning: State, regions, and geographical planning scope. Marine Policy, 33: 624-634.

This paper explores geopolitical factors influencing maritime policies and marine spatial planning in Europe. LMEs are one of a number of European "marine ecoregions" reviewed in a discussion on marine ecosystems and politico-administrative boundaries.

P. Yorio. (2009). Marine protected areas, spatial scales, and governance: implications for the conservation of breeding seabirds. Conservation Letters, 2 (4): 171-178.

This paper examines the challenges of protecting breeding seabirds given their spatial requirements spanning multiple jurisdictions. A relatively new MPA is used as a case study to explore the complicated nature of seabird conservation. LMEs are mentioned as a potential scale for seabird conservation management strategies.

M. L. Guarinello, E. J. Shumchenia and J. W. King. (2010). Marine habitat classification for ecosystem-based management: a proposed hierarchical framework. Environmental Management, 45 (4): 793-806.

This paper presents a multi-scale hierarchical framework for habitat classification and mapping marine and coastal ecosystems. LMEs are presented as the broad-scale level of the proposed framework.

R. A. Kenchington. (2010). Strategic roles of marine protected areas in ecosystem scale conservation. Bulletin of Marine Science, 86 (2): 303-313.

In this article, Kenchington addresses marine protected areas in the context of marine ecosystem management on multiple scales and for multiple objectives. LMEs are mentioned in the section on the scales of marine ecosystems.

Y.-J. Shin, L. Shannon, A. Bundy, M. Coll, K. Aydin, N. Bez, J. L. Blanchard, M. de Fatima Borges, I. Diallo, E. Diaz, J. J. Heymans, L. Hill, E. Johannesen, D. Jouffre, S. Kifani, P. Labrosse, J. S. Link, S. Mackinson, H. Masski, C. Mollmann, S. Neira, H. Ojaveer, K. ould Mohammed Abdallahi, I. Perry, D. Thiao, D. Yemane and P. Cury. (2010). Using indicators for evaluating, comparing, and communicating the ecological status of exploited marine ecosystems. 2. Setting the scene. ICES Journal of Marine Science, 67 (4): 692-716.

This paper reviews in detail the ecological indicators selected by the IndiSeas Working Group. The Large Marine Ecosystem approach is referenced as a regional unit for ecosystem delineation. However, the criteria for delineating LMEs did not match the objectives of the IndiSeas project, so the project instead decided to use EEZs as management units.

M. V. McGinnis and C. E. McGinnis. (2011). Adapting to Climate Impacts in California: The importance of civic science in local coastal planning. Coastal Management, 39 (3): 225-241.

This paper reviews the science-based planning elements and programs developed in California to address climate change. The article suggests that California's local coastal plans broaden their scope to incorporate land-use elements and biodiversity protection. The authors also provide strategies to strengthen the relationship between local coastal planners, stakeholders, and scientists. LMEs are referenced in the context of President Obama's Executive Order for the Stewardship of Our Oceans, Coasts, and Great Lakes, calling for the MSP for LMEs like the California Current.

P. Miloslavich. (2011). Marine biodiversity in the Atlantic and Pacific Coasts of South America: knowledge and gaps. PLoS One, 6 (1): e14631.

This article reviews the status of knowledge of marine biodiversity long the coast of South America. For comparison, the study area is divided into five subregions based on the LMEsof South America: the Tropical Eastern Pacific, the Humboldt Current, the Patagonian Shelf, the Brazilian Shelves, and the Tropical West Atlantic.

M. G. Pennino, J. M. Bellido, D. Conesa and A. Lopez-Quilez. (2011). Trophic indicators to measure the impact of fishing on an exploited ecosystem. Animal Biodiversity and Conservation, 34 (1): 123-131.

The study area of this paper is the Black Sea, where the authors propose a set of indicators to assess the dynamics and trophic changes in this LME. The examined indicators suggest a decrease in the abundance of high trophic-level species and fishing down the marine food web.

C. J. M. Philippart. (2011). Impacts of climate change on European marine ecosystems: observations, expectations, and indicators. Journal of Experimental Marine Biology and Ecology, 400 (1-2): 52-69.

This paper discusses the impacts of climate change on European marine ecosystems and how these impacts will vary based on numerous factors. For example, enclosed bodies of water may lose their endemic species due to temperature changes, while species may simply move northward in open bodies of water. LMEs are referenced in relation to the Belkin 2009 paper showing that 10 out of the 18 European LMEs have experienced rapid warming. The Iberian Coastal LME is also mentioned.

D. A. Reusser and H. Lee. (2011). Evolution of natural history information in the 21st century—developing an integrated framework for biological and geographical data. Journal of Biogeography, 38 (7): 1225-1239.

This article presents a standardized framework for capturing and integrating geographical and biological data to facilitate studies on the macroecological scale. LMEs are referenced as a biogeographical hierarchical schema.

G. C. Roegner, C. Seaton and A. M. Baptista. (2011). Climatic and tidal forcing of hydrography and chlorophyll concentrations in the Columbia River Estuary. Estuaries and Coasts, 34 (2): 281-296.

This study examined the chlorophyll concentrations and hydrographic patterns of the Columbia River estuary during the spring and summer seasons between 2004 and 2006. The authors discuss differences between Pacific Northwest estuaries and estuaries not bounded by coastal upwelling zones. In the context of coastal upwelling zones, the paper references the Canary Current, Benguela Current, and Humboldt Current LMEs.

V. W. Y. Lam, W. W. Cheung, W. Swartz and U. R. Sumaila. (2012). Climate change impacts on fisheries in West Africa: implications for economic, food and nutritional security. African Journal of Marine Science, 34 (1): 103-117.

This paper uses a dynamic bioclimatic envelope model to project the future distribution of fisheries and the maximum fisheries catch potential of coastal West Africa to assess the potential impacts of climate change on these fisheries. The 2010 Cheung et al. study provided data on the projected change in maximum fisheries catch potential, and the authors used the values for both the Canary Current LME and the GCLME for their study. The authors conclude that climate change could lead to a substantial reduction in fish production, resulting in a decline in fish protein supply to the West African region.

E. Ramos, J. A. Juanes, C. Galvan, J. M. Neto, R. Melo, A. Pedersen, C. Scanlan, R. Wilkes, E. van den Bergh, M. Blomqvist, H. P. Karup, W. Heiber, J. M. Reitsma, M. C. Ximenes, A. Silio, F. Mendez and B. Gonzalez. (2012). Coastal waters classification based on physical attributes along the NE Atlantic region. An approach for rocky macroalgae potential distribution. Estuarine, Coastal and Shelf Science, 112: 105-114.

This paper establishes a new classification system for coastal regions based on requirements for intercalibration of methods to assess the quality of vegetation on the Northeast Atlantic coast. LMEs are referenced as a global-scale biogeographic classification.

S. Taljaard, J. H. Slinger, P. D. Morant, A. K. Theron, L. van Niekerk and J. van der Merwe. (2012). Implementing integrated coastal management in a sector-based governance system. Ocean and Coastal Management, 67: 39-53.

This paper explores the implementation of integrated coastal management (ICM) in South Africa, which is characterized as a sector-based governance system. LMEs are presented as one approach to demarcating geographical boundaries for regional management units.

O. Diankha, B. A. Sow, M. Thiaw and A. T. Gaye. (2013). Seasonal variability of sea surface temperature, chlorophyll-a, and *Ethmalosa fimbriata* abundance off the coast of Senegal. Journal of Integrated Coastal Zone Management, 13 (4): 491-497.

This study used satellite data to explore the seasonal variability of *Ethmalosa fimbriatai* off the coast of Senegal. The authors conclude that seasonal fluctuations of landings are explained by the combined effect of Chl-a and SST. LMEs are referenced in the introduction with regards to the Belkin 2009 study on the warming of LMEs worldwide, specifically the Canary Current LME.

S. Kidd. (2013). Rising to the integration ambitions of Marine Spatial Planning: reflections from the Irish Sea. Marine Policy, 39: 273-382.

This article introduced a framework aimed at assisting those involved with MSP with different dimensions of integration. The Celtic-Biscay Shelf LME is referenced as the context of the Irish Sea.

S. Kidd and L. McGowan. (2013). Constructing a ladder of transnational partnership working in support of marine spatial planning: thoughts from the Irish Sea. Journal of Environmental Management, 126: 63-71.

In this article, the authors present a ladder of transnational partnership to aid partnership development for marine spatial planning. They argue that MSP national-level activities should be nested within international spheres of action, such as within LMEs. The Celtic-Biscay Shelf LME is referenced as the study area for the paper's Irish Sea focus.

H. D. Smith. (2013). The regional development and management of fisheries: the UK case. Marine Policy, 37: 11-19.

This article examines the fishing industry of the United Kingdom and concludes that a regional management system adapted to regional geography will be the most effective method for managing UK fisheries. LMEs are mentioned briefly in a description of the delineated biogeographic regions around the UK.

J. A. Koslow and J. Couture. (2015). Pacific Ocean observation programs: Gaps in ecological time series. Marine Policy, 51: 408-414.

This paper seeks to answer the question “How well do existing ocean observation programs monitor the oceans through space and time?” The authors conducted a meta-analysis of ocean observation programs in the Pacific Ocean to determine where and how ocean parameters are measured. The authors concluded that ecological monitoring is unsystematic and inconsistent. LMEs are mentioned as a global effort by the GEF and the World Bank to develop sustainable management practices. The Yellow Sea LME is used as an example of an adaptive management project.

M. Lehtiniemi, H. Ojaveer, M. David, B. Galil, S. Gollasch, C. McKenzie, D. Minchin, A. Occhipinti-Ambrogi, S. Olenin and J. Pederson. (2015). Dose of truth—monitoring marine non-indigenous species to serve legislative requirements. Marine Policy, 54: 26-35.

This article presents a conceptual framework for the early detection of non-indigenous species for the purpose of rapid management response. The authors argue for large-scale monitoring of these species. LMEs are referenced as the geographical component of AquaNIS, a database for aquatic non-indigenous species (NIS).

P. McConney, S.-A. Cox and K. Parsram. (2015). Building food security and resilience into fisheries governance in the Eastern Caribbean. Regional Environmental Change, 15: 1355-1365.

This article calls for the integration of food security into fisheries governance in the small island developing states (SIDS) of the Eastern Caribbean. The Caribbean Sea LME is mentioned briefly.

E. Ramos, A. Puente and J. A. Juanes. (2015). An ecological classification of rocky shore at a regional scale: a predictive tool for management of conservation values. Marine Ecology: 1-18.

This paper suggests a downscaling methodology for the classification of coastal waters at a regional scale. The study uses standardized data and objective decision rules to classify the Northeast Atlantic. The Large Marine Ecosystem approach is described in the introduction as one of the first global classification schemes for the coasts.

Group Three

B. Cicin-Sain and R. W. Knecht. (1993). Implications of the Earth Summit for Ocean and Coastal Governance. Ocean Development & International Law, 24: 323-353.

This article discusses the 1992 Earth Summit in Rio de Janeiro, specifically Chapter 17 on oceans and coasts. The authors review the events prior to the summit, results of and conflicts at the summit, and current efforts to implement the recommendations of Chapter 17. The debate at the UNCED negotiations with regards to using LMEs versus EEZs as the major organizing principle of Chapter 17 is discussed.

M. P. H. Paul R. Epstein, M.D. (1995). Disease, Pests, and Impact Assessment. Impact Assessment, 13 (2): 189-197.

In this paper, Epstein explores the indirect effects of chemicals (e.g., dioxin, pesticides, PCBs) as they relate to evolving pandemics that span a wide taxonomic range. LME projects through the GEF are described in the section on biological indicators and environmental monitoring. Epstein states that marine species, such as plankton and shellfish, may be monitored for chemical pollution through these projects.

T. J. Done and R. E. Reichelt. (1998). Integrated Coastal Zone and Fisheries Ecosystem Management: Generic Goals and Performance Indices. Ecological Applications, 8 (1): S110-S118.

The authors describe indices used to report progress towards ecosystem-based management that are visible to scientists, managers, and fishers alike. LMEs are introduced in the concept of fisheries ecosystem management and are embraced by the authors as the appropriate scale at which their indices may achieve sustainable production, high biodiversity, and high ecosystem functioning.

R. Mahon, S. K. Brown, K. C. T. Zwanenburg, D. B. Atkinson, K. R. Buja, L. Claflin, G. D. Howell, M. E. Monaco, R. N. O'Boyle and M. Sinclair. (1998). Assemblages and biogeography of demersal fishes of the east coast of North America. Canadian Journal of Fisheries and Aquatic Sciences, 55 (7): 1704-1738.

To evaluate assemblage distribution in relation to biogeographical boundaries, this study mapped demersal fish assemblages along the eastern coast of North America using demersal trawl survey data. LMEs are the regional biogeographical boundaries with which the demersal fish distribution data is compared. The authors conclude that the boundaries of the two northern LMEs, the Scotian Shelf and the Newfoundland Shelf, are not important boundaries within the context of the distribution of the fishes evaluated in this study.

J.-P. Ducrotoy and S. Pullen. (1999). Integrated Coastal Zone Management: commitments and developments from an International, European, and United Kingdom perspective. Ocean & Coastal Management, 42 (1): 1-18.

This article examines Integrated Coastal Zone Management (ICZM) in the context of the influence of international instruments on national policies using the UK as an example. The authors conclude that decisive movement toward sustainable development must still be made, emphasizing the need for a holistic approach to ICZM. LMEs are referenced as a scale at which ICZM is applicable, using the North Sea LME as an example. One conclusion of the article is that ICZM must be used at regional and local scales to achieve a multi-scale approach and a full understanding of LMEs.

S. M. Garcia and M. Hayashi. (2000). Division of the oceans and ecosystem management: a contrastive spatial evolution of marine fisheries governance. Ocean & Coastal Management, 43 (6): 445-474.

This article examines two trends in marine fisheries governance: the extension of national jurisdiction outwards with the internal fragmenting of this area, and larger geographical management units. LMEs are presented in relation to EEZs as approaches for spatially delineating boundaries for the management of the world's marine fisheries. LMEs are also presented as recent instruments of ecosystem management.

C. H. Greene and A. J. Pershing. (2000). The response of *Calanus finmarchicus* populations to climate variability in the Northwest Atlantic: basin-scale forcing associated with the North Atlantic Oscillation. ICES Journal of Marine Science, 57 (6): 1536-1544.

This paper presents a new conceptual framework for exploring the effects of climate variability on shelf ecosystems in the North Atlantic Ocean. The framework is applied to the North Atlantic Oscillation to examine the response of *Calanus finmarchicus* populations. The framework itself analyzes the North Atlantic Basin as a network of LMEs; however, it defines the boundaries of Northwest Atlantic LMEs differently from Sherman and Alexander (1986).

L. Juda. (2002). Rio Plus Ten: The Evolution of International Marine Fisheries Governance. Ocean Development & International Law, 33 (2): 109-144.

In this article, Duda explores the evolution of international marine fisheries governance since the 1992 United Nations Conference on Environment and Development, describing how the principles from this event have been reflected in marine fisheries governance. The decision not to use the LME approach in Chapter 17 at UNCED is discussed.

A. Vallega. (2002). The regional approach to the ocean, the ocean regions, and ocean regionalization—a post-modern dilemma. Ocean & Coastal Management, 45 (11-12): 721-760.

In this paper, Vallega uses criteria designed by the inter-governmental organization framework and approaches developed from scientific literature in a discussion on the implementation of ocean regionalization. LMEs are presented and discussed in his section on newly designed ocean regions.

H. I. Browman and K. I. Stergiou. (2004). Marine protected areas as a central element of ecosystem-based management: defining their location, size and number. Marine Ecology Progress Series, 274: 269-303.

This article briefly reviews marine protected areas as a central element of ecosystem-based management. The author argues that MPAs must be embedded in an operational spatial unit and presents LMEs as such a unit.

K. L. Cochrane, C. J. Augustyn, A. C. Cockcroft, J. H. M. David, M. H. Griffiths, J. C. Groeneveld, M. R. Lipińnski, M. J. Smale, C. D. Smith, and R. J. Q. Tarr. (2004). An ecosystem approach to fisheries in the southern Benguela context. African Journal of Marine Science, 26 (1): 9-35.

This article explores the progression towards ecosystem approaches to fisheries management (EAFM) in the southern Benguela, specifically with regard to the Food and Agricultural Organization's (FAO) technical guidelines. The importance of the ecosystem approach is emphasized through a review of the impacts of fisheries on species other than the target species of a specific fishery. The BENEFIT program and the BCLME project are referenced as activities relevant to EAFM implementation.

G. Hempel and D. Daler. (2004). Why a Global International Waters Assessment (GIWA)? Ambio, 33 (1): 2-6.

This article answers the question "Why a Global International Waters Assessment?" It presents the history of the GIWA and discusses the benefits and achievements of the assessment. The strong role of the LME approach in the creation of the 66 Regional Focal Points for the GIWA is also discussed.

C. Bas. (2005). Fishery research: current approaches, tensions and emerging aspects. The future and how to approach it. Scientia Marina, 69: 139-156.

This paper discusses fisheries from both a technical and scientific–conceptual perspective. It analyzes the evolution of the concepts of fishing effort and carrying capacity. The author argues that the LME approach is useful in that it explains the whole fishing process, including both the bioecologic and socioeconomic aspects.

Y. Schaeffer-Novelli, G. Cintron-Molero, M. Cunha-Lignon and C. Coelho Jr. (2005). A conceptual hierarchical framework for marine coastal management and conservation: a "janus-like" approach. Journal of Coastal Research, 42: 191-197.

The authors of this article suggest a hierarchical approach for the definition of spatial and process boundaries by providing a multi-dimensional perspective to organize coastal conservation within the context of mangrove conservation. LMEs are described as a coastal province unit in which other smaller units may be nested.

S. D. Batten, K. D. Hyrenbach, W. J. Sydeman, K. H. Morgan, M. F. Henry, P. P. Y. Yen and D. W. Welch. (2006). Characterizing meso-marine ecosystems of the North Pacific. Deep Sea Research Part II, 53 (3-4): 270-290.

This paper argues for smaller, mesoscale approaches to gathering information on the variability of oceanographic processes and productivity, nested within the LME framework. They present as an example the California Current LME, which has been divided into four subregions based on hydrography and biology. The study itself explored mesoscale variability in ecosystems of the North Pacific using plankton and avifaunal surveys. The authors identified 10 distinct biological communities in the North Pacific and coin the term "mesoscale marine ecosystems" to define them.

M. A. Carmen and A. Ablan. (2006). Genetics and the study of fisheries connectivity in Asian developing countries. Fisheries Research 78 (2-3): 158-168.

Within the geographical context of Southeast Asia, the authors summarize available methods for determining genetic connectivity to identify resource boundaries and connectivity between management units. The authors discuss transboundary management units in the South China Sea, discussing LMEs, but argue that transboundary sites exist within LMEs and should be considered for transboundary management.

M. Meybeck, H. H. Durr and C. J. Vorosmarty. (2006). Global coastal segmentation and its river catchment contributors: a new look at land-ocean linkage. Global Biogeochemical Cycles, 20 (1): GB1S90.

This paper presents 151 exorheic area catchments from the COSCAT global database. LMEs are discussed as a parallel approach to regionalizing the world oceans. The authors provide a preliminary assessment of correspondence between COSCAT and LME entities.

R. Monfils, T. Gilbert and S. Nawadra. (2006). Sunken WWII shipwrecks of the Pacific and East Asia: The need for regional collaboration to address the potential marine pollution threat. Ocean & Coastal Management, 49 (9-10): 779-788.

This paper presents the issue of oil, chemicals, and unexploded materials on sunken warships from the Second World War, highlighting the extent of the risks this source of marine pollution poses. The authors also explore the issues of responsibility and ownership of these wrecks, as well as the need for regional collaboration to address the threats they present. LMEs are used to section out the East Asian Seas region for analysis.

E. Sala and N. Knowlton. (2006). Global Marine Biodiversity Trends. Annual Review of Environment and Resources, 31: 93-122.

Sala and Knowlton provide an overview of global marine biodiversity trends, exploring the recent decline in biodiversity caused by human activity and the potential consequences of this trend. LMEs are described as the closest attempt of an integrated effort to map ecosystems at the global scale.

R. R. Christian and S. Mazzilli. (2007). Defining the coast and sentinel ecosystems for coastal observations of global change. Hydrobiologia, 577: 55-70.

This study used the Global Terrestrial Observing System (C-GTOS) to select coastal sentinel ecosystems using various delineations of coastal areas on a global scale. LMEs are listed as the definition of coastal areas based on an international initiative (the LME program) and were included in the analysis; however, they are not mentioned outside the methodology.

P. Christie, D. L. Fluharty, A. T. White, L. Eisma-Osorio and W. Jatulan. (2007). Assessing the feasibility of ecosystem-based fisheries management in tropical contexts. Marine Policy, 31: 239-250.

LME management is one of the marine ecosystem-focused management approaches described in this paper. The article itself documents reasons for the growing interest in ecosystem-based fisheries management and compares this approach to others.

P. Christie and A. T. White. (2007). Best practices for improved governance of coral reef marine protected areas. Coral Reefs, 26 (4): 1047-1056.

This paper explored current MPA governance for coral reef habitats and options for improving MPA management. In this paper, the authors reference LMEs as a management approach that runs the risk of backlash from on-the-ground resource users or field personnel who argue that this and other large-scale initiatives are unrealistic in their expectations of institutional feasibility.

A. Longhurst. (2007). Doubt and certainty in fishery science: are we really headed for a global collapse of stocks? Fisheries Research, 86: 1-5.

This article challenges the Worm et al. (2006) publication on the decline of global fisheries, arguing that they draw inappropriate conclusions from their sources. LMEs are discussed with regard to their use in the Worm et al. analyses.

S. Murawski. (2007). Ten myths concerning ecosystem approaches to marine resource management. Marine Policy, 31: 681-690.

In this article, Murawski discusses ecosystem approaches to marine resource management (EAM) and addresses ten "myths" propagated in the interest of maintaining current management practices. The LME approach is presented as an example of the application of EAM at the multinational, regional scale with developing nations.

L. Ortiz-Lozano, I. Espejel, A. Granados-Barba and P. Arceo. (2007). A functional and integrated approach of methods for the management of protected marine areas in the Mexican Coastal Zone. Ocean & Coastal Management, 50 (5-6): 379-391.

This paper reviews management methodologies for the Marine Protected Areas in the Coastal Zone (MPACZ) and proposes a method that incorporates regulation zones, different scales, and the role of people in management. LMEs are described in a discussion of the macroscale approach to MPACZ management.

M. Spalding, H. E. Fox, G. R. Allen, N. Davidson, Z. A. Ferdana, M. Finlayson, B. S. Halpern, M. A. Jorge, S. A. Lourie, K. D. Martin, E. McManus, J. L. Molnar, C. A. Recchia and J. Robertson. (2007). Marine Ecoregions of the World: A bioregionalization of coastal and shelf areas. BioScience, 57 (7): 573-583.

This article presents the Marine Ecoregions of the World (MEOW), a nested, biogeographic classification system for the oceans. LMEs are referenced as an approach for defining marine boundaries, and the MEOW are described as a system offering the framework for more multiscale analyses.

C. Campagna, E. W. Sanderson, P. B. Coppolillo, V. Falabella, A. R. Piola, S. Strindberg and J. P. Croxall. (2008). A species approach to marine ecosystem conservation. Aquatic Conservation: Marine and Freshwater Ecosystems, 17: S122-S147.

This study applied the landscape species concept to the Extended Patagonian Marine Ecosystem. This approach developed a suite of "seascape species" as a foundation for conservation efforts to work in conjunction with a space-habitat perspective, such as the LME approach. The Patagonian Shelf LME was included as a subarea of the larger primary study area, and was also used as the template target area for identifying seascape species in one of the scenarios in the study.

S.-M. Cheong. (2008). A new direction in coastal management. Marine Policy, 32: 1090-1093.

Cheong argues for the integration of marine science and coastal management studies for the purpose of improved management policies. This paper describes LMEs and the LME framework as an integrative effort to combine marine science and management.

C. Costello, S. D. Gaines and J. Lynham. (2008). Can Catch Shares Prevent Fisheries Collapse? Science, 321: 1678-1681.

This analysis uses a global database of fisheries institutions and catch statistics (1950–2003) to evaluate the impacts of catch-share fishery reforms. The authors find that catch share implementation halts or reverses the global trend of fisheries collapse predicted by Worm et al. (2006). Based on their use in the Worm paper, LMEs were incorporated into this study as well.

F. Maes. (2008). The international legal framework for marine spatial planning. Marine Policy, 32: 797-810.

In this article, Maes explores marine spatial planning within the context of the United Nations Convention on the Law of the Sea and the convention on Biological Diversity, which provide the main legal framework for this approach to marine resource management. LMEs are presented as an approach to the delineation of marine ecosystems on a global scale, and GEF-funded projects are described for introducing ecosystem-based management in the context of LMEs.

R. Maranger, N. Caraco, J. Duhamel and M. Amyot. (2008). Nitrogen transfer from sea to land via commercial fisheries. Nature, 1 (2): 111-113.

This study compares the input of nitrogen fertilizer into the coastal ocean with the return of nitrogen to land via fisheries. Results indicate that on the scale of LMEs, both have increased during the past 40 years, but the rate of input of nitrogen fertilizer has increased faster than the return of nitrogen to land via fisheries.

M. Ruckelshaus, T. Klinger, N. Knowlton and D. P. DeMaster. (2008). Marine Ecosystem-based Management in Practice: Scientific and Governance Challenges. BioScience, 58 (1): 55-63.

This article reviews ecosystem-based management (EBM) principles and applies them to four case studies. LMEs are referenced in the first two boxes of the paper as currently used spatial boundaries defined on the basis of hydrographic, bathymetric, and biogeographic information.

J. A. Ekstrom. (2009). California Current Large Marine Ecosystem: Publicly available dataset of state and federal laws and regulations. Marine Policy, 33 (3): 528-531.

This article identifies a gap in work aimed at improving and understanding ocean management systems. The author presents a dataset for objective analysis of ocean management across the California Current LME.

A. J. Kenny, H. R. Skjoldal, G. H. Engelhard, P. J. Kershaw and J. B. Reid. (2009). An integrated approach for assessing the relative significance of human pressures and environmental forcing on the status of Large Marine Ecosystems. Progress in Oceanography, 81 (1-4): 132-148.

This paper presents the main findings of a scientific expert group convened to prepare a plan for an ICES contribution to an Integrated Ecosystem Assessment of the North Sea. The authors compared their findings with similar assessments of other LMEs.

C. Möllmann, R. Diekmann, B. Muller-Karulis, G. Kornilovs, M. Plikshs and P. Axe. (2009). Reorganization of a large marine ecosystem due to atmospheric and anthropogenic pressure: a discontinuous regime shift in the Central Baltic Sea. Global Change Biology, 15 (6): 1377-1393.

This paper presents the reorganization of a Large Marine Ecosystem—a discontinuous regime shift in the Baltic ecosystem structure, initiated by climate-induced changes and stabilized by fisheries-induced feedback loops.

P. J. Somerfield, C. Arvanitidis, S. Faulwetter, G. Chatzigeorgiou, A. Vasileiadou, J. M. Amoroux, N. Anisimova, K. L. Cochrane, J. Craeymeersch, S. Dahle, S. Denisenko, K. Dounas, G. Duineveld, A. Gremare, C. H. R. Heip, M. Herrmann, I. Karakassis, M. Kendra, M. A. Kendall, P. Kingston, L. Kotwicki, C. Labrune, J. Laudien, H. Nevrova, A. Nicolaidou, A. Occhipinti-Ambrogi, R. Palerud, A. Petrov, E. Rachor, N. K. Revkov, H. Rumohr, R. Sarda, U. Janas, E. Vanden Berghe and M. Wlodarska-Kowalczuk. (2009). Assessing evidence for random assembly of marine benthic communities from regional species pools. Marine Ecology Progress Series, 382: 279-286.

This study used the MacroBen database to determine that marine soft-sediment macrofauna communities are likely determined by regional processes versus being randomly assembled from regional species pools. LMEs were one of several regional schemes used to divide European waters into areas for the construction of lists for regional species pools.

R. van der Elst, J. C. Groeneveld, A. P. Baloi, F. Marsac, K. I. Katonda, R. K. Ruwa and W. L. Lane. (2009). Nine nations, one ocean: a benchmark appraisal of the South Western Indian Ocean Fisheries Project (2008–2012). Ocean & Coastal Management, 52: 258-267.

This paper discusses the South Western Indian Ocean Fisheries Project (SWIOFP) within the context of regional ocean management. The authors present the program as a model of participatory scientific cooperation at the regional scale. The ASCLME program is described as the larger program in which SWIOFP is nested.

T. J. Webb, I. F. Aleffi, J. M. Amoroux, G. Bachelet, S. Degraer, C. Dounas, D. Fleischer, A. Gremare, M. Herrmann, H. Hummel, I. Karakassis, M. Kedra, M. A. Kendall, L. Kotwicki, C. Labrune, E. L. Nevrova, A. Occhipinti-Ambrogi, A. Petrov, N. K. Revkov, R. Sarda, N. Simboura, J. Speybroeck, G. Van Hoey, M. Vincx, P. Whomersley, W. Willems and M. Wlodarska-Kowalczuk. (2009). Macroecology of the European soft sediment benthos: insights from the MacroBen database. Marine Ecology Progress Series, 382: 287-296.

This paper discusses the application of macroecology in the marine environment with the development in Europe of regional species occurrence databases, such as MacroBen. The authors review this database of soft sediment benthic fauna and identify trends in the data.

J. R. E. Lutjeharms and T. G. Bornman. (2010). The importance of the greater Agulhas Current is increasingly being recognized. South African Journal of Science, 106: (3, 4): 1-4.

This article discusses the increasing recognition of the Agulhas Current as an important ecosystem. Various research programs are discussed for the Agulhas Current, including the GEF ASCLME project.

J. C. Ogden. (2010). Marine spatial planning (MSP): a first step to ecosystem-based management (EBM) in the Wider Caribbean. International Journal of Tropical Biology, 58: 71-79.

This article discusses the decline of the Wider Caribbean and the push by the conservation and science communities to implement marine spatial planning to address the need for ecosystem-based management in the region. Ogden argues that the Association of the Marine Laboratories of the Caribbean is poised to implement a pilot MSP project.

A. C. Kraberg, N. Wasmund, J. Vanaverbeke, D. Schiedek, K. H. Wiltshire and N. Mieszkowska. (2011). Regime shifts in the marine environment: the scientific basis and political context. Marine Pollution Bulletin, 62 (1): 7-20.

This review paper addresses regime shifts in the marine environment and explores policies relevant to these regime shifts with a focus on the North and Baltic Seas. The LME framework is described in the context of these studies.

A. McCrea-Strub, K. Kleisner, U. R. Sumaila, W. Swartz, R. Watson, D. Zeller and D. Pauly. (2011). Potential impact of the Deepwater Horizon oil spill on commercial fisheries in the Gulf of Mexico. Fisheries, 36 (7): 332-336.

This study used spatial databases of annual reported commercial catch in the Gulf of Mexico LME to estimate the potential economic impacts of the Deepwater Horizon oil spill. Findings suggest that post-spill closures have impacted more than 20% of the average annual U.S. commercial catch, equating to a loss of $247 million.

N. McGinty, A. M. Power and M. P. Johnson. (2011). Variation among northeast Atlantic regions in the responses of zooplankton to climate change: not all areas follow the same path. Journal of Experimental Marine Biology and Ecology, 400: 120-131.

This study warns against the over-extrapolation of results from a limited number of sites across an entire region due to the influence of local environmental processes on ecological phenomena. The study used satellite chlorophyll measurements to create nine subregions in an area similar in size to the Celtic Biscay LME. The authors found that the relationships among variables were not consistent across these subregions.

E. Olsen, A. R. Kleiven, H. R. Skjoldal and C. H. von Quilfeldt. (2011). Place-based management at different spatial scales. Journal of Coastal Conservation, 15 (2): 257-269.

This article presents an adaptive ecosystem classification scheme to capture mesoscale temporal dynamics for ecosystem-based management. This new scheme identifies 15 distinct marine regions in the North Pacific Ocean and explores their seasonal variability. LMEs are listed as one of three marine classifications that delineate boundaries based on biological and physical features, as well as geographical location. However, the authors argue that they could not find a description of the quantitative approach used to identify LME boundaries.

O. Salmeron-Garcia, J. Zavala-Hidalgo, A. Mateos-Jasso and R. Romero-Centeno. (2011). Regionalization of the Gulf of Mexico from space-time chlorophyll-a concentration variability. Ocean Dynamics, 61 (4): 439-448.

This paper identified regions in the Gulf of Mexico based on SeaWiFS satellite data on concentrations of chlorophyll-a. LMEs and the NOAA LME program are discussed in the introduction of the article in the context of efforts to regionalize the world's oceans.

J. N. Araujo and A. Bundy. (2012). Effects of environmental change, fisheries and trophodynamics on the ecosystem of the western Scotian Shelf, Canada. Marine Ecology Progress Series, 464: 51-67.

The study explored the trophodynamics of the western Scotian Shelf ecosystem by reducing the complexity to 57 functional living groups. This approach allowed the model to reproduce observed dynamics related to trends in group abundance and mortality. SST data for the Scotian Shelf LME was used to evaluate estimates for primary productivity.

J. P. Croxall, S. H. M. Butchart, B. Lascelles, A. J. Stattersfield, B. Sullivan, A. Symes and P. Taylor. (2012). Seabird conservation status, threats and priority actions: a global assessment. Bird Conservation International, 22 (1): 1-34.

This paper reviews the conservation status of 346 seabird species, and identifies principal current land-based and sea-based threats and priority actions to advance seabird conservation. LMEs were used as one set of regional boundaries to explore species' distribution. A large overlap was emphasized due to the inclusion of highly productive current systems in the LMEs, which support numerous species. The authors conclude that the appropriate management of LMEs would be a substantial step forward in the management of at least 80% of the total number of globally threatened seabird species.

S. Kao, N. S. Pearre and J. Firestone. (2012). Regional Cooperation in the South China Sea: analysis of existing practices and prospects. Ocean Development & International Law, 43: 283-295.

In this article, the authors recommend a regional mechanism for cooperation on the South China Sea. The South China Sea LME Project is described as an example of regional cooperation.

M. Makino and Y. Sakurai. (2012). Adaptaion to climate-change effects on fisheries in the Shiretoko World Natural Heritage area, Japan. ICES Journal of Marine Science.

This article presents the observed and predicted effects of climate change on fisheries in the Shiretoko World Natural Heritage area. The authors support LMEs as the appropriate scale for international research and monitoring to support climate change adaptation policy measures.

D. Obura. (2012). The diversity and biogeography of Western Indian Ocean reef-building corals. PLoS One, 7 (9): e45013.

This study uses the diversity and distribution of coral species to evaluate the biogeographic classification of the Western Indian Ocean. The LME approach is referenced as having guided planning efforts for global marine ecosystems. In addition, some of the changes proposed by the study for modifications to the current classification are suggested for the ASCLME.

D. Ricard, C. Minto, O. P. Jensen and J. K. Baum. (2012). Examining the knowledge base and status of commercially exploited marine species with RAM Legacy Stock Assessment Database. Fish and Fisheries, 13 (4): 380-398.

This article presents a new commercial marine fisheries database, the RAM Legacy Stock Assessment Database, to facilitate meta-analyses of stock assessments. Some of the stock assessment data came from 27 LMEs.

M. Spalding, V. N. Agostini, J. Rice and S. M. Grant. (2012). Pelagic provinces of the world: a biogeographic classification of the world's surface pelagic waters. Ocean & Coastal Management, 60: 19-30.

This paper presents a biogeographic classification scheme for the world's pelagic waters, describing a nested system of 37 regions around the world within 4 realms and a system of 7 biomes. The LME concept is referenced as an influential biogeographical regional classification scheme.

D. J. Staples and R. Hermes. (2012). Marine biodiversity and resource management—what is the link? Aquatic Ecosystem Health & Management, 15 (3): 245-252.

This article evaluates marine biodiversity and its relationship to resource management, identifying major threats to marine biodiversity and reasons for failures of successful resource management. The application of LME management is offered as a solution to these issues, and the Bay of Bengal LME Project is discussed as an example.

B. Worm and T. A. Branch. (2012). The future of fish. Trends in Ecology and Evolution, 27 (11): 594-599.

This paper describes a current trend in global marine fisheries of the stabilization of fish biomass in some regions and continued decline in others, which indicates differences in management capacity. The authors discuss the need for management to focus on “fisheries-conservation hotspots” on the scale of LMEs, where exploitation rates are increasing in high biodiversity areas.

M. David, S. Gollasch and M. Pavliha. (2013). Global ballast water management and the "same location" concept: a clear term or a clear issue? Ecological Applications, 23 (2): 331-338.

This article addresses the lack of clarity about the use of the term "same location" with regard to the update and discharge of ballast water. The authors recommend that this term be defined as the smallest practicable unit, such as the same harbor or anchorage. LMEs are referenced as a large geographic unit, with the Baltic and Mediterranean Seas as examples.

M. J. Fogarty. (2013). The art of ecosystem-based fishery management. Canadian Journal of Fisheries and Aquatic Sciences, 71: 479-490.

In this article, Fogarty attempts to simplify the movement from single-sector management to integrated place-based management. In a discussion on spatial domains, LMEs are mentioned as a possible starting point for the definition of geographical units for spatial management; however, the author suggests the further subdivision of LMEs.

B. Salihoglu, S. Neuer, S. Painting, R. Murtugudde, E. E. Hofmann, J. H. Steele, R. R. Hood, L. Legendre, M. W. Lomas, J. D. Wiggert, S. Ito, Z. Lachkar, G. L. Hunt, Jr., K. F. Drinkwater and C. L. Sabine. (2013). Bridging marine ecosystems and biogeochemistry research: lessons and recommendations from comparative studies. Journal of Marine Systems, 109-110: 161-175.

In this paper, the authors argue that comparative studies are the appropriate means for linking marine biogeochemistry with marine ecosystems research to understand the effects of global climate change on the marine environment, presenting successful examples. LMEs are presented as ecologically defined regions with the potential to be the basis of these comparative studies.

B. Wiryawan and A. Tahir. (2013). Experiences in zonation planning for management of marine protected area: the Indonesian case. Galaxea, Journal of Coral Reef Studies (Special Issue): 285-294.

This paper reviews zonation planning in Indonesia for the planning and management of marine protected areas. LMEs are presented and discussed within the context of large-scale conservation areas.

A. Yáñez-Arancibia, J. W. Day and E. Reyes. (2013). Understanding the Coastal Ecosystem-Based Management Approach in the Gulf of Mexico. Journal of Coastal Research, 63: 244-262.

This paper discusses coastal ecosystem-based management in the Gulf of Mexico (GoM), referencing the GoM LME. The authors conclude that the health of this region is critical to sustain environmental and socioeconomic conditions, and the basis of sustainable coastal management should be ecosystem functioning.

D. G. Ainsley and D. Pauly. (2014). Fishing down the food web of the Antarctic continental shelf and slope. Polar Record, 50 (1): 92-107.

This paper reviews historic biotic exploitation of the Antarctic LME continental margin, emphasizing that this is a clear case of "fishing down the food web" and the tragedy of the commons. The authors use examples of cetacean populations, groundfish stocks, krill fishing, and fisheries for Antarctic toothfish.

C. Brugere. (2014). Mainstreaming gender in transboundary natural resources projects—the experience of the Bay of Bengal Large Marine Ecosystem (BOBLME) project. Environmental Development, 11: 84-97.

This paper proposes the use of the Theory of Change to promote women's empowerment and gender equality within the context of transboundary resource projects. Brugere explains how this framework could be applied to the BOBLME project.

A. Cruz-Trinidad, P. M. Alino, R. C. Geronimo and R. B. Cabral. (2014). Linking food security with coral reefs and fisheries in the Coral Triangle. Coastal Management, 42 (2): 160-182.

This paper discusses the Coral Triangle Initiative on Coral Reefs, Fisheries, and Food Security. The LME approach is presented as the monitoring and evaluation framework for the Coral Triangle Initiative area as a structure through which EBM can be operationalized. The LME framework is described and its five modules introduced in the context of the Coral Triangle.

D. A. Feary, A. M. Fowler and T. J. Ward. (2014). Developing a rapid method for undertaking the World Ocean Assessment in data-poor regions—A case study using the South China Sea Large Marine Ecosystem. Ocean & Coastal Management, 95: 129-137.

This article presents a hierarchical and adaptable assessment framework for the rapid assessment of the state of regional-scale marine ecosystems for use through UNEP’s World Ocean Assessment program. The approach is applied to the South China Sea LME to serve as a case study.

G. E. Hofmann, T. G. Evans, M. W. Kelly, J. L. Padilla-Gamiño, C. A. Blanchette, L. Washburn, F. Chan, M. A. McManus, B. A. Menge, B. Gaylord, T. M. Hill, E. Sanford, M. LaVigne, J. M. Rose, L. Kapsenberg and J. M. Dutton. (2014). Exploring local adaptation and the ocean acidification seascape—studies in the California Current Large Marine Ecosystem. Biogeosciences, 11 (4): 1053-1064.

This paper describes the strategy of the Ocean Margin Ecosystems Group for Acidification Studies (OMEGAS) for evaluating the California Current LME. The review presents the initial findings of the carbonate chemistry at study sites spanning the entire U.S. west coast, as well as the biological data on the capacity of benthic invertebrates to acclimatize or adapt to ocean acidification.

T. C. Malone, P. M. DiGiacomo, E. Goncalves, A. H. Knap, L. Talaue-McManus and S. de Mora. (2014). A global ocean observing system framework for sustainable development. Marine Policy, 43: 262-272.

This paper argues for a global coastal network for worldwide sustainable development. The authors present a provisional network of sites for sustained observations of species richness in MPAs nested within 16 LMEs.

T. C. Malone, P. M. diGiacomo, E. Goncalves, A. H. Knap, L. Talaue-McManus, S. de Mora and J. Muelbert. (2014). Enhancing the Global Ocean Observing System to meet evidence based needs for the ecosystem-based management of coastal ecosystem services. Natural Resources Forum, 38 (3): 168-181.

This article presents an approach for establishing a global network of coastal observations and identifies indicator variables useful for Integrated Ecosystem Assessments (IEA). The authors build on previous work and emphasize that an observing system nested within the larger LME network is an appropriate scale.

J. A. Nye, M. R. Baker, R. Bell, A. J. Kenny, K. H. Kilbourne, K. D. Friedland, E. Martino, M. M. Stachura, K. S. Van Houtan and R. Wood. (2014). Ecosystem effects of the Atlantic Multidecadal Oscillation. Journal of Marine Systems, 133: 103-116.

This paper discusses the ecosystem effects of the Atlantic Multidecadal Oscillation (AMO), concluding that a better understanding of the causes and effects of AMO would facilitate EBM in the Atlantic Basin. LMEs are referenced as a spatial scale at which AMO effects may be evaluated.

S. Olenin, A. Narscius, D. Minchin, M. David, B. Galil, S. Gollasch, A. Marchini, A. Occhipinti-Ambrogi, H. Ojaveer and A. Zaiko. (2014). Making non-indigenous species information systems practical for management and useful for research: an aquatic perspective. Biological Conservation, 173: 98-107.

This article describes the AquaNIS advanced information system for addressing the issue of aquatic non-indigenous species in aquatic ecosystems. Data entries in AquaNIS are organized by region or subarea within an LME.

C. Z. Santos and A. Schiavetti. (2014). Assessment of the management in Brazilian Marine Extractive Reserves. Ocean & Coastal Management, 93: 26-36.

This study presents an analysis of the management of Marine Extractive Reserves (MERs) of Brazil. These reserves are a fisheries management tool nested within Brazil's LMEs, which were used to group the reserves for analyses. Management of MERs within all three LMEs included in the analysis were found to be inadequate.

C. Z. Santos and A. Schiavetti. (2014). Spatial analysis of Protected Areas of the coastal/marine environments of Brazil. Journal for Nature Conservation, 22: 453-461.

This article presents analyses of the spatial distribution of Brazilian coastal and marine protected areas. LMEs are used to group the protected areas.

H. C. Soares, D. F. M. Gherardi, L. P. Pezzi, M. T. Kayano and E. T. Paes. (2014). Patterns of interannual climate variability in large marine ecosystems. Journal of Marine Systems, 134: 57-68.

This study investigated the influence of local and remote forcing on Brazilian and West African LMEs. The results of this study indicate that climate forcings must be considered in the ecosystem-based management and conservation of marine resources.

Q. Tang. (2014). Management strategies of marine food resources under multiple stressors with particular reference of the Yellow Sea large marine ecosystem. Frontiers of Agricultural Science and Engineering, 1 (1): 85-90.

This paper discusses the development of conservation-based capture fisheries and environmentally friendly aquaculture, arguing that both should be used together. Integrated multi-trophic aquaculture used in the Yellow Sea LME is introduced.

G. Triantafyllou, F. Yao, G. Petihakis, K. P. Tsiaras, D. E. Raitsos and I. Hoteit. (2014). Exploring the Red Sea seasonal ecosystem functioning using a three-dimensional biophysical model. Journal of Geophysical Research Oceans, 119 (3): 1791-1811.

This study developed a three-dimensional ecosystem model to explore the complex hydrodynamic and biogeochemical characteristics of the Red Sea. The results of a simulation run under climatological forcings aligned with satellite and in situ data. The Red Sea is referenced as an LME.

J. R. Watson, C. Stock and J. L. Sarmiento. (2014). Exploring the role of movement in determining the global distribution of marine biomass using a coupled hydrodynamic–size-based ecosystem model. Progress in Oceanography, 138B: 521-532.

The authors of this article use a size-based food web model and simulations of global ocean physical and biogeochemical processes to estimate the abundance and distribution of fish biomass. They conclude that the total ocean fish biomass would be approximately 2.84x10^9 tons in the absence of fishing. LMEs are discussed in the context of the 2012 Blanchard et al. publication, which presented a model of marine animal abundance in several LMEs.

H. Hao, C. Bin and L. Jinlan. (2015). The marine spatial classification and the identification of priority conservation areas (PCAs) for marine biodiversity conservation—A case study of the offshore China. Ocean & Coastal Management, 116: 224-236.

This paper explores the identification of priority conservation areas in offshore China. LMEs are listed as one of several marine spatial classification schemes. The authors divide offshore China into five regions that are similar but not identical to the LMEs of this area.

N. C. Hoi and V. H. Dang. (2015). Building a regional network and management regime of marine protected areas in the South China Sea for sustainable development. Journal of International Wildlife Law and Policy, 18 (2): 128-138.

This article recommends the development of an MPA network with an effective regional management scheme in the South China Sea with the goal of implementing the ecosystem-based management approach. The South China Sea is referenced as an LME numerous times in the document.

P. J. Jacques. (2015). Are world fisheries a global panarchy? Marine Policy, 53: 165-170.

This paper compares two fisheries policy perspectives: (i) to think of fisheries as a global, integrated, adaptive system, or (ii) to think of fisheries as a panarchy, a specific form of governance that encompasses all others. LMEs are presented as an example of a fisheries panarchy.

T. Jansen, P. Kainge, L. Singh, M. Wilhelm, D. Durholtz, T. Strømme, J. Kathena and V. Erasmus. (2015). Spawning patterns of shallow-water hake (*Merluccius capensis*) and deep-water hake (*M. paradoxus*) in the Benguela Current Large Marine Ecosystem inferred from gonadosomatic indices. Fisheries Research, 172: 168-180.

This paper presents a new gonadosomatic index threshold for identifying spawning *Merluccius capensis* and *Merluccius paradoxus* in the Benguela Current LME. This index is used to explore spawning patterns of these species. The findings suggest that multiple stocks of both species exist, indicated by multiple spawning seasons.

A. A. Keller, L. Ciannelli, W. W. Wakefield, V. Simon, J. A. Barth and S. D. Pierce. (2015). Occurrence of demersal fishes in relation to near-bottom oxygen levels within the California Current large marine ecosystem. Fisheries Oceanography, 24 (2): 162-176.

This study sought to understand the impacts of decreased oceanic dissolved oxygen on higher trophic-level species due to climate change. Catch was sampled near both limits of the oxygen minimum zone in the California Current LME. The results showed a significant and positive relationship between catch and species richness with near-bottom oxygen concentration.

A. Khan and V. Amelie. (2015). Assessing climate change readiness in Seychelles: implications for ecosystem-based adaptation mainstreaming and marine spatial planning. Regional Environmental Change, 15 (4): 721-733.

This article assesses potential for the use of ecosystem-based adaptation in response to climate change, specifically for small Island Developing States. The Seychelles are presented as an example within the context of LME governance and the mainstreaming of climate change.

S. I. Large, G. Fay, K. D. Friedland and J. S. Link. (2015). Critical points in ecosystem responses to fishing and environmental pressures. Marine Ecology Progress Series, 521: 1-17.

This study created a surface dependent on fishing and environmental pressures using ecological indicator responses for the Northeast U.S. Continental Shelf LME. This modeling approach identified critical points in these ecological indicators.

J. Rochette, R. Bille, E. J. Molenaar, P. Drankier and L. Chabason. (2015). Regional oceans governance mechanisms: a review. Marine Policy, 60: 9-19.

This article compares three regional governance mechanisms for the management of natural marine resources: the Regional Seas programs, Regional Fishery Bodies, and LMEs. The authors evaluate the capacity of each mechanism to facilitate EBM of the marine and coastal environment.

L. Grønnevet. (2016). The joint Russian-Norwegian governance of the Barents Sea LME fisheries. Environmental Development, 17 (1): 296-309.

This paper discusses the governance of the Barents Sea fisheries and emphasizes their success. The author attributes this success to the Joint Fisheries Commission bringing together Russia and Norway.

Group Four

K. Sherman, R. Lasker, W. Richards and A. W. J. Kendall. (1983). Ichthyoplankton and fish recruitment studies in large marine ecosystems. Marine Fisheries Review, 45: 1-25.

This paper provides an overview of the NMFS–NOAA Marine Resources Monitoring Assessment and Prediction (MARMAP) program. Fisheries and ichthyoplankton studies in LMEs are discussed.

G. A. Bisbal. (1995). The Southeast South American shelf large marine ecosystem: evolution and components. Marine Policy, 19 (1): 21-38.

This article presents the Southeastern South American Shelf as an LME, given its physical and biological characteristics, overlapping of anthropogenic stressors, and conflicting unilateral marine resource management. The author discusses the suitability of the LME approach for achieving sustainable management and development of this region.

B. H. Sherman. (2000). Marine ecosystem health as an expression of morbidity, mortality, and disease events. Marine Pollution Bulletin, 41 (1-6): 232-254.

This paper develops a retrospective marine epidemiological approach that uses data mining to recover marine morbidity, mortality, and disease information. Sherman applies this approach in an analysis of the Northwestern Atlantic, the Gulf of Mexico, and the Caribbean Sea during the past 30 years and finds that anomalous marine morbidity and mortality events have increased. LMEs are used for data aggregation and specific LMEs are referenced throughout the document.

M. C. A. Ablan, J. W. McManus, C. A. Chen, K. T. Shao, J. Bell, A. S. Cabanban, V. S. Tuan and I. W. Arthana. (2002). Meso-scale Transboundary Units for the Management of Coral Reefs in the South China Sea Area. Naga, WorldFish Center Quarterly, 24 (3, 4): 4-9.

This paper proposes the development of mesoscale transboundary units within LMEs for managing coral reef and reef-associated resources in Southeast Asia. These boundaries may be delineated based on data from genetic variation on the reef species populations. LMEs are discussed as a geographic management approach for coastal fisheries. The four LMEs of Southeast Asia and their bounding nations are introduced. Based on their analyses of genetic data, the authors suggest mesoscale transboundary units.

J. E. Moore and J. P. Barlow. (2003). Declining abundance of beaked whales (Family Ziphiidae) in the California Current large marine ecosystem. PLoS One, 8 (1): 1-12.

This study estimated the abundance and population trends of beaked whales using sightings data from six ship line-transect cetacean abundance surveys in the California Current Large Marine Ecosystem. The authors also gathered records of beaked whale stranding events, which were consistent with survey results. The results of the study indicate a decline in abundance; however, the causes of this decline are unknown.

P. G. Wells. (2003). Assessing health in the Bay of Fundy—concepts and framework. Marine Pollution Bulletin, 46 (9): 1059-1077.

This article discusses ecosystem health and presents a conceptual framework for assessing ecosystem health within the context of the Bay of Fundy. The pollution and ecosystem health module and the associated indices of the Large Marine Ecosystem approach are discussed as applicable analyses to the Bay of Fundy as part of the Northeast Shelf LME.

N. Mantua. (2004). Methods for detecting regime shifts in large marine ecosystems: a review with approaches applied to North Pacific data. Progress in Oceanography, 60: 165-182.

This paper presents and evaluates five analytical methods for diagnosing regime shifts. This diagnosis is done on the scale of LMEs. Mantua uses data from the North Pacific as a case study for evaluating these methods.

L. Vidal and D. Pauly. (2004). Integration of subsystems models as a tool toward describing feeding interactions and fisheries impacts in a large marine ecosystem, the Gulf of Mexico. Ocean & Coastal Management, 47 (11-12): 709-725.

This paper uses Ecopath with Ecosim software to integrate different models into an integrated, spatially explicit model for application to the GoM LME. The results of this analysis provide information on GoM LME fisheries.

R. Watson, A. Kitchingman, A. Gelchu and D. Pauly. (2004). Mapping global fisheries: sharpening our focus. Fish and Fisheries, 5 (2): 168-177.

This article uses disaggregated landing statistics to present time series catch data composition within LMEs and EEZs. LMEs are briefly reviewed and used as geographic boundaries for exploring this data.

R. Froese, S. Garthe, U. Piatkowski and D. Pauly. (2005). Trophic signatures of marine organisms in the Mediterranean as compared with other ecosystems. Belgian Journal of Zoology, 135 (2): 139-143.

This study compares the species numbers and trophic levels of fishes, sea birds, marine mammals, and cephalopods to explore differences and similarities across six LMEs, with a focus on the Mediterranean. The North Sea LME, Baltic Sea LME, Black Sea LME, Caribbean Sea LME, and the South China Sea were all included in this study.

J. Keesing and T. Irvine. (2005). Coastal biodiversity in the Indian Ocean: the known, the unknown and the unknowable. Indian Journal of Marine Sciences, 34 (1): 11-26.

This article compares the coastal marine biodiversity of the Indian Ocean versus the Atlantic and Pacific Oceans. The authors propose a framework to increase the understanding of Indian Ocean biodiversity using ecosystem bioregionalization. The authors conduct regional assessment on the basis of LMEs and discuss the approach as a current approach to Indian Ocean bioregionalization.

A. Bakun and S. J. Weeks. (2006). Adverse feedback sequences in exploited marine systems: are deliberate interruptive actions warranted? Fish and Fisheries, 7: 316-333.

In this paper, the authors present several mechanisms for self-enhancing feedback instabilities in marine ecosystems. The northern subarea of the Benguela Current LME is used as a cautionary example of the unanticipated interactions among multiple feedback loops.

T. E. Essington, A. H. Beaudreau and J. Wiedenmann. (2006). Fishing through marine food webs. Proceedings of the National Academy of Science of the United States of America, 103 (9): 3171-3175.

This article examines the trend of "fishing down the food web" in LMEs, finding that this trend was pervasive in 30 ecosystems. However, the serial addition of low-trophic-level fisheries ("fishing through the food web") was common as a mechanism for declines in the mean trophic level of fisheries landings.

B. Worm, E. B. Barbier, N. Beaumont, J. E. Duffy, C. Folke, B. S. Halpern, J. B. Jackson, H. K. Lotze, F. Micheli, S. R. Palumbi, E. Sala, K. A. Selkoe, J. J. Stachowicz and R. Watson. (2006). Impacts of biodiversity loss on ocean ecosystem services. Science, 314 (5800): 787-90.

This research article finds that marine biodiversity loss has increased, threatening critical ecosystem services. LMEs were used as the spatial scale/boundaries for analyzing global fisheries, finding that since 1994, cumulative yields across LMEs have declined 13%.

J. A. Barth, B. A. Menge, J. Lubchenco, F. Chan, J. M. Bane, A. R. Kirincich, M. A. McManus, K. J. Nielsen, S. D. Pierce and L. Washburn. (2007). Delayed upwelling alters nearshore coastal ocean ecosystems in the northern California currentProceedings of the National Academy of Science of the United States of America, 104 (10): 3719-3724.

This paper discusses the California Current Large Marine Ecosystem (CCLME) and the upwelling system that fuels this highly productive coastal ecosystem. Global warming is predicted to influence coastal upwelling regions with delays in early-season upwelling and stronger late-season upwelling. This study explores the effects of a 1-month delay in the 2005 onset of upwelling-favorable wind stress in the CCLME, including warm water, low primary productivity, and low nutrient levels.

P. Burgherr. (2007). In-depth analysis of accidental oil spills from tankers in the context of global spill trends from all sources. Journal of Hazardous Materials, 140 (1-2): 245-256.

In this paper, Burgherr describes the frequency and trends of accidental oil spills on a global scale from 1970 to 2004. The number of spills occurring in LMEs was analyzed to explore spill frequency in areas deemed “ecologically sensitive.” Forty-four percent of the spills included in this study occurred in LMEs.

P. Chavance, P. Morand, L. Thibaut and M. Ba. (2007). Challenges and difficulties of cooperation between fisheries information systems—Experiences in six West African developing countries. Ocean & Coastal Management, 50 (9): 713-731.

The authors compared existing fisheries information systems in the West African countries of the Sub Regional Fisheries Commission. The study incorporated the CCLME and the GCLME and argued for fisheries data at the LME scale.

D. J. Doulman. (2007). Coping with the extended vulnerability of marine ecosystems: implementing the 1995 FAO Code of Conduct for Responsible Fisheries. Social Science Information, 46 (4): 189-237.

This article reviews the 1995 FAO Code of Conduct for Responsible Fisheries. An entire section is devoted to LMEs, with specific reference to the fisheries activities of the Canary Current, Bay of Bengal, and Benguela Current LME projects.

M. H. Taylor and M. Wolff. (2007). Trophic modeling of Eastern Boundary Current Systems: a review and prospectus for solving the "Peruvian Puzzle". Revista Peruana de Biologia, 14 (1): 87-100.

To evaluate the potential use of EBCS trophic modeling in Peru, a literature review was completed, examining studies on EBCS dynamics and trophic modeling. The results are presented in this article. The Humboldt Current LME is the study area and the other LMEs corresponding with EBCSs are referenced.

F. Chan, J. A. Barth, J. Lubchenco, A. Kirincich, H. Weeks, W. T. Peterson and B. A. Menge. (2008). Emergence of Anoxia in the California Current large marine ecosystem. Science, 319 (5865): 920.

This brief article explores the rise in water-column anoxia and intensification of severe inner-shelf hypoxia in the California Current LME.

M. Coll, S. Libralato, S. Tudela, I. Palomera and F. Pranovi. (2008). Ecosystem overfishing in the ocean. PLoS One, 3 (12): e3881.

This study quantified the depletion of secondary production to evaluate the current and historical risk of ecosystem overfishing. The results suggest an increase in the number of unsustainable fisheries during the second half of the twentieth century. LMEs are the geographical unit used in this study.

K. M. F. Freire, V. Christensen and D. Pauly. (2008). Description of the East Brazil Large Marine Ecosystem using a trophic model. Scientia Marina, 72 (3): 477-491.

This study used Ecopath with Ecosim (EwE) to develop a trophic model to describe the East Brazil Shelf LME in the 1970s. Forty-one functional groups were identified and the relationships between these groups were explored.

O. A. Nubi, E. A. Ajao, E. O. Oyewo and J. P. Unyimadu. (2008). Nutrient levels in Guinea Current large marine ecosystem (GC-LME) waters. Science World Journal, 3 (2): 89-94.

This study explored the nutrient levels in water and sediment samples in the GCLME, finding the phosphate and nitrate levels of water samples to be higher than the natural background level. The collection of these samples was part of the GCLME program.

D. Alemany, E. M. Acha and O. Iribarne. (2009). The relationship between marine fronts and fish diversity in the Patagonian Shelf Large Marine Ecosystem. Journal of Biogeography, 36 (11): 2111-2124.

This study compared three frontal systems and eight zones (non-frontal areas) and used fisheries (trawling) data to evalutate the impact of fronts on fish communities in the Patagonian Shelf Large Marine Ecosystem, which served as the geographical context of this study.

C. Arvanitidis, P. J. Somerfield, H. Rumohr, S. Faulwetter, V. Valavanis, A. Vasileiadou, G. Chatzigeorgiou, E. Vanden Berghe, J. Vanaverbeke, C. Labrune, A. Gremare, M. L. Zettler, M. Kendra, M. Wlodarska-Kowalczuk, I. F. Aleffi, J. M. Amouroux, N. Anisimova, G. Bachelet, M. Buntzow, S. J. Cochrane, M. J. Costello, J. Crawymeersch, S. Dahle, S. Degraer, S. Denisenko, C. Dounas, G. Duineveld, C. Emblow, V. Escavarage, M. C. Fabri, D. Fleischer, J. S. Gray, C. H. R. Heip, M. Herrmann, H. Hummel, U. Janas, I. Karakassis, M. A. Kendall, P. Kingston, L. Kotwicki, J. Laudien, A. S. Y. Mackie, E. L. Nevrova, A. Occhipinti-Ambrogi, P. G. Oliver, F. Olsgard, R. Palerud, A. Petrov, E. Rachor, N. K. Revkov, A. Rose, R. Sarda, W. C. H. Sistermans, J. Speybroeck, G. Van Hoey, M. Vincx, P. Whomersley, W. Willems and A. Zenetos. (2009). Biological geography of the European seas: results from the MacroBen database. Marine Ecology Progress Series, 382: 265-278.

This study examines the possibility of using soft-bottom macrobenthic community data to validate biogeographical and/or managerial divisions in European seas. LMEs were used as one of the geographic boundaries for this study.

I. M. Belkin. (2009). Rapid warming of Large Marine Ecosystems. Progress in Oceanography, 81 (1-4): 207-213.

This article describes the warming effect of global climate change on LMEs. Belkin examined SST changes in LMEs between 1957 and 2006, finding rapid warming in the latter half of this period in the LMEs of the Subarctic Gyre, East Asian Seas, and European Seas. The California and Humboldt Current LMEs show a slight drop in SST.

I. M. Belkin, P. C. Cornillon and K. Sherman. (2009). Fronts in Large Marine Ecosystems. Progress in Oceanography, 81 (1-4): 223-236.

This article presents the first remote sensing survey of fronts within LMEs on a global scale. Algorithms were applied to satellite data to create maps for identifying major fronts and their distribution for all LMEs. Specific examples are presented, including the Yellow Sea LME (YSLME), the Northeast U.S. Continental Shelf LME, and the GoM LME.

V. Christensen, C. J. Walters, R. Ahrens, J. Alder, J. Buszowski, L. B. Christensen, W. W. L. Cheung, J. Dunne, R. Froese, V. Karpouzi, K. Kaschner, K. Kearney, S. Lai, V. Lam, M. L. D. Palomares, A. Peters-Mason, C. Piroddi, J. L. Sarmiento, J. Steenbeek, R. Sumaila, R. Watson, D. Zeller and D. Pauly. (2009). Database-driven models of the world's Large Marine Ecosystems. Ecological Modelling, 220 (17): 1984-1996.

This article presents a new methodology for the generation of ecosystem models, relying on the databases developed through the Sea Around Us project. The methodology is applied to all 66 LMEs to obtain an estimate of fish biomass for each region.

M. Coll, L. Shannon, D. Yemane, J. S. Link, H. Ojaveer, S. Neira, D. Jouffre, P. Labrosse, J. J. Heymans, E. A. Foulton and Y.-J. Shin. (2009). Ranking the ecological relative status of exploited marine ecosystems. ICES Journal of Marine Science, 67: 1-18.

This study used ecological indicators to rank ecosystems with exploited fisheries. Primary productivity data used in this analysis was gathered from the Sea Around Us Project; LMEs were used as the spatial unit.

K. Sherman, I. Belkin, K. D. Friedland, J. O'Reilly and K. Hyde. (2009). Accelerated warming and emergent trends in fisheries biomass yields of the World's LMEs. Ambio, 38 (4): 215-224.

This article presents the results of a global study on the impact of SST on fisheries yields during the past 25 years. LMEs were used as the spatial units for this study. Results showed that 61 of the 63 global LMEs are warming, and the greatest effects of this warming are in the rapidly warming LMEs of the Northeastern Atlantic.

K. W. Shertzer, E. H. Williams and J. C. Taylor. (2009). Spatial structure and temporal patterns in a large marine ecosystem: Exploited reef fishes of the southeast United States. Fisheries Research, 100 (2): 126-133.

To improve ecosystem-based management of the Southeast U.S. Continental Shelf LME, this study used data from both recreational and commercial fisheries to identify a zoogeographic boundary in Florida and shifts in species composition of landings in 1992 and between 1999 and 2000. This new information should be taken into account when managing this LME.

B. Worm, R. Hilborn, J. K. Baum, T. A. Branch, J. S. Collie, C. Costello, M. J. Fogarty, E. A. Fulton, J. A. Hutchings, S. Jennings, O. P. Jensen, H. K. Lotze, P. M. Mace, T. R. McClanahan, C. Minto, S. R. Palumbi, A. M. Parma, D. Ricard, A. A. Rosenberg, R. Watson and D. Zeller. (2009). Rebuilding Global Fisheries. Science, 325 (5940): 578-585.

This article analyzes the results of increased efforts to rebuild marine fisheries, describing a decline in the average exploitation rate in half of the 10 well-studied LMEs included in this investigation. The paper also addresses the need to rebuild 63% of fish stocks worldwide and the numerous challenges of this task.

C. J. Byron and J. S. Link. (2010). Stability in the feeding ecology of four demersal fish predators in the US Northeast Shelf Large Marine Ecosystem. Marine Ecology Progress Series, 406: 239-250.

This study examined the diets of four demersal fish species in the U.S. Northeast Shelf LME to determine the stability of their feeding ecology. The authors conclude that the feeding ecology has been consistent during the past 3 decades, which will enhance large marine ecosystem resilience.

E. Chassot, S. Bonhommeau, N. K. Dulvy, F. Melin, R. Watson, D. Gascuel and O. Le Pape. (2010). Global marine primary production constrains fisheries catches. Ecology Letters, 13 (4): 495-505.

This study shows that the primary productivity of phytoplankton is related to global fisheries catches. LMEs are used as the geographic scale of this investigation, and annual catch data was prepared by the Sea Around Us project. The findings suggest that global primary productivity is declining and may impact global fisheries.

L. Conti and M. Scardi. (2010). Fisheries yield and primary productivity in large marine ecosystems. Marine Ecology Progress Series, 410: 233-244.

This study analyzed primary productivity data (SeaWIFS) and fish catch data (Sea Around Us Project) between 1998 and 2002 in 14 LMEs. The results include a significant and positive correlation between the average trophic level of catches and variability of primary productivity over time.

C. Costello, J. Lynham, S. E. Lester and S. D. Gaines. (2010). Economic Incentives and Global Fisheries Sustainability. Annual Review of Resource Economics, 2 (1): 299-318.

This article builds on the analysis of a previous paper by the same authors (2008). The original analysis is expanded using a program evaluation design. The findings confirm that catch shares prevent and may reverse the collapse of fisheries. The study identifies 121 fisheries managed using individual transferable quotas (ITQ) (or variations of this management scheme), which are defined at the level of LMEs.

J. J. Cruz-Motta, P. Miloslavich, G. Palomo, K. Iken, B. Konar, G. Pohle, T. Trott, L. Benedetti-Cecchi, C. Herrera, A. Hernandez, A. Sardi, A. Bueno, J. Castillo, E. Klein, E. Guerra-Castro, J. Gobin, D. I. Gomez, R. Riosmena-Rodriguez, A. Mead, G. Bigatti, A. Knowlton and Y. Shirayama. (2010). Patterns of spatial variation of assemblages associated with intertidal rocky shores: a global perspective. PLoS One, 5 (12): e14354.

This study evaluated species assemblages associated with rocky intertidal shores with the goal of identifying latitudinal trends. LMEs were a spatial scale at which species richness and taxonomic distinctiveness were evaluated. There were no clear patterns among LMEs for these factors.

D. Fautin, P. Dalton, L. S. Incze, J. C. Leong, C. Pautzke, A. A. Rosenberg, P. Sandifer, G. Sedberry, J. W. Tunnell, I. Abbot, R. E. Brainard, M. Brodeur, L. G. Eldredge, M. Feldman, F. Moretzsohn, P. S. Vroom, M. Wainstein and N. Wolff. (2010). An overview of marine biodiversity in United States waters. PLoS One, 5 (8): e11914.

This extensive review article provides an overview of marine biodiversity in the waters of the United States. The authors identify threats to biodiversity and knowledge gaps in the existing data. LMEs are used as the geographic boundaries for analysis in this article. Specific sections address the Northeast U.S. Continental Shelf LME, the Southeast U.S. Continental Shelf LME, the Gulf of Mexico LME, the California Current LME, and Alaska's LMEs (the Gulf of Alaska, the East Bering Sea, the Aleutian Islands, and the Chukchi and Beaufort Seas).

J. A. D. Fisher, K. T. Frank and W. C. Leggett. (2010). Breaking Bergmann's rule: truncation of Northwest Atlantic marine fish body sizes. Ecology, 91 (9): 2499-2505.

The study area for this investigation consisted of three LMEs: the Northeast U.S. Continental Shelf, the Scotian Shelf, and the Newfoundland–Labrador Shelf. The authors analyzed body size and community composition data for Northwest Atlantic fish species across these three LMEs. They found that during the past 3 decades, there has been a rapid and widespread reduction in the body sizes of these species, which may impact the recovery of these important ecosystems.

J. A. D. Fisher, K. T. Frank and W. C. Leggett. (2010). Global variation in marine fish body size and its role in biodiversity–ecosystem functioning. Marine Ecology Progress Series, 405: 1-13.

This paper presents analyses indicating that the relationship between global marine fish species richness and ecosystem functioning may be influenced by fish body size. These analyses used LMEs as the study area and conclude that management initiatives should include fish body size as an important functional trait.

K. M. F. Freire and D. Pauly. (2010). Fishing down Brazilian marine food webs, with emphasis on the east Brazil large marine ecosystem. Fisheries Research, 105 (1): 57-62.

This study examined marine fisheries catch data in the East Brazil LME between 1978 and 2000. When the catch data is disaggregated to smaller entities, the Marine Trophic Index indicates that the "fishing down the food web" phenomenon is occurring.

D. F. M. Gherardi, E. T. Paes, H. C. Soares, L. P. Pezzi and M. T. Kayano. (2010). Differences between spatial patterns of climate variability and large marine ecosystems in the western South Atlantic. Pan-American Journal of Aquatic Sciences, 5 (2): 310-319.

This paper explores the influence of climate forcings on LMEs in the western South Atlantic. The authors argue that the ecological criteria used to delineate LMEs may not control the response of LMEs to climate change. Rather, climate change responses are influenced by the physical processes not bounded by LMEs, such as El Niño/Southern Oscillation (ENSO) or the Antarctic Oscillation Index (AAO).

M. E. Hunsicker, T. E. Essington, R. Watson and U. R. Sumaila. (2010). The contribution of cephalopods to global marine fisheries: can we have our squid and eat them too? Fish and Fisheries, 11: 421-438.

This study used data from the Sea Around Us Project, which uses LMEs as geographic boundaries for its fish catch data, to explore the ecosystem services provided by cephalopods to fisheries. LMEs were also used in this study to explore this topic across a range of ecosystems.

N. Kannan, H. K. Choi, S. H. Hong, J. R. Oh and W. J. Shim. (2010). Occurrence and Biological Fate of Persistent Organic Contaminants in the Yellow Sea Fish. Environment Asia, 3 (1): 20-31.

The Yellow Sea Large Marine Ecosystem (YSLME) is the study area for this paper, which examined Persistent Organic Pollutants (POPs) in the muscle and liver tissues of Yellow Sea croakers. Through Principle Component Analysis, the authors identified “hot spots” within the YSLME but concluded that the concentration of POPs in the YSLME is far below that of the United States or the North Sea.

M. A. MacNeil, N. A. J. Graham, J. E. Cinner, N. K. Dulvy, P. A. Loring, S. Jennings, N. V. C. Polunin, A. T. Fisk and T. R. McClanahan. (2010). Transitional states in marine fisheries: adapting to predicted global change. Philosophical Transactions of the Royal Society B: Biological Sciences, 365: 3753-3763.

This article explores the direct and indirect impacts of climate change and marine fisheries from production, biodiversity, social, and economic perspectives. This study was completed at the LME scale, with a specific focus on the North Atlantic and Arctic LMEs.

S. C. Anderson, J. M. Flemming, R. Watson and H. K. Lotze. (2011). Rapid global expansion of invertebrate fisheries: trends, drivers, and ecosystem effects. PLoS One, 6 (3).

This paper addresses the rapid expansion of invertebrate fisheries and the lack of information on the trends, drivers, and population and ecosystems consequences of these fisheries. Using data from the Sea Around Us Project, the authors report the highest concentrations of invertebrate catch per unit area by LMEs from 2000 to 2004.

S. R. Benson, T. Eguchi, D. G. Foley, K. A. Forney, H. Bailey, C. Hitipeuw, B. P. Samber, R. F. Tapilatu, V. Rei, P. Ramohai, J. Pita and P. H. Dutton. (2011). Large-scale movements and high-use areas of western Pacific leatherback turtles, *Dermochelys coriacea*. Ecosphere, 2 (7): 1-27.

This study reports the findings from a large-scale satellite telemetry study of the western Pacific leatherback turtle. LMEs are used as a spatial scale for categorizing the movements of tagged turtles, with specific reference to the South China Sea LME and the California Current LME.

W. W. Cheung, J. Dunne, J. L. Sarmiento and D. Pauly. (2011). Integrating ecophysiology and plankton dynamics into projected maximum fisheries catch potential under climate change in the Northeast Atlantic. ICES Journal of Marine Science, 68 (6): 1008-1018.

This paper addresses the gap in projected shifts of species distributions and maximum fisheries catch potential across ocean basins, which, until now, have not incorporated the effects of climate change in biogeochemistry or phytoplankton community structure. This study employed a dynamic bioclimatic envelope model to incorporate these factors. LMEs were used as a spatial unit for analyzing total maximum fisheries catch potential.

M. A. Huston and S. Wolverton. (2011). Regulation of animal size by eNPP, Bergmann's rule, and related phenomena. Ecological Monographs, 81 (3): 349-405.

This study uses the Sea Around Us catch data, which uses LME boundaries, to present the "eNPP rule" regarding geographic variation in animal body size. The results are presented in the context of LMEs.

A. McCrea-Strub and D. Pauly. (2011). Oil and Fisheries in the Gulf of Mexico. Ocean & Coastal Management, 16 (2): 473-480.

This study examines the impacts of the Deepwater Horizon oil spill in the Gulf of Mexico LME and compares the pre-spill spatial distribution of commercial fish catch and its landed value with the post-spill fisheries closure. The potential economic losses are evaluated.

D. Zeller, S. Booth, E. Pakhomov, W. Swartz and D. Pauly. (2011). Arctic fisheries catches in Russia, USA, and Canada: baselines for neglected ecosystems. Polar Biology, 34 (955-973): 955-973.

This article presents reconstructed catch data for the Amerasian Arctic, where catches are not always reported to the FAO. The authors calculate that the catches reported for FAO in this region are 75 times lower than their reconstructed estimates. The several LMEs of this region served as the geographic boundaries for this analysis.

J. L. Blanchard, S. Jennings, R. Holmes, J. Harle, G. Merino, J. I. Allen, J. Holt, N. K. Dulvy and M. Barange. (2012). Potential consequences of climate change for primary production and fish production in large marine ecosystems. Philosophical Transactions of the Royal Society B: Biological Sciences, 367 (1605): 2979-2989.

This study uses a dynamic, size-based food web approach to understand the potential impacts of climate change on LMEs. LMEs are employed as a large geographical unit.

L. Brotz, W. W. L. Cheung, K. Kleisner, E. Pakhomov and D. Pauly. (2012). Increasing jellyfish populations: trends in Large Marine Ecosystems. Hydrobiologia, 690 (1): 3-20.

This study uses nonconventional information to complement data on jellyfish abundance at the scale of LMEs. Of the 45 LMEs included in the analysis, 28 showed increasing jellyfish abundance.

L. M. Buruaem, M. A. Hortellani, J. E. Sarkis, L. V. Costa-Lotufo and D. M. Abessa. (2012). Contamination of port zone sediments by metals from Large Marine Ecosystems of Brazil. Marine Pollution Bulletin, 64 (3): 479-88.

This study examined the sediments in port zones of two different Brazil LMEs to determine the distribution of major and trace metals. The authors detected differences in the sediments with which the metals are associated in each region and found that the metal concentrations were higher in these port zones than elsewhere in the LMEs.

L. Conti, G. Grenouillet, S. Lek and M. Scardi. (2012). Long-term changes and recurrent patterns in fisheries landings from Large Marine Ecosystems (1950–2004). Fisheries Research, 119-120: 1-12.

To detect trends in fisheries landings data in LMEs, an analysis was undertaken using data from the Sea Around Us project. A Self Organizing Map analyzed 51 LMEs over 5 decades and detected 2 main types of fisheries: small and medium pelagic fisheries and demersal fisheries. The former is characterized by cyclic behaviors and stable compositions; the latter is more affected by economic drivers.

J. H. Cowan Jr., J. C. Rice, C. J. Walters, R. Hilborn, T. E. Essington, D. W. Day Jr. and K. M. Boswell. (2012). Challenges for Implementing an Ecosystem Approach to Fisheries Management. Marine and Coastal Fisheries, 4 (1): 496-510.

In this article, the authors explore the empirical, jurisdictional, and societal challenges of implementing an ecosystem approach to fisheries management. LMEs are used as the geographic units for an evaluation of the disparity of purchasing power with multiple countries managing shared fish stocks, with the Gulf of Mexico LME as a specific example.

M. Frederiksen, B. Moe, F. Daunt, R. Phillips, R. T. Barrett, M. I. Bogdanova, T. Boulinier, J. W. Chardine, O. Chastel, L. S. Chivers, S. Christensen-Dalsgaard, C. Clement-Chastel, K. Calhoun, R. Freeman, A. J. Gason, J. Gonzalez-Solis, A. Goutte, D. Gremillet, T. Guilford, G. H. Jensen, Y. Krasnov, S. Lorentsen, M. L. Mallory, M. Newell, B. Olsen, D. Shaw, H. Steen, H. Strom, G. H. Systad, T. L. Thorarinsson and T. Anker-Nilssen. (2012). Multicolony tracking reveals the winter distribution of a pelagic seabird on an ocean basin scale. Diversity and Distributions, 18 (6): 530-542.

This study used LMEs as the spatial scale for exploring the winter distribution of a pelagic seabird, the black-legged kittiwake (*Rissa tridactyla*). This information will assist with improving the management of this declining species.

K. D. Friedland, C. Stock, K. F. Drinkwater, J. S. Link, R. T. Leaf, B. V. Shank, J. M. Rose, C. H. Pilskaln and M. J. Fogarty. (2012). Pathways between primary production and fisheries yields of large marine ecosystems. PLoS One, 7 (1): e28945.

This paper examines the relationship between primary productivity and fisheries yield, exploring several metrics (e.g., net primary production). The study uses LMEs as the spatial unit for analyses and finds that primary production is a poor predictor of fisheries yield in 52 LMEs; however, other metrics are more useful.

G. Lassalle, J. Lobry, F. Le Loc'h, S. Mackinson, F. Sanchez, M. T. Tomczak and N. Niquil. (2012). Ecosystem status and functioning: searching for rules of thumb using an intersite comparison of food-web models of Northeast Atlantic continental shelves. ICES Journal of Marine Science.

This study aimed to identify ecosystem indicators to help achieve a better understanding of trophic control mechanisms, as well as the structure and function of marine ecosystems. Four Northeast Atlantic LMEs were compared using Ecopath models.

G. G. Matishov, D. Moiseev, O. Lyubina, A. Zhichkin, S. Dzhenyuk, O. Karamushko and E. Frolova. (2012). Climate and cyclic hydrobiological changes of the Barents Sea from the twentieth to twenty-first centuries. Polar Biology, 35 (12): 1773-1790.

This study examined the response of marine biota to climate change to evaluate the state and stability of living marine resources in this highly sensitive transition zone. The Large Marine Ecosystem concept is described as the basis for contemporary research methods. In addition, the study mentions the following LMEs: Greenland Sea, Norwegian Sea, Barents Sea, and Kara Sea.

N. McGinty, A. M. Power, and M. P. Johnson. (2012). Trophodynamics and stability of regional scale ecosystems in the Northeast Atlantic. ICES Journal of Marine Science, 69(5): 764-775.

This article presents the results from a study exploring plankton trophic groupings in the Northeast Atlantic. The Celtic Biscay LME was the study area for this investigation; however, the area was expanded to include off-shelf areas.

F. Mingzhu, W. Zongling, P. Xinming, X. Zongjun and Z. Mingyuan. (2012). Changes of nutrient concentrations and N:P:Si ratios and their possible impacts on the Huanghai Sea ecosystem. Acta Oceanologica Sinica, 31 (4): 101-112.

This study explored the impacts of nutrient concentrations and N:P:Si ratios in the Yellow Sea. Data from the UNDP/GEF YSLME program was used to examine the concentrations and ratios of nutrients, as well as phytoplankton community structure.

M. C. Payne, C. A. Brown, D. A. Reusser and H. Lee, II. (2012). Ecoregional analysis of nearshore sea-surface temperature in the North Pacific. PLoS One, 7 (1): e30105.

This study analyzed a 29-year nearshore time series dataset of mean monthly SST. Marine Ecoregions of the World (MEOW) was the primary hierarchical schema used to explore temperature patterns along the North Pacific coastline; however, these patterns were also compared to LMEs.

C. J. M. Philippart, A. Amaral, R. Asmus, J. van Bleijswijk, J. Bremner, F. Buchholz, M. Cabanellas-Reboredo, D. Catarino, A. Cattrijsse, F. Charles, T. Comtet, A. Cunha, S. Deudero, J. C. Duchene, S. Fraschetti, F. Gentil, A. Gittenberger, K. Guizien, J. M. Goncalves, G. Guarnieri, I. Hendriks, B. Hussel, R. P. Vieira, B. T. Reijnen, I. Sampaio, E. Serrao, I. S. Pinto, E. Thiebaut, F. Viard and A. F. Zuur. (2012). Spatial synchronies in the seasonal occurrence of larvae of oysters (*Crassostrea gigas*) and mussels (*Mytilus edulis/galloprovincialis*) in European coastal waters. Estuarine, Coastal and Shelf Science, 108: 52-63.

To explain the observed seasonal patterns of the occurrence of bivalve larvae in Europe, this study tested a series of hypotheses. One hypothesis was that seasonal patterns are related to specific spatial scales such as LMEs. The study area itself covered four distinct LMEs: the North Sea, the Celtic-Biscay Shelf, the Mediterranean, and the Iberian Coastal.

W. W. Cheung, R. Watson and D. Pauly. (2013). Signature of ocean warming in global fisheries catch. Nature, 497 (7449): 365-8.

In this article, the authors report an index for the signature of climate-change effects on global fisheries catch: the mean temperature of the catch (MTC). Between 1970 and 2006, the global MTC has increased. Within 52 LMEs, the MTC changes and the regional SST changes were positively and significantly correlated.

A. H. Khan, E. Levac and G. L. Chmura. (2013). Future sea surface temperatures in Large Marine Ecosystems of the Northwest Atlantic. ICES Journal of Marine Science, 70 (5): 915-921.

This study used global climate change models, earth system models, and representative concentration pathways to explore projections for SST in six Northwest Atlantic LMEs. Results indicate that SST will increase in most of the LMEs but seasonality will increase in all.

S. P. Kirkman, D. Yemane, J. Kathena, S. K. Mafwila, S. E. Nsiangango, T. Samaai, B. Axelsen and L. Singh. (2013). Identifying and characterizing demersal fish biodiversity hotspots in the Benguela Current Large Marine Ecosystem: relevance in the light of global changes. ICES Journal of Marine Science, 70 (5): 943-954.

This study explored species richness patterns of demersal fish and cephalopod species in the Benguela Current LME. Consistently predictable diversity hotspots were identified. The results showed an inconsistency across countries with the relationship between species richness and various environmental variables.

V. Lapitkhovsky, A. Arkhipkin and P. Brickle. (2013). From small bycatch to main commercial species: explosion of stocks of rock cod *Patagonotothen ramsayi* (Regan) in the Southwest Atlantic. Fisheries Research, 147: 399-403.

This paper describes the twentyfold to thirtyfold increase in rock cod catch in the Patagonian Shelf LME. This increase occurred after the collapse of the southern blue whiting stocks and coincided with increases in hakes and kingclip, which are rockfish predators.

J. S. Link and P. J. Auster. (2013). The challenges of evaluating competition among marine fishes: who cares, when does it matter, and what can one do about it? Bulletin of Marine Science, 89 (1): 213-247.

This study examined competitive species pairings in the Northeast U.S. Continental Shelf LME to explore rules of thumb for detecting competition. The authors argue that there are rules of thumb, but with caveats and theoretical considerations.

B. A. Menge and D. N. L. Menge. (2013). Dynamics of coastal meta-ecosystems: the intermittent upwelling hypothesis and a test in rocky intertidal regions. Ecological Monographs, 83 (3): 283-310.

This study applies a conceptual meta-ecosystem model to the rocky intertidal coastal ecosystems within two LMEs to explore ecosystem dynamics. The two LMEs are the California Current and the New Zealand Shelf.

P. Miloslavich, J. J. Cruz-Motta, E. Klein, K. Iken, V. Weinberger, B. Konar, T. Trott, G. Pohle, G. Bigatti, L. Benedetti-Cecchi, Y. Shirayama, A. Mead, G. Palomo, M. Ortiz, J. Gobin, A. Sardi, J. M. Diaz, A. Knowlton, M. Wong and A. C. Peralta. (2013). Large-scale spatial distribution patterns of gastropod assemblages on rocky shores. PLoS One, 8 (8): e71396.

This study samples gastropods across 12 LMEs to explore their large-scale spatial distribution. Environmental variables and species composition were compared, but no significant correlation was found. The authors call for a global database for rocky intertidal assemblage information to examine large-scale diversity.

R. Mondreti, P. Davidar, C. Péron and D. Grémillet. (2013). Seabirds in the Bay of Bengal large marine ecosystem: Current knowledge and research objectives. Open Journal of Ecology, 3 (2): 172-184.

This article explores the current status of seabirds in the Bay of Bengal LME and their potential use as ecological indicators. Gaps in the knowledge about seabirds and the BOBLME are identified.

P. Quillfeldt and J. F. Massello. (2013). Impacts of climate variation and potential effects of climate change on South American seabirds—a review. Marine Biology Research, 9 (4): 337-357.

This article reviews current knowledge of the impacts of climate change on the seabirds of South America within the context of LMEs. The authors conclude that the seabird communities in the Patagonian Shelf and Humboldt Current LMEs are the best studied, but overall knowledge is inadequate.

D. E. Raitsos, Y. Pradhan, R. J. W. Brewin, G. Stenchikov and I. Hoteit. (2013). Remote sensing the phytoplankton seasonal succession of the Red Sea. PLoS One, 8 (6): e64909.

This study explored large-scale phytoplankton dynamics in the Red Sea LME. Seasonal trends are identified using a 10-year, high-resolution chlorophyll-a dataset. Four distinct provinces and seasons are presented.

A. Schiavetti, J. Manz, C. Z. dos Santos, T. C. Magro and M. I. Pagani. (2013). Marine Protected Areas in Brazil: An ecological approach regarding the large marine ecosystems. Ocean & Coastal Management, 76: 96-104.

This study examined Brazilian Coastal and Marine Protected Areas. LMEs were used to determine the distribution and characteristics of these areas. The results show that coastal areas are significantly more protected than marine systems, and the authors recommend that the Brazilian government expand protected areas within each of the three Brazilian LMEs.

K. Sherman, I. Belkin, K. D. Friedland and J. O'Reilly. (2013). Changing states of North Atlantic large marine ecosystems. Environmental Development, 7: 46-58.

This study explores climate forcing effects in 15 LMEs to identify trends in multi-decadal time-series data. Data were examined for temperature, chlorophyll, primary productivity, nutrients, and fisheries yields. Predicted changes include latitudinal shifts in fisheries yields and increased nutrient over-enrichment in the North Atlantic.

J. D. Simons, M. Yuan, C. Carollo, M. Vega-Cendejas, T. Shirley, M. L. D. Palomares, P. Roopnarine, L. Gerardo Abarca Arenas, A. Ibañez, J. Holmes, C. Mazza Schoonard, R. Hertog, D. Reed and J. Poelen. (2013). Building a Fisheries Trophic Interaction Database for Management and Modeling Research in the Gulf of Mexico Large Marine Ecosystem. Bulletin of Marine Science, 89 (1): 135-160.

This article presents the compilation of 747 references from fish trophic interaction studies in the Gulf of Mexico LME. Using this database, the authors studied the spatial and taxonomic distributions of Gulf fishes and identified gaps in these data.

H. K. Alleway, S. D. Connell, T. M. Ward and B. M. Gillanders. (2014). Historical changes in mean trophic level of southern Australian fisheries. Marine and Freshwater Research, 65 (10): 884-893.

This study provides more accurate estimates of mean trophic level (MTL) for southern Australian fisheries. The MTL model was applied to fish catch statistics for South Australia and showed a decline in mean trophic level between 1951 and 2010. The Southwest Australian Shelf LME and the Southeast Australian Shelf LME were included in the study area for this investigation.

B. N. Blomberg and P. A. Montagna. (2014). Meta-analysis of Ecopath models reveals secondary productivity patterns across the Gulf of Mexico. Ocean & Coastal Management, 100: 32-40.

This study completed a meta-analysis of 18 Ecopath models in the Gulf of Mexico LME. Patterns in secondary productivity were detected and described.

S. M. Glaser, M. J. Fogarty, H. Liu, I. Altman, C. H. Hsieh, L. Kaufman, A. D. MacCall, A. A. Rosenberg, H. Ye and G. Sugihara. (2014). Complex dynamics may limit prediction in marine fisheries. Fish and Fisheries, 15 (4): 616-633.

This study used nonlinear forecasting models to analyze the fisheries of the California Current LME and the Northeast U.S. Continental Shelf LME. More than 200 time series of fisheries survey abundance and landings were analyzed. For 70% of these time series, dynamics were predictable over a single year. However, after a year, predictability declined exponentially. These results indicate the complexity of prediction in marine fisheries.

J. McOwen, W. W. L. Cheung, R. R. Rykaczewski, R. A. Watson and L. J. Wood. (2014). Is fisheries production within Large Marine Ecosystems determined by bottom-up or top-down forcing? Fish and Fisheries, 16 (4): 623-632.

This study explored top-down and bottom-up forcing in 47 LMEs, finding that these effects varied based on a number of different factors, including past fishing pressure and oceanographic conditions. The authors found a trend of bottom-up control in overfished but productive regions and top-down control in under-exploited but unproductive regions. These results suggest that generalities may be made even in complex ecological marine systems.

D. C. Reuman, H. Gislason, C. Barnes, F. Melin and S. Jennings. (2014). The marine diversity spectrum. Journal of Animal Ecology, 83 (4): 963-979.

This article addresses the distribution of species' body sizes across geographic assemblages rather than taxonomy. The authors developed a mechanistic model to explore this topic and applied it to 63 LMEs.

J. T. Sterling, A. M. Springer, S. J. Iverson, S. P. Johnson, N. A. Pelland, D. S. Johnson, M. A. Lea and N. A. Bond. (2014). The Sun, Moon, Wind, and Biological Imperative—shaping contrasting wintertime migration and foraging strategies of adult male and female northern fur seals (*Callorhinus ursinus*). PLoS One, 9 (4): e93068.

In this study, LMEs were used as the geographic boundaries for statistical analysis of the seasonal migration patterns of adult male and female northern fur seals (*Callorhinus ursinus*). Results showed that female northern fur seals migrated farther south during the winter to the Gulf of Alaska and the California Current. On the other hand, the male northern fur seals stayed north in the Bering Sea and the northern North Pacific Ocean.

S. Szuwalski, K. A. Vert-Pre, A. E. Punt, T. A. Branch and R. Hilborn. (2014). Examining common assumptions about recruitment: a meta-analysis of recruitment dynamics for worldwide marine fisheries. Fish and Fisheries, 16 (4): 633-648.

This article challenges the assumption used in fisheries management that recruitment is related to spawning biomass. Results suggest that recruitment is more strongly influenced by the environment. LMEs were used as the geographic boundaries within which synchronies in recruitment shifts were identified and compared to environmental indices.

R. Watson and D. Pauly. (2014). Coastal catch transects as a tool for studying global fisheries. Fish and Fisheries, 15 (3): 445-455.

This paper presents "catch transects" to represent the catch density of both benthic and pelagic fisheries. LMEs and EEZs are used as the geographic boundaries for these analyses, which reveal trends of fishing intensification.

R. Watson, D. Zeller and D. Pauly. (2014). Primary productivity demands of global fishing fleets. Fish and Fisheries, 15 (2): 231-241.

This paper explores historical fishing behavior and the primary production required to sustain global fishing fleets. These analyses were completed within the geographic boundaries of LMEs. This study found that the required primary production frequently exceeds that which is available.

D. Yemane, S. P. Kirkman, J. Kathena, S. E. N'siangango, B. E. Axelsen and T. Samaai. (2014). Assessing changes in the distribution and range size of demersal fish populations in the Benguela Current Large Marine Ecosystem. Reviews in Fish Biology and Fisheries, 24 (2): 463-483.

This study examined changes in the distribution and range of demersal fish species in the BCLME over 25 years to explore the possible impacts of global climate change on this important food source. Results varied, highlighting the complexity of the impacts of climate change.

B. E. Axelsen and E. Johnsen. (2015). An evaluation of the bottom trawl surveys in the Benguela Current Large Marine Ecosystem. Fisheries Oceanography, 24: 74-87.

The study evaluated fisheries-independent trawl survey data on the Benguela Current Large Marine Ecosystem. The study found that demersal trawl data was not comparable among all countries in the LME. In addition, countries differed in terms of the catchability of demersal fishes. The authors concluded that caution should be taken when using this data to identify temporal trends, and that the data for each country in the BCLME should be used separately.

G. Certain and B. Planque. (2015). Biodiversity baseline for large marine ecosystems: an example from the Barents Sea. ICES Journal of Marine Science, 72 (6): 1756-1768.

This article explores biodiversity in the Barents Sea LME, implementing a diversity measure for pelagic and demersal fish communities using trawl survey data. The results serve as a baseline for future biodiversity studies in the region and also identify community spatio-temporal fluctuations versus true shifts.

V. Christensen, M. Coll, J. Buszowski, W. W. Cheung, T. Frolicher, J. Steenbeek, C. Stock, R. Watson and C. J. Walters. (2015). The global ocean is an ecosystem: simulating marine life and fisheries. Global Ecology and Biogeography, 24 (5): 507-517.

This article explores the impacts on upper-trophic-level organisms from both climate change and fisheries using a new modelling complex. LMEs were used as the spatial boundaries for reporting the findings of this study, and the work built on previous modelling efforts using LMEs.

M. Colleter, A. Valls, J. Guitton, D. Gascuel, D. Pauly and V. Christensen. (2015). Global overview of the applications of the Ecopath with Ecosim modeling approach using the EcoBase models repository. Ecological Modelling, 302: 42-53.

This paper compiled 433 unique Ecopath with Ecosim (EwE) models developed since 1984 and characterized these models and their evolution. During the characterization, EwE models were classified by geographic location. One approach was to document the models by LME and identify which LMEs have the most/least EwE models.

R. Gamito, M. J. Costa and H. N. Cabral. (2015). Fisheries in a warming ocean: trends in fish catches in the large marine ecosystems of the world. Regional Environmental Change, 15 (1): 57-65.

This article compared changes in SST with trends in annual fish catch in LMEs. The results indicate a poleward shift of species in response to warming SST.

S. P. Kirkman, D. Yemane, L. J. Atkinson, J. Kathena, S. E. Nsiangango, L. Singh, B. E. Axelsen and T. Samaai. (2015). Regime shifts in demersal assemblages of the Benguela Current Large Marine Ecosystem: a comparative assessment. Fisheries Oceanography, 24: 15-30.

This article explores the demersal faunal communities of the BCLME using long-term survey data to identify changes in these communities. Shifts are described at the country level for the three nations adjacent to the BCLME.

S. I. Large, G. Fay, K. D. Friedland and J. S. Link. (2015). Quantifying patterns of change in marine ecosystem response to multiple pressures. PLoS One, 10 (3): e0119922.

This study applied ecological indicators to the Northeast Shelf LME to understand how this ecosystem responds to environmental and anthropogenic pressures.

M. H. Monk, J. E. Powers and E. N. Brooks. (2015). Spatial patterns in species assemblages associated with the northwestern Gulf of Mexico shrimp trawl fishery. Marine Ecology Progress Series, 519: 1-12.

This feature article explores the bycatch species of the shrimp trawl fishery in the Gulf of Mexico LME. The spatial dynamics of the demersal fish community associated with this fishery were investigated using data from the Southeast Area Monitoring and Assessment Program.

P. Pepin, C. L. Johnson, M. Harvey, B. Casault, J. Chasse, E. B. Colbourne, P. S. Galbraith, D. Hebert, G. Lazin, G. Maillet, S. Plourde and M. Starr. (2015). A multivariate evaluation of environmental effects on zooplankton community structure in the western North Atlantic. Progress in Oceanography, 134: 197-220.

For more than 12 years, this study examined the zooplankton community structure of the Newfoundland Shelf LME, the Gulf of St. Lawrence LME, and the Scotian Shelf LME to evaluate the relationships between community structure and environmental factors.

S. E. Piacenza, A. K. Bamer, C. E. Benkwitt, K. S. Boersma, E. B. Cemy-Chipman, K. E. Ingeman, T. L. Kindinger, J. D. Lee, A. J. Lindsley, J. N. Reimer, J. C. Rowe, C. Shen, K. A. Thompson, L. L. Thurman and S. S. Heppell. (2015). Patterns and Variation in Benthic Biodiversity in a Large Marine Ecosystem. PLoS One, 10 (8): e0135135.

This article presents benthic marine fauna biodiversity patterns in the California Current LME detected from a large-scale, public-monitoring database. Important descriptors of fish and invertebrate species diversity included year, substrate, latitude, and depth.

S. E. Piacenza, L. L. Thurman, A. K. Barner, C. E. Benkwitt, K. S. Boersma, E. B. Cerny-Chipman, K. E. Ingeman, T. L. Kindinger, A. J. Lindsley, J. Nelson, J. N. Reimer, J. C. Rowe, C. Shen, K. A. Thompson and S. S. Heppell. (2015). Evaluating Temporal Consistency in Marine Biodiversity Hotspots. PLoS One, 10 (7): e0133301.

This article describes an objective approach to investigate the temporal consistency of biodiversity hotspots within LMEs. The approach was applied to the California Current LME and determined that static measurements are insufficient for identifying biodiversity hotspot for mobile species.

M. L. Pinsky and D. Byler. (2015). Fish, fast growth and climate variability increase the risk of collapse. Proceedings of the Royal Society B: Biological Sciences, 282: 20151053.

This article explores the possibility that climate change and its interactions with harvest dynamics may change the general rule of slow-growing marine fish populations being the most at risk of collapse. LMEs were used as the spatial units for this global study.

K. L. Scales, P. I. Miller, N. Varo-Cruz, D. J. Hodgson, L. A. Hawkes and B. J. Godley. (2015). Oceanic loggerhead turtles *Caretta caretta* associate with thermal fronts: evidence from the Canary Current Large Marine Ecosystem. Marine Ecology Progress Series, 519: 195-207.

The Canary Current LME was the study area for this paper, which examined the association of loggerhead sea turtles (*Caretta caretta*) with thermal fronts. The authors found that, due to the aggregation of their prey species, turtles forage epipelagically around mesoscale thermal fronts within the upwelling region.

M. Skern-Mauritzen, G. Ottersen, N. O. Handegard, G. E. Dingser, N. C. Stenseth and O. S. Kjesbu. (2015). Ecosystem processes are rarely included in tactical fisheries management. Fish and Fisheries, 17 (1): 165-175.

For this study, the authors reviewed more than 1,200 marine fish stocks and found that only 24 showed ecosystem drivers were implemented in their management, with most located in the North Atlantic and northeast Pacific. LMEs were used as the geographic boundaries within which scientific support in these regions was evaluated.

C. A. Stock, K. Pegion, G. A. Vecchi, M. A. Alexander, D. Tommasi, N. A. Bond, P. S. Fratantoni, R. G. Gudgel, T. Kristiansen, T. D. O'Brien, Y. Xue and X. Yang. (2015). Seasonal sea surface temperature anomaly prediction for coastal ecosystems. Progress in Oceanography, 137: 219-236.

This article explores SST anomaly predictions within the context of LMEs, starting with well-studied U.S. LMEs and expanding to the global scale. The findings suggest that forecast systems must be refined, but present predictions are still useful for integration into marine resource management.

T. M. Thys, J. P. Ryan, H. Dewar, C. R. Perle, K. Lyons, J. O'Sullivan, C. Farwell, M. J. Howard, K. C. Weng, B. E. Lavaniegos, G. Gaxiola-Castro, L. E. M. Bojorquez, E. L. Hazen and S. J. Bograd. (2015). Ecology of the Ocean Sunfish, *Mola mola*, in the Southern California Current System. Journal of Experimental Marine Biology and Ecology, 471: 64-76.

This tagging study explored the movement of *Mola mola* in the California Current LME. Findings suggest that favorable foraging habitat is created by biophysical interactions with coastal upwelling fronts.

I. Trindade-Santos and K. M. F. Freire. (2015). Analysis of reproductive patterns of fishes from three Large Marine Ecosystems. Frontiers in Marine Science, 2: 38.

This article presents the findings of a study that analyed the reproductive patterns of marine fishes in the three Brazilian LMEs. Trends in these LMEs were compared and contrasted.

D. Yemane, S. K. Mafwila, J. Kathena, S. E. Nsiangango and S. P. Kirkman. (2015). Spatio-temporal trends in diversity of demersal fish species in the Benguela current large marine ecosystem region. Fisheries Oceanography, 24: 102-121.

For more than 25 years, the authors studied the diversity of demersal fish species in the BCLME. Scientific survey data was used to identify trends in species richness across depth and latitude. Results indicate significant differences across the three BCLME countries.

D. Alemany, E. M. Acha and O. Iribarne. (2016). Distribution and intensity of bottom trawl fisheries in the Patagonian Shelf Large Marine Ecosystem and its relationship with marine fronts. Fisheries Oceanography, 25 (2): 1-10.

This study used VMS data from 2006 to 2012 to explore bottom trawl fishing in the Patagonian Shelf Large Marine Ecosystem (PSLME). The findings suggest that the magnitude of the effect of bottom trawling on marine habitats in the PSLME is relatively small. The authors also found more trawling effort than expected at the shelf-break front, one of three main oceanic fronts explored in this study.

D. Belhabib, A. Mendy, Y. Subah, N. T. Broh, A. S. Jueseah, N. Nipey, W. W. Boeh, N. Willemse, D. Zeller and D. Pauly. (2016). Fisheries catch under-reporting in The Gambia, Liberia and Namibia and the three large marine ecosystems which they represent. Environmental Development, 17 (1): 157-174.

This study compares the reconstructed fisheries catches from three West African countries, each representing an LME, with the fisheries data reported to the FAO. The authors found that both The Gambia and Liberia, representing the CCLME and the GCLME, were grossly underreported, while in Namibia, the catch reconstruction almost matched the FAO data. This result was primarily attributed to Namibia's measures to prevent illegal fishing.

I. M. Belkin. (2016). Comparative assessment of the West Bering Sea and East Bering Sea Large Marine Ecosystems. Environmental Development, 17 (1): 145-156.

In this article, Belkin compares LMEs in the West and East Bering Seas using their geographical, bathymetric, and geomorphological characteristics, which will have implications for their climate, circulation, frontal patterns, and productivity.

Y. Dong, R. K. Rosenbaum and M. Z. Hauschild. (2016). Assessment of Metal Toxicity in Marine Ecosystems: Comparative Toxicity Potentials for Nine Cationic Metals on Coastal Seawater. Environmental Science and Technology, 50 (1): 269-278.

This study uses LMEs as the geographic scale at which to develop comparative toxicity potentials (CTPs) or ecotoxicity characterization factors for metals in the marine environment. LMEs with the longest seawater residence times were also found to have the highest metal toxicity potential.

M. Fogarty, A. A. Rosenberg, A. B. Cooper, M. Dickey-Collas, B. Fulton, N. Gutiérrez, K. J. W. Hyde, K. M. Kleisner, T. Kristiansen, C. Longo, C. Minte-Vera , C. Minto, I. Mosqueira, G. C. Osio, D. Ovando, E. R. Selig, J. T. Thorson and Y. Ye. (2016). Fishery Production Potential of Large Marine Ecosystems: A Prototype Analysis. Environmental Development, 17 (1): 211-219.

This project estimated marine ecosystem productivity using satellite-based estimates of primary productivity by size classes with food webs containing more information relative to previous food webs. The results suggest that the overall fishery production potential of LMEs is 180 million metric tons.

J. Kathena, A. Nielsen, U. H. Thygesen and C. W. Berg. (2016). Hake species (*Merluccius capensis* and *M. paradoxus*) assessment in the Benguela Current Large Marine Ecosystem. Environmental Development, 17 (1): 193-201.

This paper assessed two species of hake in the BCLME off Namibia, which have traditionally been managed as one stock. The authors explore the tradeoffs between species-specific and species-combined stock assessments.

J. A. Koslow and P.C. Davison. (2016). Productivity and biomass of fishes in the California Current Large Marine Ecosystems: Comparison of fishery-dependent and -independent time series. Environmental Development, 17 (1): 23-32.

This study compared ichthyoplankton data from the California Cooperative Oceanic Fisheries Investigation (CalCOFI) with data from commercial fisheries to explore the relationship between fisheries landings and ichthyoplankton abundance in the California Current LME between 1951 and 2011. The results highlight the need for sustained fishery-independent time series data.

R. Y. Lee, S. Seitzinger, and E. Mayorga. (2016). Land-based nutrient loading to LMEs: A global watershed perspective on magnitudes and sources. Environmental Development, 17 (1): 220-229.

This study explored land-based dissolved inorganic nitrogen (DIN) loading to LMEs. The findings suggest that in most LMEs, anthropogenic sources account for more than 50% of the total DIN load, mostly related to agricultural sources.

G. G. Matishov, S. L. Dzhenyuk, D. V. Moiseev and A. P. Zhichkin. (2016). Trends in hydrological and ice conditions in the Large Marine Ecosystems of the Russian Arctic during periods of climate change. Environmental Development, 17 (1): 33-45.

This article presents current climatic trends in two LMEs: the Barents Sea and the Kara Sea. Russian observational data and other external information sources were used to identify a warming period replaced by a cooling trend of water masses accompanied by a decrease in ice cover.

B. Sambe, M. Tandstad, A. M. Caramelo and B. E. Brown. (2016). Variations in productivity of the Canary Current Large Marine Ecosystem and their effects on small pelagic fish stocks. Environmental Development, 17 (1): 105-117.

This article discusses the Canary Current Large Marine Ecosystem (CLME) and its important fish stocks. A downward trend in primary production with decreased upwelling and a net warming of the system has been detected in the region. Dynamics such as these within the CCLME system should be the focus of future studies.

K. I. Stergiou, S. Somarakis, G. Triantafyllou, K. P. Tsiaras, M. Giannoulaki, G. Petihakis, A. Machias, and A. C. Tsikliras. (2016). Trends in productivity and biomass yields in the Mediterranean Sea Large Marine Ecosystem during climate change. Environmental Development, 17 (1): 57-74.

This article explores climate change in the Mediterranean Sea LME using fisheries catch data on yearly catch, species composition, and mean temperature of the catch. Different models are also used to explore this topic, including habitat models and a full lifecycle population model for anchovy biomass.

U. R. Sumaila. (2016). Socio-economic benefits of Large Marine Ecosystem valuation: The case of the Benguela Large Marine Ecosystem. Environmental Development, 17 (1): 244-248.

For this article, Sumaila conducted an economic valuation of some of the goods and services supported by the BCLME, including fisheries, marine recreational activities, and mariculture. His findings suggest that these services support approximately 75,000 jobs and have a direct economic impact of more than half a billion USD.

Q. Tang, Y. Ying and Q. Wu. (2016). The biomass yields and management challenges for the Yellow sea large marine ecosystem. Environmental Development, 17 (1): 175-181.

This article builds on a previous publication by one of the authors on adaptive management strategies in the YSLME. This paper explores changes in YSLME biomass yields and potential drivers of this change.

C. D. van der Lingen, L. Hutchings, T. Lamont and G. C. Pitcher. (2016). Climate change, dinoflagellate blooms and sardine in the southern Benguela Current Large Marine Ecosystem. Environmental Development, 17 (1): 230-243.

This article explores harmful algal blooms in the Benguela Current Large Marine Ecosystem (BCLME) using data from a bloom in 2011. The results suggest that sardine were more negatively impacted by the bloom relative to other species, and the authors speculate why this occurred.

Verheye, H. M., Lamont, T., Huggett, J. A., Kreiner, A. and I. Hampton. (2016). Plankton productivity of the Benguela Current Large Marine Ecosystem (BCLME). Environmental Development, 17 (1): 75-92.

This paper describes changes in phytoplankton biomass, production, species and size composition, and abundance due to environmental drivers in the BCLME. The authors emphasize the importance of phytoplankton as indicators of ecosystem change and the need to continue monitoring in the BCLME.

Vivekanandan, E., Hermes, R., and C. O'Brien. (2016). Climate change effects in the Bay of Bengal Large Marine Ecosystem. Environmental Development, 17 (1): 46-56.

This article explores the impacts of climate change in the Bay of Bengal and the efforts made by the Bay of Bengal LME project toward understanding these impacts and adapting through building the capacity and resilience of coastal communities while also managing pollution, fisheries, and habitat.

G. Wiafe, E. Dovlo and K. Agyekum. (2016). Comparative productivity and biomass yields of the Guinea Current LME. Environmental Development, 17 (1): 93-104.

This article presents the results of a plankton production study undertaken in the GCLME during the pilot phase of the GCLME project. Data was obtained from Continuous Plankton Recorder tows and identified trends in plankton yields, community composition, and abundance. This data provides a baseline for future studies.

Group Five

J. R. Morgan. (1987). Large Marine Ecosystems: an emerging concept of regional management. Environment, 29 (10): 4-34.

This article presents the LME concept with a focus on fisheries. Three LMEs are presented as case studies: the Indonesian Seas, the Sea of Japan, and the Southern Ocean. Issues for LMEs are also addressed.

K. Sherman. (1991). The large marine ecosystem concept: research and management strategy for living marine resources. Ecological Applications, 1 (4): 349-360.

The LME concept is introduced in this article with a special focus on the management of living marine resources.

L. M. Alexander. (1993). Large Marine Ecosystems: a new focus for marine resources management. Marine Policy, 186-198.

This article describes the concept of LMEs and their suitability as geographic units for regional marine resource management.

R. C. Francis and S. R. Hare. (1994). Decadal scale regime shifts in the large marine ecosystems of the North-East Pacific: a case for historical science. Fisheries Oceanography, 3: 279-291.

This article presents the issue of the shrinking scale at which components of marine ecosystems are being studied. The authors argue for an understanding of order at the scale of LMEs and use an historical–descriptive approach to science, specifically exploring the abundance and distribution of salmon and zooplankton in the Gulf of Alaska LME.

K. Sherman. (1994). Review: Sustainability, biomass yields, and health of coastal ecosystems: an ecological perspective. Marine Ecology Progress Series, 112: 277-301.

This review article discusses the UNCED objectives of the scientific framework being developed to improve the monitoring and assessment of coastal ecosystems for mitigating stressors such as nutrient over-enrichment. Sherman argues for a more holistic and ecology-based strategy for coastal resource management and presents the LME concept.

K. Sherman. (1995). Achieving regional cooperation in the management of marine ecosystems: the use of the large marine ecosystem approach. Ocean & Coastal Management, 29 (1-3): 165-185.

This article describes concerns over the deteriorating condition of coastal ecosystems across the globe within the context of UNCED. The LME approach to managing marine resources is presented with descriptions of the five modules.

R. B. Griffis and K. W. Kimball. (1996). Ecosystem approaches to coastal and ocean stewardship. Ecological Applications, 6 (3): 708-712.

This 1996 paper on ecosystem management presents LMEs as one of two major systems approaches to ocean and coastal management. The article reviews the approach and compares it with Integrated Coastal Management.

D. Pauly. (1998). Large marine ecosystems: analysis and management. South African Journal of Marine Science, 19 (1): 487-499.

This article addresses the argument that Longhurst's 57 biochemical provinces are a more appropriate standard for global stratification than are LMEs, based on their ability to facilitate direct comparisons of studies from different disciplines. Pauly uses the competition between fisheries and marine mammals in the Pacific Ocean to argue for the use of LMEs. Pauly also calls for the reconstruction of ecosystems to establish baselines for studying the impact of fisheries in LMEs.

L. Juda. (1999). Considerations in Developing a Functional Approach to the Governance of Large Marine Ecosystems. Ocean Development & International Law, 30: 89-125.

This article describes the governance problems, concepts, and principles for implementing effective marine ecosystem management through LMEs.

S.-G. Lee and J. G. Sutinen. (1999). Large marine ecosystems, socioeconomic and governance: Implications for Korea. Korea Observer, 30 (1).

This article explores the LME concept for managing the marine environment with a focus on the human dimensions of the framework. The authors present a methodology for these human dimensions (socioeconomics and governance) using the YSLME, including recommendations for research in the nations adjacent to the LME.

K. Sherman and A. M. Duda. (1999). Large Marine Ecosystems: An emerging paradigm for fishery sustainability. Fisheries, 24 (12): 15-26.

This article describes the modular framework for LME assessment and management within the context of fishery sustainability. Current LME projects are discussed.

K. Sherman and A. M. Duda. (1999). Review: An ecosystem approach to global assessment and management of coastal waters. Marine Ecology Progress Series, 190: 271-287.

This review article presents the issue of the decline of coastal ecosystems and describes the modular ecosystems approach for the assessment and management of coastal ecosystems across the globe. The GEF and its current work assisting developing countries to implement this approach are discussed.

K. Sherman. (2000). Why regional coastal monitoring for assessment of ecosystem health? Ecosystem Health, 6 (3): 205-216.

This article discusses both the public and scientific concern over coastal environmental degradation and recent actions to resolve these problems at both national and international scales. EBM, LMEs, and the five modules are presented.

L. Juda and T. Hennessey. (2001). Governance profiles and the management of the uses of large marine ecosystems. Ocean Development & International Law, 32: 43-69.

This article focuses on the governance module of the five-module framework for LME assessment and management. The authors describe three primary governance institutions and present the need to develop governance profiles for each LME, which will serve as a baseline study for gauging change over time.

K. Sherman and A. M. Duda. (2001). Toward ecosystem-based recovery of marine biomass yield. Ambio, 30 (3): 168-169.

This synopsis article addresses the claim that we have reached the maximum global level of primary production for sustainable average biomass yield of fisheries. The article also recommends ecosystem-based assessment and management practices for the recovery of global fisheries resources within the context of LMEs.

A. M. Duda and K. Sherman. (2002). A new imperative for improving management of large marine ecosystems. Ocean & Coastal Management, 45 (11-12): 797-833.

This article describes the work of the GEF in supporting the adoption by developing nations of ecosystem-based management of marine resources in LMEs. Some of the features and early results of LME projects are presented and discussed. The five-module approach for LME assessment and management is presented, and some LME projects are discussed in-depth.

A. M. Duda. (2003). Integrated management of land and water resources based on a collective approach to fragmented international conventions. Philosophical Transactions of the Royal Society B: Biological Sciences, 358 (1440): 2051-2062.

In this article, Duda describes global environmental management challenges and the risks associated with a lack of integrated management approaches. The article presents results from GEF transboundary water projects, including LME projects such as the BCLME.

F. J. Gable. (2003). A Practice-Based Coupling of the Precautionary Principle to the Large Marine Ecosystem Fisheries Management Concept with a Policy Orientation: The Northeast United States Continental Shelf as a Case Example. Coastal Management, 31 (4): 435-456.

This article explores the interdisciplinary, sustainable aspects of fisheries within the context of LMEs, using the Northeast U.S. Continental Shelf LME as an example.

A. Longhurst. (2003). The symbolism of large marine ecosystems. Fisheries Research, 61 (1-3): 1-6.

This viewpoint article argues that the LME concept is too broad to accomplish actual progress. Although it does raise awareness of the need for fisheries research at the ecosystem scale, the fisheries science reported in LME volumes is not actually initiated by LME projects but by national agencies.

K. Sherman, T. Ajayi, E. Anang, P. Cury, M. C. M. Pierre Freon, N. J. Hardman-Mountford, C. A. Ibe, K. A. Koranteng, J. McGlade, C. E. C. Cornelia Nauen, D. Pauly, P. A. G. M. Scheren, H. R. Skjoldal, Q. Tang, S. G. Zabi and A. J. Diaz-de-Leon. (2003). Suitability of the large marine ecosystem concept. Fisheries Research, 64 (2-3): 197-204.

This letter to the editor discusses the suitability of the large marine ecosystem concept and addresses criticisms of the concept from Longhurst's 2003 paper. The critique discussed the North Atlantic and Gulf of Guinea LMEs, and this response addresses those areas as well.

C. N. Ukwe, C. A. Ibe, B. I. Alo and K. K. Yumkella. (2003). Achieving a paradigm shift in environmental and living resources management in the Gulf of Guinea: the large marine ecosystem approach. Marine Pollution Bulletin, 47 (1-6): 219-225.

This article describes the Gulf of Guinea and the paradigm shift in coastal and marine resource management achieved through the large marine ecosystem approach. The authors discuss the environmental issue of pollution faced by this region and the GEF-funded project to address it.

A. Escofet and I. Espejel. (2004). Geographic Indicators of Coastal Orientation and Large Marine Ecosystems: Alternative Basis for Management-Oriented Cross-National Comparisons. Coastal Management, 32 (2): 117-128.

This study used geographic indicators of coastal orientation and LMEs to create a two-coordinate matrix with which to examine coastal countries. The matrix was applied to 11 coastal countries in the Americas. The authors conclude that this matrix may serve as an important tool for rapid cross-country comparisons.

H. Wang. (2004). An Evaluation of the Modular Approach to the Assessment and Management of Large Marine Ecosystems. Ocean Development & International Law, 35 (3): 267-286.

Within the context of LMEs, this article discusses the five-module approach for assessment and management as well as the transboundary diagnostic analysis (TDA), strategic action program (SAP), and national action plan as tools in LME projects.

H. Wang. (2004). Ecosystem Management and Its Application to Large Marine Ecosystems: Science, Law, and Politics. Ocean Development & International Law, 35 (1): 41-74.

This article discusses the science, law, and politics of ecosystem management within the context of LMEs.

A. Yáñez-Arancibia and J. C. Day. (2004). The Gulf of Mexico: towards an integration of coastal management with large marine ecosystem management. Ocean & Coastal Management, 47: 537-563.

This paper is an introductory article to a special issue on the GoM LME. It presents the Gulf as an LME and describes some of the major threats to the marine resources of this region and the bilateral efforts to address these threats with integrated coastal management.

A. M. Duda. (2005). Contributing to ocean security: Global Environment Facility support for integrated management of land-sea interactions. Journal of International Affairs, 59 (1): 179-201.

This article first presents the numerous problems surrounding ocean and coastal resources and the complications these cause for effective management. The majority of the paper describes the GEF's efforts to support integrated ocean and coastal management with specific references to LMEs.

A. M. Duda. (2005). Targeting development assistance to meet WSSD goals for large marine ecosystems and small island developing states. Ocean & Coastal Management, 48 (1): 1-14.

In this article, Duda provides examples of GEF projects to outline GEF development assistance for developing countries. Between 1991 and 2003, the GEF approved 105 projects totaling $2.71 billion through both coastal and ocean focal areas: biodiversity and international waters. These projects are developed for specific LMEs along the coasts of economically developing countries and use the LME assessment and management approach.

K. Hyun. (2005). Transboundary Solutions to Environmental Problems in the Gulf of California Large Marine Ecosystem. Coastal Management, 33 (4): 435-445.

This article assesses the Gulf of California LME using the five-module approach to develop a TDA that identifies three primary issues: (i) pollution, (ii) habitat destruction, and (iii) fishery depletions. The author presents solutions to these problems and emphasizes the need to reconnect the Gulf of California and the Colorado River.

K. Sherman, M. Sissenwine, V. Christensen, A. Duda, G. Hempel, C. A. Ibe, S. A. Levin, D. Lluch-Belda, G. G. Matishov, J. McGlade, M. J. O'Toole, S. Seitzinger, R. Serra, H. R. Skjoldal, Q. Tang, J. Thulin, V. Vandeweerd and K. C. T. Zwanenburg. (2005). A global movement toward an ecosystem approach to management of marine resources. Marine Ecology Progress Series, 300: 275-279.

This article introduces a theme section on the politics of ecosystem-based management and discusses the global movement toward the ecosystem approach to marine resource management, specifically through the LME approach.

A. M. Duda. (2006). Policy, legal and institutional reforms for public-private partnerships needed to sustain large marine ecosystems of East Asia. Ocean & Coastal Management, 49 (9-10): 649-661.

This article presents the issue of marine environmental degradation in East Asia, arguing for reforms centered on the creation of public–private partnerships to improve industries and reduce their impacts on marine and coastal waters and their associated resources. The GEF projects in East Asia are presented, and their focus on integrated coastal management for LMEs is emphasized.

R. Payet. (2006). Decision processes for large marine ecosystems management and policy. Ocean & Coastal Management, 49 (3, 4): 110-132.

This study presents the findings of a pressure-state-response model as part of an indicator-based study in the Seychelles. Payet found the precautionary principle is used by Seychelles policy-makers in most situations. These policy-makers are sensitive to public opinion and favor “control-and-command” and market mechanisms for living marine resource management.

L. J. Shannon, P.M. Cury, D. Nel, C. D. van der Lingen, R. W. Leslie, S. L. Brouwer, A. C. Cockcroft and L. Hutchings. How can science contribute to an ecosystem approach to pelagic, demersal and rock lobster fisheries in South Africa? African Journal of Marine Science, 28 (1): 115-157.

This article reviews the progress made toward implementing an Ecosystem Approach to Fisheries (EAF) in South Africa through the Benguela Current Large Marine Ecosystem Program. The article focuses on three key fisheries in the region—pelagic, demersal, and rock lobster—and the research and monitoring efforts to address ecosystems.

K. Sherman. (2006). The Large Marine Ecosystem network approach to WSSD targets. Ocean & Coastal Management, 49 (9-10): 640-648.

This article discusses GEF LME projects in the context of achieving World Summit on Sustainable Development (WSSD) targets. Sherman focuses on the reduction of land-based sources of pollution, the designation of MPA networks, and the restoration of fisheries within the context of LME projects.

C. N. Ukwe, C. A. Ibe, P. C. Nwilo and P. A. Huidobro. (2006). Contributing to the WSSD Targets on Oceans and Coasts in West and Central Africa: the Guinea Current Large

Marine Ecosystem Project. International Journal of Oceans and Oceanography, 1 (1): 21-44.

This article describes the GCLME program within the context of the WSSD targets and describes how the implementation of the SAP will help achieve the targets.

C. N. Ukwe, C. A. Ibe and K. Sherman. (2006). A sixteen-country mobilization for sustainable fisheries in the Guinea Current Large Marine Ecosystem. Ocean & Coastal Management, 49 (7-8): 385-412.

This article describes the GCLME projects, which successfully mobilized 16 countries in western Africa with assistance from the GEF and UNIDO.

P. Verlaan. (2006). Current Legal Developments: Bay of Bengal. The International Journal of Marine and Coastal Law, 21 (1): 111-118.

This paper describes the current legal developments in the Bay of Bengal made through the BOBLME project. A project brief is provided and the relevant international legal instruments are presented.

L. Fanning, R. Mahon, P. McConney, J. Angulo, F. Burrows, B. Chakalall, D. Gil, M. Haughton, S. Heileman, S. Martínez, L. O. Ostine, A. Oviedo, S. Parsons, T. Phillips, C. Santizo Arroya, B. Simmons and C. Toro. (2007). A large marine ecosystem governance framework. Marine Policy, 31 (4): 434-443.

This paper first presents the large marine ecosystem governance framework for the sustainable management of the living marine resources in the Wider Caribbean Region. The framework identified critical areas for intervention using a variety of governance factors.

M. Bavinck and V. Salagrama. (2008). Assessing the governability of capture fisheries in the Bay of Bengal—a conceptual enquiry. The Journal of Transdisciplinary Environmental Studies, 7 (1): 1-13.

This article discusses governability as it applies to capture fisheries in the Bay of Bengal. One focus of the work is the setting of governance boundaries. The authors present LMEs as an ecological designation, and non-governmental fisher councils as a social designation, concluding that both delineations have strengths and weaknesses.

K. Coleman. (2008). Research Review of Collaborative Ecosystem-Based Management in the California Current Large Marine Ecosystem. Coastal Management, 36 (5): 484-494.

In this article, Coleman reviews ecosystem-based management in the California Current Large Marine Ecosystem (CCLME), which required the collaboration of states along the U.S. West Coast. The LME approach to EBM is presented in the introduction, which precedes a detailed examination of marine resource management in the CCLME region.

P. Hoagland and D. Jin. (2008). Accounting for marine economic activities in large marine ecosystems. Ocean & Coastal Management, 51 (3): 246-258.

This article presents a new index to measure the intensity of marine activities in the context of LMEs. The authors compare the index with a regional socioeconomic development index and identify regions with the potential to achieve sustainable development as targets for future international financial assistance.

R. Siron, K. Sherman, H. R. Skjoldal and E. Hiltz. (2008). Ecosystem-based management in the Arctic Ocean: a multi-level spatial approach. Arctic, 61 (1): 86-102.

This article describes the major ecological features of the 17 Arctic LMEs. The Beaufort Sea Large Ocean Management Area (LOMA) is presented as a case study highlighting Canada's national spatial framework and integrated ocean management. This approach is compared to the LME approach. They are found to be complementary given their different spatial and governance levels.

D. Vousden, L. E. P. Scott, W. Sauer, T. G. Bornman, M. Ngoile, J. Stapley and J. R. E. Lutjeharms. (2008). Establishing a basis for ecosystem management in the western Indian Ocean. South African Journal of Science, 104 (11-12): 417-420.

This article describes the research cruises in the ASCLME region for the purpose of establishing a basis for the implementation of ecosystem-based management. The authors describe the ASCLME project and the need for these research cruises, capacity building, and data and information management.

J. Aristegui, E. D. Barton, X. A. Alvarez-Salgado, A. M. P. Santos, F. G. Figueiras, S. Kifani, S. Hernandez-Leon, E. Mason, E. Machu and H. Demarcq. (2009). Sub-regional ecosystem variability in the Canary Current upwelling. Progress in Oceanography, 83 (1-4): 33-48.

This paper introduces the Canary Current upwelling ecosystem as a large marine ecosystem characterized by high productivity. Recent observations indicate that this region is experiencing increased warming accompanied by decreased productivity. The authors update recent information on the Canary Current upwelling ecosystem and conclude that subregional differences in fish abundance and distribution may be explained by the variability of factors including coastline configuration, shelf width, coastal upwelling, and productivity. Other factors include nutrient fertilization, and retentive versus dispersive physical mechanisms.

N. A. Chukwuone, C. N. Ukwe, A. Onugu and C. A. Ibe. (2009). Valuing the Guinea Current large marine ecosystem: Estimates of direct output impact of relevant marine activities. Ocean & Coastal Management, 52 (3-4): 189-196.

This study provides a preliminary valuation of the GCLME in the interest of supporting restoration and conservation efforts. The authors estimate that the total value of output of this LME is $49,941.4 million, with offshore oil accounting for more than half of that figure.

K. L. Cochrane, C. J. Augustyn, T. Fairweather, D. Japp, K. Kilongo, J. Iitembu, N. Moroff, J. P. Roux, L. Shannon, B. Van Zyl and F. Vaz Velho. (2009). Benguela Current Large Marine Ecosystem—Governance and Management for an Ecosystem Approach to Fisheries in the Region. Coastal Management, 37 (3-4): 235-254.

This paper evaluates the present status of coastal and marine management in the BCLME and presents the strengths and weaknesses of the current management approach. The authors argue that all three participating countries have employed the single-sector conventional approaches to fisheries management, but have still made progress toward addressing problems at the ecosystem scale.

L. Fanning, R. Mahon and P. McConney. (2009). Focusing on Living Marine Resource Governance: The Caribbean Large Marine Ecosystem and Adjacent Areas Project. Coastal Management, 37 (3-4): 219-234.

This paper reviews the Caribbean LME in the context of ecosystem-based living marine resource management at the LME-scale in preparation for the governance reforms to be undertaken by the Caribbean LME and Adjacent Areas Project. The authors provide a comprehensive overview of governance in the region and introduce the LME Governance Framework as a solution for achieving effective management in this complex system.

Y. Li, Y. Chen, D. Olson, N. Yu and L. Chen. (2009). Evaluating ecosystem structure and functioning of the East China Sea Shelf ecosystem, China. Hydrobiologia, 636 (1): 331-351.

A trophic mass–balance model was developed in this study to characterize the structure and function of the East China Sea Shelf LME. The findings support the need for the development of an ecosystem-based fisheries management regime to address the issues of eutrophication and the depletion of fisheries resources.

R. Mahon, L. Fanning and P. McConney. (2009). A governance perspective on the large marine ecosystem approach. Marine Policy, 33 (2): 317-321.

This article questions the use of the LME concept and approach to structure interventions with the goal of improving marine ecosystem management. The article raises concerns that the LME approach is not ideal for governance interventions, which should instead be addressed through multi-level governance policy cycles.

A. Chircop. (2010). Regional cooperation in marine environmental protection in the South China Sea: a reflection on new directions for marine conservation. Ocean Development & International Law, 41 (4): 334-356.

This article argues for more effective management of the SCSLME via transboundary networks of MPAs. Chircop explains that to adapt to climate change, SCS states must prioritize marine conservation in conjunction with development activity.

Y. deReynier, P. S. Levin and N. L. Shoji. (2010). Bringing stakeholders, scientists, and managers together through an integrated ecosystem assessment process. Marine Policy, 34: 534-540.

This article proposes the integrated ecosystem assessment process for shifting from a single-sector management framework toward ecosystem-based management of marine resources. The authors argue that management approaches should consider regional ecosystem issues as nested within LMEs. LMEs and the LME approach are discussed throughout the paper as an appropriate scale for ecosystem management, or rather, for the nesting of smaller sites.

S. M. Lucey and J. A. Nye. (2010). Shifting species assemblages in the Northeast U.S. Continental Shelf Large Marine Ecosystem. Marine Ecology Progress Series, 415: 23-33.

This study explored the fishing and climate pressures influencing the Northeast U.S. Continental Shelf LME and confirms that the assemblages within subregions of the LME are shifting over time due to fishing pressure and climate change.

R. Mahon, L. Fanning, P. McConney and R. Pollnac. (2010). Governance characteristics of large marine ecosystems. Marine Policy, 34 (5): 919-927.

This study shows the considerable differences among the LMEs of the world with regard to factors that influence governance, implying that different approaches will be required to address governance in the various LMEs. The authors also conclude that LMEs can be grouped to create clusters based on the factors influencing governance.

F. B. Schwing, R. Mendelssohn, S. J. Bograd, J. E. Overland, M. Wang and S. Ito. (2010). Climate change, teleconnection patterns, and regional processes forcing marine populations in the Pacific. Journal of Marine Systems, 79 (3-4): 245-257.

This paper describes the key features of five Pacific LMEs: the Humboldt Current, the California Current, the Gulf of Alaska, the Kuroshio Current, and the Oyashio Current. The objective of this work is to understand the mechanisms and impacts of climate change of fluctuations in marine populations.

M. Sowman and P. Cardoso. (2010). Small-scale fisheries and food security strategies in countries in the Benguela Current Large Marine Ecosystem (BCLME) region: Angola, Namibia and South Africa. Marine Policy, 34 (6): 1163-1170.

This paper explores the small-scale fisheries of the Benguela Current LME, comparing the different legal and policy frameworks of the three countries involved in the BCLME Program: Angola, Namibia, and South Africa.

C. N. Ukwe and C. A. Ibe. (2010). A regional collaborative approach in transboundary pollution management in the Guinea Current region of western Africa. Ocean & Coastal Management, 53 (9): 493-506.

This review paper provides an in-depth description of the GCLME project as a regional, collaborative approach to the management of transboundary pollution. The TDA/SAP process, as well as the Guinea Current Commission, is highlighted.

M. Wang, J. E. Overland and N. A. Bond. (2010). Climate projections for selected large marine ecosystems. Journal of Marine Systems, 79 (3-4): 258-266.

This study evaluated the twentieth-century hindcasts of 23 coupled atmosphere–ocean general circulation models within several LMEs. The goal of the study was to identify models capable of simulating large-scale aspects of historical observations to build confidence for their future projections of ocean conditions.

S. M. Ainsley, D. A. Ebert and G. M. Calliet. (2011). A comparison of reproductive parameters of the Bering skate, *Bathyraja interrupta*, from two Alaskan large marine ecosystems. Marine and Freshwater Research, 62 (6): 557-566.

The study area for this article covers two LMEs: the East Bering Sea and the Gulf of Alaska. The authors compared age and growth parameters of the Bering skate (*Bathyraja interrupta*) in these two LMEs. The results of the study indicate that when skates are managed as a single group based on the life-history traits of one species, there may be a substantial over- or under-estimation of the parameters.

K. T. Frank, B. Petrie, J. A. Fisher and W. C. Leggett. (2011). Transient dynamics of an altered large marine ecosystem. Nature, 477 (7362): 86-89

This article describes the collapse of large benthic fishes on Canada's Scotian Shelf and the restructured food webs resulting from this collapse. The authors present evidence that, given management measures in the region, this ecosystem is transient and in the process of returning to the previous regime, with food webs dominated by large benthic fish species. The ecosystem of the Scotian Shelf LME is the focus of this paper.

K. Sherman, J. O'Reilly, I. M. Belkin, C. Melrose and K. D. Friedland. (2011). The application of satellite remote sensing for assessing productivity in relation to fisheries yields of the world's large marine ecosystems. ICES Journal of Marine Science, 68 (4): 667-676.

This article introduces LMEs and the five-module approach for LME assessment and management, with a focus on the use of satellite remote sensing to evaluate changing conditions within LMEs. The article emphasizes two main changes occurring due to climate change: (i) Primary production is decreasing in the lower latitudes; and (ii) Fishery yields are increasing in the Northeast Atlantic LMEs.

H. L. Nash and R. J. McLaughlin. (2012). Opportunities for Trinational Governance of the Ecologically Connected Habitat Sites in the Gulf of Mexico. KMI International Journal of Maritime Affairs and Fisheries, 4 (1): 1-32.

This article presents opportunities for the United States, Mexico, and Cuba to collaborate for improved management of transboundary living marine resources with the goal of developing an international network of MPAs. The paper describes the Gulf of Mexico as an LME and references the GEF/UNIDO GoM LME project.

A. Tengberg and A. S. Cabanban. (2012). Lessons learned from investing in marine and coastal management initiatives in the East Asian seas. Marine Policy, 38: 355-364.

This article assesses the GEF International Waters projects in the seas of the East Asian Region in an effort to guide future LME projects.

M. Valdes-Pizzini, C. G. Garcia-Quijano and M. T. Scharer-Umpierre. (2012). Connecting humans and ecosystems in tropical fisheries: social sciences and the ecosystem-based fisheries management in Puerto Rico and the Caribbean. Caribbean Studies, 40 (2): 95-128.

This article discusses the Caribbean Sea LME and the use of ecosystem-based fisheries management in this region. The authors provide recommendations for improving the application of this approach.

A. M. Duda and A. C. Hume. (2013). A new imperative to harness sound science in the GEF international waters focal area. Environmental Development, 7: 102-108.

This article introduces the GEF International Waters focal area, its importance in addressing transboundary water issues, and example projects. Challenges and approaches for the science–policy interface are also presented.

L. Fanning, R. Mahon and P. McConney. (2013). Applying the large marine ecosystem (LME) governance framework in the Wider Caribbean Region. Marine Policy, 42: 99-110.

This article addresses the LME governance framework within the Wider Caribbean Region. The framework is applied to three examples: the Eastern Caribbean flyfish fishery, MPA management, and the Eastern Caribbean tuna fishery.

V. García-Ríos, L. Alpuche-Gual, J. Herrera-Silveira, J. Montero-Muñoz, S. Morales-Ojeda, D. Pech, M. F. Cepeda-González, O. Zapata-Pérez and G. Gold-Bouchot. (2013). Towards a coastal condition assessment and monitoring of the Gulf of Mexico Large Marine Ecosystem (GoM LME): Terminos Lagoon pilot site. Environmental Development, 7: 72-79.

This article presents the Coastal Condition Index, which consists of five modules (similar, but not identical, to the five modules for LME monitoring and assessment). The index is used to evaluate the Gulf of Mexico LME. The paper also discusses the importance of bilateral agreements for addressing transboundary water issues in the GoM LME.

L. Harris, S. Holness, R. Nel, A. T. Lombard and D. Schoeman. (2013). Intertidal habitat composition and regional-scale shoreline morphology along the Benguela coast. Journal of Coastal Conservation, 17 (1): 143-154.

The Benguela Current Commission called for a spatial biodiversity assessment to assist with conservation planning. To assist with this effort, the authors used aerial imagery to map the distribution of coastal habitats within the context of the BCLME.

A. Telesketsky. (2013). Restoration and Large Marine Ecosystems: Strengthening Governance for an Emerging International Regime Based on "Ecoscape" Management. 35 University of Hawaii Law Review, 735 2013.

This article discusses existing GEF LME projects, restoration efforts at the LME level, and governance institutions supporting such efforts. Telesetsky proposes the use of "ecoscape" interventions for improved LME governance.

J. T. Trevors and P. Weiler. (2013). Challenges, issues and research in transboundary water systems. Environmental Development, 7: 1-5.

This article serves as an introduction to a special issue. The authors review transboundary water systems within the context of LMEs. Trevors describes the GEF support for LME projects through the International Waters focal area.

D. Vousden and J. Stapley. (2013). Evolving new Governance approaches for the Agulhas and Somali Current Large Marine Ecosystems through Dynamic Management Strategies and partnerships. Environmental Development, 7: 32-45.

This paper introduces the Western Indian Ocean Sustainable Ecosystem Alliance (WIOSEA), a coalition forged from regional partnerships developed through the LME projects in the western Indian Ocean. The authors describe WIOSEA exploration of a "Dynamic Management Strategy" for using new scientific information to inform management decisions.

S. M. Ainley, D. A. Ebert, L. J. Natanson and G. M. Cailliet. (2014). A comparison of age and growth of the Bering skate, *Bathyraja interrupta* (Gill and Townsend, 1897), from two Alaskan large marine ecosystems. Fisheries Research, 154: 17-25.

The study area for this article is two LMEs: the East Bering Sea and the Gulf of Alaska. The authors compared age and growth parameters of the Bering skate (*Bathyraja interrupta*) between these two LMEs. The results of the study indicate that when skates are managed as a single group, based on the life-history traits of one species, this may be a substantial over- or under-estimation of the parameters.

K. M. Carlisle. (2014). The Large Marine Ecosystem approach: Application of an integrated, modular strategy in projects supported by the Global Environment Facility. Environmental Development, 11: 19-42.

This article describes the LME approach, with a focus on its use in GEF projects to manage and restore LMEs. Projects and programs of three different LMEs are presented: GoM LME, BCLME, and YSLME.

S. S. Elvin. (2014). The large marine ecosystem approach to assessment and management of polar bears during climate change. Environmental Development, 11: 67-83.

This article applies the adaptive, transboundary, ecosystem-based management approach to the issue of polar bear conservation. The LME framework is used to assess environmental conditions as they relate to this issue and pave the way for conservation of this species during climate change.

K. Sherman. (2014). Adaptive management institutions at the regional level: the case of large marine ecosystems. Ocean & Coastal Management, 90: 38-49.

This paper discussed the movement of developing nations toward ecosystem-based management (EBM) of marine resources at the LME scale through projects funded by the GEF and based on the five-module approach to LME assessment and management. The Yellow Sea LME is presented as an example of the application of EBM practices.

K. Sherman. (2014). Toward ecosystem-based management (EBM) of the world's large marine ecosystems during climate change. Environmental Development, 11: 43-66.

This article discusses the five-module approach to LME assessment and management with a particular focus on nutrient over-enrichment and climate change stressors at the lower latitudes.

M. Sigman, R. Dublin, A. Anderson, N. Deans, J. Warburton, G. I. Matsumoto, D. Dugan and J. Harcharek. (2014). Using large marine ecosystems and cultural responsiveness as the context for professional development of teachers and scientists in ocean sciences. Journal of Geoscience Education, 62: 25-40.

This article describes a series of workshops with K-12 educators and research scientists in Alaska's three LMEs. Lesson plans were developed through collaboration between these two groups. These lesson plans are both place-based and culturally responsive to native Alaskan cultures.

I. Mukuvari, S. K. Mafwila and L. Chimuka. (2015). Measuring the recovery of the Northern Benguela Current Large Marine Ecosystem (BCLME): An application of the DPSIR framework. Ocean & Coastal Management, 119: 227-233.

This study used the DPSIR framework to evaluate the LME approach for recovering marine ecosystems in a multisector and multispecies manner. The results from an analysis of 27 indicators show that the BCLME is showing signs of recovery, but some negative trends persist, including biomass.

J. Abe, B. Brown, E. A. Ajao and S. Donkor. (2016). Local to regional polycentric levels of governance of the Guinea Current Large Marine Ecosystem. Environmental Development, 17 (1): 287-295.

This paper discusses the successes of the Gulf of Guinea LME and GCLME projects in building trust and partnerships in this region. The paper introduces the GEF-funded LME projects, addresses governance in the context of the GOGLME and GCLME, and provides an in-depth discussion of the projects' strategies for building support.

J. Barbière and S. Heileman. (2016). Intergovernmental Oceanographic Commission-UNESCO's support for management of Large Marine Ecosystems. Environmental Development, 17 (1): 349-352.

This commentary describes the initiatives of the Intergovernmental Oceanographic Commission (IOC) of the United Nations Education, Scientific and Cultural Organization (UNESCO) LME. These are the Transboundary Waters Assessment Programme of the LME: Learning Exchange and Resources Network project and annual LME Consultative Committee meetings.

V. d. Barros Neto, M. d. F. Jardim, J. M. B. d. Vasconcelos, A. d. S. Tomás, A. Naruseb, B. Esau, O. Kandjoze, P. Shifeta, D. Peters, E. Molewa, N. Ramatlhodi, S. Zokwana and H. Hamukuaya. (2015). Two decades of inter-governmental collaboration: Three developing countries on the move towards ecosystem-based governance in the Benguela Current Large Marine Ecosystem. Environmental Development, 17 (1): 349-352.

This paper discusses the achievements of the three countries in southern Africa involved in the management of the Benguela Current LME: Angola, Namibia, and South Africa. The article focuses on the Benguela Current Commission.

V. Bers, I. Porsché and G. Finke. (2016). Supporting sustainable ocean development planning for Large Marine Ecosystems. Environmental Development, 17 (1): 338-339.

This article discusses the commitment of the BCLME countries to use the process of Marine Spatial Planning (MSP). The partnership with the Deutsche Gesellschaft fur Internationale Zusammenarbeit (GIZ) and its project identifying Ecologically or Biologically Significant Areas (EBSA) in the BCLME are described.

G. Bianchi, Å. Bjordal, K. A. Koranteng, M. Tandstad, B. Sambe and T. Stromme. (2016). Collaboration between the Nansen Programme and the Large Marine Ecosystem Programmes. Environmental Development, 17 (1): 340-348.

This article discusses the EAF-Nansen Project and its role as a partner of LME projects in Africa, specifically the ASCLME, BCLME, CCLME, and GCLME projects. These partnerships and their mutual benefits are reviewed.

G. Bianchi, S. Funge-Smith, R. Hermes, C. O'Brien, B. Sambe and M. Tandstad. (2016). Sustainable fisheries within an LME context. Environmental Development, 17 (1): 182-192.

This paper describes FAO's role in the LME program, with an emphasis on EAF and EBM. The BoBLME and the CCLME are presented as examples of LME projects led by the FAO.

B. E. Brown. (2016). Regional fishery management organizations and large marine ecosystems. Environmental Development, 17 (1): 202-210.

This paper addresses the relationships between LME Programs and Regional Fisheries Management Organizations (RFMOs) with regard to fisheries management, with a focus on Western Africa using lessons learned from the U.S. East Coast.

S. Chen and D. Ganapin. (2016). Polycentric coastal and ocean management in the Caribbean Sea Large Marine Ecosystem: harnessing community-based actions to implement regional frameworks. Environmental Development, 17 (1): 264-276.

In this article, the authors examine the Caribbean islands in the context of SIDS and the environmental challenges they face. The paper uses the Caribbean Sea LME region and the results of the GEF Small Grants Program to conclude that a regional, inter-governmental approach, combined with local, community-based solutions, will yield effective coastal and ocean management in the Caribbean Sea LME.

W.W. Cheung, M.C. Jones, G. Reygondeau, C. A. Stock, V. W. Y. Lam and T. Frolicher. (2016). Structural uncertainty in projecting global fisheries catches under climate change. Ecological Modelling, 325: 57-66.

This study compares projections of potential fish catches from 1971 to 2060 using three types of Dynamic Bioclimate Envelope Models (DBEM), which have predicted the movement of potential catch from low to high latitude regions. The results of the three DBEMs were compared with maximum catch data for LMEs from the Sea Around Us database.

A. M. Duda. (2016). Strengthening global governance of Large Marine Ecosystems by incorporating coastal management and Marine Protected Areas. Environmental Development, 17 (1): 249-263.

This article argues for the incorporation of Integrated Coastal Management and Marine Protected Areas into GEF-funded LME projects to strengthen LME governance through a multi-scale approach.

D. Gutiérrez, M. Akester and L. Naranjo. (2016). Productivity and Sustainable Management of the Humboldt Current Large Marine Ecosystem under climate change. Environmental Development, 17 (1): 126-144.

This article describes the Humboldt Current Large Marine Ecosystem (HCLME) within the context of climate change and the expected impacts on productivity. The findings of the HCLME TDA and the results of a valuation of the HCLME goods and services are summarized.

H. Hamukuaya, C. Attwood and N. Willemse. (2016). Transition to ecosystem-based governance of the Benguela Current Large Marine Ecosystem. Environmental Development, 17 (1): 310-321.

This paper presents the transition of the BCLME to ecosystem-based marine resource management through the collaboration of Angola, Namibia, and South Africa. The article emphasizes the LME approach and the signing and ratification of the Benguela Current Convention.

G. Hempel. (2016). Reflections on the LME Movement. Environmental Development, 17 (1): 7-10.

Hempel provides this reflection article, discussing the beginnings of the LME movement and how the concept has developed over time. He concludes with advice for the next generation, emphasizing capacity-building in all fields of the five modules and communication among LME projects.

G. Hempel, J. Thulin, R. Hermes, W. Ekau, D. Vousden and M. O'Toole. (2016). Large marine ecosystems training and capacity development. Environmental Development, 17 (1): 322-239.

This commentary outlines best practices for training and capacity development in LMEs. Concepts and action plans are presented for capacity-building in developing countries with regard to training, education, and mutual assistance (TEMA). The authors established the Center for Tropical Marine Ecology (ZMT) in Bremen, Germany, as a center for TEMA.

A. Hudson. (2016). United Nations Development Program (UNDP) perspectives on global large marine ecosystems movement. Environmental Development, 17 (1): 330-331.

This commentary reviews the application of the LME approach for the assessment and management of marine ecosystems from the perspective of UNDP. The article emphasizes the importance of (i) including the high seas and LME drainage basins with LME management efforts, (ii) engaging the private sector in LME management, and (iii) LMEs as mechanisms for national and regional economic development.

S. P. Kirkman, L. Blamey, T. Lamont, J. G. Field, G. Bianchi, J. A. Juggett, L. Hutchings, J. Jackson-Veitch, A. Jarre, C. Lett, M. R. Lipinski, S. W. Mafwila, M. C. Pfaff, T. Samaai, L. J. Shannon, Y-J Shin, C.D. van der Lingen and D. Yemane. (2016). Spatial characterization of the Benguela ecosystem for ecosystem-based management. African Journal of Marine Science, 38 (1): 7-22.

This article provides a spatial characterization of the BCLME as a basis for the implementation of EBM in the BCLME using MSP. Four different subsystems are characterized, and the research and monitoring needs for each region are identified in relation to MSP and EBM. Using this information, 14 cross-shelf transects are proposed for environmental monitoring.

B. P. Satia. (2016). An overview of the large marine ecosystem programs at work in Africa today. Environmental Development, 17 (1): 11-19.

This paper provides an overview of the four LME programs in Africa: the Guinea Current, the Canary Current, the Benguela Current, and the Agulhas and Somali Currents. The LME approach and the advancements made using this approach are discussed.

K. Sherman. (2016). Planning and networking for ecosystem based management of large marine ecosystems. Environmental Development, 17 (1): 20-22.

This article reviews the LME project-planning process and LME global networking. Sherman also discusses the way forward: the support of 31 EBM projects in LMEs worldwide for a total of $2.86 billion from 2014 to 2018. An LME Massive Online Open Course is also described with the goal of accommodating distance learning to certify LME practitioners.

K. Sherman and H. Hamukuaya. (2016). Sustainable development of the world’s Large Marine Ecosystems. Environmental Development, 17 (1): 1-6.

This article is a note from the editors of a special issue of *Environmental Development* focused on the ecosystem-based management of LMEs. The articles in this issue are summarized within the context of the five modules for large marine ecosystem assessment, monitoring, and management.

C. Susan. (2016). UNIDO and LMEs: a commentary. Environmental Development, 17 (1): 334-337.

This commentary article addresses the relationship between UNIDO and LME projects. UNIDO and Inclusive and Sustainable Industrial Development (ISID) are discussed, as well as the Green Industry Policy and the Transfer of Environmentally Sound Technologies (TEST) as promotion tools for ISID. UNIDO's engagement with four specific LME projects is also discussed.

D. Vousden. (2016). Local to regional polycentric governance approaches within the Agulhas and Somali Current Large Marine Ecosystems. Environmental Development, 17 (1): 277-286.

This paper presents the ASCLME as an example of polycentric governance. This approach is critical for the effective implementation of ecosystem-based management, which requires involved and invested stakeholders.

D. Vousden. (2016). Productivity and biomass assessments for supporting management of Agulhas Current and Somali Current Large Marine Ecosystems. Environmental Development, 17 (1): 118-125.

This article reviews some of the key findings from the TDA of the ASCLMEs and baseline studies conducted in this area. Vousden also discusses the role of this data in the adaptive management of this region.

Y. Walther. (2016). ICES perspectives on LMEs and contributions to global partnerships. Environmental Development, 17 (1): 332-333.

This brief article provides an overview of ICES and its role as a partner in LME projects. The areas where ICES can provide project support are highlighted.

C. IOC-IUCN-NOAA Consultative Committee Meeting on Large Marine Ecosystems Reports

These reports may be retrieved from the LME website hosted by the University of Rhode Island: http://lme.edc.uri.edu/index.php?option=com_content&view=featured&Itemid=101

IOC. (2013). IOC-IUCN-NOAA Consultative Committee Meeting on Large Marine Ecosystems. 15th Annual Session. Paris, France. pp *i-iii*+36.

IOC. (2012). IOC-IUCN-NOAA Consultative Committee Meeting on Large Marine Ecosystems. 14th Annual Session. Paris, France. pp *i-iii*+24.

IOC. (2011). IOC-IUCN-NOAA Consultative Committee Meeting on Large Marine Ecosystems. 13th Annual Session. Paris, France. pp 1-23.

IOC. (2010). IOC-IUCN-NOAA Consultative Committee Meeting on Large Marine Ecosystems. 12th Annual Session. Paris, France. pp 1-28.

IOC. (2009). IOC-IUCN-NOAA Consultative Committee Meeting on Large Marine Ecosystems. 11th Annual Session. Paris, France. pp 1-34.

IOC. (2008). IOC-IUCN-NOAA Consultative Committee Meeting on Large Marine Ecosystems. 10th Annual Session. Paris, France. pp 1-23.

IOC. (2007). IOC-IUCN-NOAA Consultative Committee Meeting on Large Marine Ecosystems. 9th Annual Session. Paris, France. pp 1-28.

IOC. (2006). IOC-IUCN-NOAA Consultative Committee Meeting on Large Marine Ecosystems. 8th Annual Session. Paris, France. pp 1-15.

IOC. (2005). IOC-IUCN-NOAA Consultative Committee Meeting on Large Marine Ecosystems. 7th Annual Session. Paris, France. pp 1-20.

IOC. (2004). IOC-IUCN-NOAA Consultative Committee Meeting on Large Marine Ecosystems. 6th Annual Session. Paris, France. pp 1-13.

IOC. (2003). IOC-IUCN-NOAA Consultative Committee Meeting on Large Marine Ecosystems. 5th Annual Session. Paris, France. pp 1-20.

IOC. (2002). IOC-IUCN-NOAA Consultative Committee Meeting on Large Marine Ecosystems. 4th Annual Session. Paris, France. pp 1-15.

IOC. (2000). IOC-IUCN-NOAA Consultative Committee Meeting on Large Marine Ecosystems. 3rd Annual Session. Paris, France. pp 1-18.

IOC. (1998). IOC-IUCN-NOAA Consultative Committee Meeting on Large Marine Ecosystems. 2nd Annual Session. Paris, France. pp 1-9.

IOC. (1997). IOC-IUCN-NOAA Ad hoc Consultative Committee Meeting on Large Marine Ecosystems. Paris, France. pp 1-13.

D. Other Relevant Reports

Asia-Pacific Economic Cooperation: Workshop IV Report on Large Marine Ecosystems. (2013) (pp. 35). Ansan, Korea.

This report summarizes the fourth APEC Workshop on Marine Ecosystem Assessment and Management. The workshop was held in Asan, Korea, August 12–13, 2013. There are 27 LMEs in the APEC region, and the goals of this workshop included reporting on the status of these LMEs, reviewing best practices for LME management and assessment, and promoting networking on APEC LME projects. Summaries are provided for each of the 24 talks given.

A. S. Cabanban and L. Mee. (2012). Large Marine Ecosystems and the Open Ocean: A global Synopsis of Large Marine Ecosystems and the Open Ocean science and transboundary management. IW:Science. [Available at http://iwlearn.net/iw-projects/3343/reports/synopsis-report-lme-and-open-oceans.]

This report is one of a series of IW:Science reports that provides synopses and analyses of the five global transboundary water systems, including LMEs, as part of the IW:Science project, *Enhancing the Use of Science in International Waters Projects to Improve Project Results*. This project aims to collate, analyze, and synthesize information from GEF IW projects completed in the last 20 years, with the goal of sharing this information across the IW portfolio. The report identifies problems encountered during this analysis, such as a lack of relevant scientific information in TDAs, and other results, such as the role of science within projects and scientific best practices. The report concludes with recommendations to the GEF for improving future projects.

B. Enticknap, A. Blacow, G. Shester, W. Sheard, J. Warrenchuk, M. LeVine, and S. Murray. (2011). Forage Fish: Feeding the California Current Large Marine Ecosystem (pp. 44). Washington, DC, USA: Oceana. [Available at http://oceana.org/reports/forage-fish-feeding-california-current-large-marine-ecosystem.]

This report examines the role of forage species in the California Current LME, with a focus on the threats to these populations and the governance structures related to their management. Management gaps hindering the conservation of these species are identified at multiple levels. The California Current LME is introduced as the geographic focus of this report, with forage species topics addressed in this context, including management, key predators, threats, and the economic value of these species.

P. Hoagland, and D. Jin. (2006). Accounting for Economic Activities in Large Marine Ecosystems and Regional Seas (pp. *vii*-59). UNEP Regional Seas Reports and Studies No. 181. UNEP/RSP and NOAA LME Partnership.

This report presents an index approach as a tool for setting priorities for international management and financial resources allocated to sustainable development on the regional scale. The authors developed an index to measure the intensity of marine activities in LMEs located within Regional Seas areas using publicly available data on marine activities such as fish landings, shipping, and tourism. This index is compared with UNDP's human development index (HDI), an index of socioeconomic development. Comparing these indices reveals regions with characteristics that indicate their ability to achieve sustainable development of marine resources without assistance, versus those regions that cannot and should be priority candidates for assistance.

M. S. Hossain, S. R. Chowdhury, S. M. Sharifuzzaman, and S. Sarker. (2015). Vulnerability of the Bay of Bengal to Ocean Acidification (pp. *vi*+55). Bangladesh Country Office, Dhaka, Bangladesh: International Union for Conservation of Nature (IUCN).

This IUCN report explores ocean acidification in the Bay of Bengal. The Bay of Bengal LME project is referenced in a discussion on monitoring networks in the section on policy and international negotiation. This section follows an extensive overview of ocean acidification and its effects on the marine environment, coastal livelihoods, and mitigation options, all within the context of the Bay of Bengal.

A. Hudson, and J. Fulton (eds). (2012). International Waters – Delivering Results. GEF, Washington, DC, USA. [Available at http://www.undp.org/content/undp/en/home/librarypage/environment-energy/water_governance/International-Waters-Delivering-Results-2016.html.]

This publication reviews the results of the GEF International Waters focal area projects, including LME projects in Africa, Asia, and the Pacific. For each project, the document presents the project context, threats and causes, and results delivered.

IOC-UNESCO. (2011). Methodology for the GEF Transboundary Waters Assessment Programme. (Vol. 5: Methodology for the Assessment of Large Marine Ecosystems, pp. *vii*+115): UNEP.

This report is one of six volumes presenting the results of the UNEP-implemented, DEWA-executed, GEF Medium Size Project, *Development of the Methodology and Arrangements for the GEF Transboundary Waters Assessment Programme* (TWAP), aimed at developing methodologies for a global assessment of transboundary waters. Volume five presents the methodology for the assessment of LMEs. The report reviews the conceptual framework and the inventory and characterization of LMEs. Indicators are presented, including the proposed TWAP indicators, designed around the five modules for LME monitoring and assessment. Interlinkages with other water systems and data and information management are addressed, and the report concludes with information on the implementation of this methodology. The final section includes discussions on partnerships and institutional arrangements, capacity-building needs, essential financial resources, and best practices.

Models of the World's Large Marine Ecosystems. (2008). GEF/LME global project Promoting Ecosystem-based Approaches to Fisheries Conservation and Large Marine Ecosystems. IOC Technical Series No. 80. UNESCO.

This report presents the application of a new methodology for database-driven ecosystem model generation, providing summary information about fisheries catch and value within LMEs. This methodology uses resources from other databases, including the Sea Around Us project, and identifies challenges to further model development.

NOAA TM NMFS-F/NEC-91: The Large Marine Ecosystem (LME) Concept and Its Application to Regional Marine Resource Management, October 1-6, 1990, K. Sherman and T. L. Laughlin (eds.), 37 p., October 1992.

This document is the event summary and collection of recommendations from the conference held in Monaco from October 1 to 6, 1990. The stated objective of this conference was to introduce scientists, managers, and administrators to the LME research and management approach for the sustainable use of marine resources. This report provides a brief summary of the conference and recommendations. The opening and welcome addresses, as well as the keynote address, are included with the conference workshop reports.

NOAA TM NMFS-F/NEC-92: Report of the Meeting of the ad hoc Committee on Large Marine Ecosystems, March 22-23, 1991, K. Sherman and T. L. Laughlin (eds.), 19 p., October 1992.

This report covers the first meeting of the ad hoc Committee on LMEs, the main topics of which were (i) provisional designation of LMEs, (ii) LME monitoring, (iii) modeling, and (iv) LME workshops and comparative studies. The report includes a meeting summary, the meeting agenda, action items, and a list of attendees.

NOAA TM NMFS-F/NEC-93: Large Marine Ecosystems Monitoring Workshop Report, July 13-14, 1991, K. Sherman and T. L. Laughlin (eds.), 22 p., October 1992.

This document summarizes a workshop convened in 1991 at Cornell University to lay the groundwork for developing a "core" monitoring strategy for LMEs by considering theoretical and pragmatic bases. This core strategy includes three foci: (i) a productivity core, centered on Continuous Plankton Recorder technology; (ii) a fish survey core; and (iii) a fishing survey time series core.

NOAA TM NMFS-F/NEC-94: Summary of the Symposium on the Northeast U.S. Shelf Ecosystem: Stress, Mitigation, and Sustainability, K. Sherman, N. Jaworski, and T. Smayda (eds.), 30 p., October 1992.

This report summarizes the symposium held at the University of Rhode Island on the Northeast U.S. Shelf Ecosystem. The event aimed to "bring pertinent science to aid in the mitigation of severe stress imposed on the sustainability of the Northeast U.S. Shelf Ecosystem and its wetlands, estuaries, coastal zone, fisheries, marine mammals and other resources" while providing the means for coordination across federal agencies with marine programs relevant to LMEs. The topics covered include pollution stress, physical stress, eutrophication, and ecosystem stress and mitigation. The summary also provides the concluding remarks on the health status of the northeast U.S. shelf ecosystem.

NOAA TM NMFS-F/NEC-100: Emerging Theoretical Basis for Monitoring the Changing States (Health) of Large Marine Ecosystems, K. Sherman (ed.), 27 p., September 1993.

This report summarizes two workshops that took place in 1992. The first was in April at the National Marine Fisheries Service in Narragansett, RI. The second was in July at Cornell University in Ithaca, NY. The goal of these workshops was to continue the effort towards developing a strategy for monitoring LMEs. Topics included case studies of the North Sea ecosystem and the Great Lakes basin ecosystem, as well as ecosystem health indices and plankton recorder technology. The theoretical framework for indexing changes in ecosystem states was also discussed.

NOAA TM NMFS-NE-158: A Framework for Monitoring and Assessing Socioeconomics and Governance of Large Marine Ecosystems, J. G. Sutinen (ed.), 32 p., August 2000.

This technical memorandum presents a framework for monitoring and assessing socioeconomic activity and governance (i.e., the human dimensions) within LMEs, in an effort to link this activity with the other three natural resource-based LME modules. This framework was developed through a NOAA contract to researchers from the University of Rhode Island.

NOAA TM NMFS-NE-183: NOAA Fisheries Service's Large Marine Ecosystems Program: Status Report, K. Sherman, P. Celone, and S. Adams (eds.), 21 p., July 2004.

This report updates the status of NOAA's LME program. A definition of LMEs is provided with a description of the approach, the major stresses this approach addresses, and the indicator modules and their applications. The report also discusses LME modelling as it contributes to policy-making and the use of the LME approach in achieving the WSSD targets.

NOAA TM NMFS-NE-208: Global Applications of the Large Marine Ecosystem Concept, 2007 – 2010, K. Sherman, M-C. Aquarone, and S. Adams (ed.s), 71 p., June 2007.

This report provides an overview of the global LME program, with an introduction to the LME approach, the GEF, and the LME indicators, as well as the opportunities to link these indicators with climate change assessments. Critical program partners are identified and planned activities for the program are presented, with a focus on the Benguela Current and Guinea Current Commissions.

S. B. Olsen, S. G. Sutinen, L. Juda, T. M. Hennessey, and T. A. Grigalunas. (2006). A Handbook on Governance and Socioeconomics of Large Marine Ecosystems (pp. vii+94). Narragansett, RI, USA: Coastal Resources Center, University of Rhode Island.

This handbook was designed for use in workshops and courses on the human dimensions of ecosystem-based marine resource management and is a practical guide to socioeconomics and governance in LME projects. The handbook first describes the paradigm shift from single-sector management to EBM and the steps in the governance process. The challenges of LME governance are presented, along with other factors to be considered when addressing LME governance. Sustainable financing is also a major topic, with examples of sustainable financing for marine governance initiatives provided.

PAME. (2013). Large Marine Ecosystems (LMEs) of the Arctic area: Revision of the Arctic LME map (2nd ed., pp. 19): Protection of the Arctic Marine Environment and the Artic Council.

This Protection of the Arctic Marine Environment (PAME) report describes the 2013 revision of the Arctic LME map. Background information is provided, including the 2006 working map, the 2007 Oil and Gas Assessment (OGA), and Arctic Marine Shipping Assessment Recommendation IIC. This recommendation identified the need to revise the LME boundaries when these assessments found that the 2006 boundaries cut arbitrarily through ecological features. New boundaries were needed to take these geophysical and ecological discontinuities into account. Between 2009 and 2012, meetings, reviews, and consultations were held to adjust the arctic LME boundaries. The final changes are presented in this report, and descriptions are provided for each of the 18 Arctic LMEs.

Scope and Objectives of Global Environment Facility Supported Large Marine Ecosystems Projects. K. Sherman, S. Adams, M-C. Aquarone (eds.). 2010. NOAA Large Marine Ecosystems Program Report.

This report describes the details of the LME projects at the time of publication, as well as the LME-based GEF–World Bank Strategic Partnership and Investment Projects. Selected LME references are also provided, along with a table of LME project financial support.

K. Sherman and G. Hempel (eds.). 2008. The UNEP Large Marine Ecosystem Report: A perspective on changing conditions in LMEs of the world's Regional Seas. UNEP Regional Seas Report and Studies No. 182 (pp. xx+852). United Nations Environment Programme, Nairobi, Kenya.

This report is a collection of synopses of the ecological conditions of each LME, both those within the Regional Seas areas and those bordering these areas. Three general issues are reported as recurrent across the synopses: (i) encroachment of industrial fisheries into the community-based fisheries in developing nations, and the need to apply the precautionary principle to protect these communities; (ii) the need for improved forecasting of events impacting LME resources; and (iii) the need to address the issue of eutrophication and its global impacts on ecosystem health.

K. Sherman and G. McGovern (eds.). 2011. Toward Recovery and Sustainability of the World's Large Marine Ecosystems During Climate Change (pp. i+19). IUCN, Gland, Switzerland.

This booklet introduces the LME approach to ecosystem-based management and discusses the warming trends in 61 of the 64 LMEs. The booklet also covers primary production changes and the shifts in biomass yields of the fisheries' in these warming LMEs. The Yellow Sea LME project and some of its major components are presented, including multi-trophic mariculture.

A. Tengberg and A. Andreasson. 2012. Large Marine Ecosystems: Study of the Concept of Large Marine Ecosystems and its Institutional Relevance for Ecosystem-based Management and Development (Vol. 17, pp. 50), Swedish Agency for Marine and Water Management.

This report was prepared by the Swedish Agency for Marine and Water Management, funded by the Swedish International Development Cooperation Agency (SIDA). The report presents the findings of a study analyzing the LME approach, its use of EBM to improve the management of ocean resources, and its relation to other global and regional initiatives with similar missions. The study was based on a review of relevant literature and responses to a questionnaire completed by LME partners in the East Asian Seas region, West and Central Africa regional seas, and South Asia. The findings suggest that navigation through the TDA/SAP process, as well as SAP implementation, does not depend on GEF funding because it depends on political factors (e.g., number of riparian countries, existing governance schemes, political will). This report suggests that institutional assessments be conducted before new organizations (e.g., commissions) are established for SAP implementation. The report also suggests that the TDA/SAP methodology be updated to incorporate new concepts, such as ICM and MSP, and that the LME modules must be better aligned with the ecosystem services concept.

Towards Ecosystem-based Management of the Guinea Current Large Marine Ecosystem. (2013). *In* K. Honey and S. Elvin (eds.), pp. v+36. New York, NY, USA: United Nations Development Program.

This booklet on the GCLME project reviews the project history and progression towards sustainable development. The five modules are addressed within the context of the project. Lessons learned from the project are presented and ways forward are discussed.

H. van Lavieren and L. Benedetti. (2015). From Coast to Coast - Celebrating 20 Years of Transboundary Management of our Shared Oceans. *In* J. Adams (ed.), pp. x+179, The Global Environment Facility.

This publication presents work completed over the past 20 years by the GEF toward advancing transboundary management of coastal and marine resources. The first section of the report discusses LMEs and frameworks for regional cooperation within the context of catalyzing global and regional partnerships. The second section addresses improving ecosystem health and services and discusses land-based sources of pollution, fisheries, navigation, and the application of the ecosystem-based management approach. The report concludes with a roadmap forward, summarizing past lessons learned from GEF IW investments and hopes for the future.

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