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Ecosystem Management and Its Application to Large Marine Ecosystems: Science, Law, and Politics

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This article discusses the implications of ecosystem management and its application to large marine ecosystems (LMEs) from a scientific, legal, and political perspective. It explores the meaning of ecosystem management and its implications for international management of environmental resources, analyzes the necessity for adopting an ecosystem approach to LME management, and discusses the difficulties and problems in LME management. The article concludes that the complexity of LMEs requires an ecosystem approach to their management, that the obligation to adopt an ecosystem approach to the management of the marine environment and resources has been established in international law, and that the successful application of an ecosystem approach to LME management largely relies on collective political will and the mutual cooperation of the states concerned.

Keywords ecosystem management, an ecosystem approach, LME management, LMEs

In recent years, the management of large marine ecosystems (LMEs) has become a focus in international ocean governance. The United Nations and other international organizations have launched a number of regional LME projects in Asia, Africa, South America, and Europe. However, a comprehensive and systematic theory of LME management has not been fully established in academic circles. Comprehensive and systematic research on this subject would be of great significance in both theory and international

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practice. This article discusses the implications of ecosystem management and its application to LMEs from a scientific, legal, and political perspective.

Ecosystems and Ecosystem Management

Ecosystems

The term “ecosystem” was introduced by Alfred George Tansley in 1935,¹ though the idea itself has a much longer history.² Tansley defined an ecosystem as a biotic assemblage and its associated physical environment in a specific space.³ Since then, this definition has remained a fundamental concept in ecology.⁴ Although the term “ecosystem” has been variously defined by numerous successors, including some international legal instruments,⁵ the basic connotations embraced in Tansley’s definition have never been altered.

The key features of an ecosystem can be summarized in five points. (1) An ecosystem exists in a space with boundaries that may or may not be explicitly delineated. Ecosystems are distinguishable from each other based on their biophysical attributes and their locations. (2) An ecosystem includes both living organisms and their abiotic environment, including pools of organic and inorganic materials. (3) The organisms interact with each other, and interact with the physical environment through fluxes of energy, organic and inorganic materials amongst the pools. These fluxes are mediated and functionally controlled by species’ behavior and environmental forces. (4) An ecosystem is dynamic.⁶ Its structure and function change with time.⁷ (5) An ecosystem exhibits emergent properties that are characteristic of its type and that are invariant within the domain of existence.⁸

Ecosystems are life-support systems and essential for the survival and welfare of human beings.⁹ The health of ecosystems is not only essential to the environment, but also important to the existence and development of human society which, however, usually sees itself as apart from the environment.¹⁰ On the other hand, as components of ecosystems, humans and their interactions have profound effects on the structure and function of ecosystems. All over the world, ecosystems are increasingly affected by human-induced impacts, which, conversely, often have profound effects on human habitats, human health, and even socioeconomic development. Ecosystem health has long been a major concern in environmental protection and has become an important concept associated with ecosystems. Ecologically, ecosystem “health” is defined in terms of “activity,” “organization” and “resilience.” These components of ecosystem health are embraced in the concept of “sustainability,” which means that the system is active, maintains its organization, and is resilient to stress over time.¹¹ By contrast, an unhealthy system is one that is not sustainable and will eventually cease to exist. Many guidelines and measures have been suggested for assessing ecosystem health.¹² Moreover, it should be pointed out that the term ecosystem health is commonly used in a broader context, i.e., including not only its ecological concept but also social, economic, and political concerns. A healthy ecosystem thus could be described as one where the environment is viable; the economy is equitable, sustainable, and adequately prosperous; and the community is liveable and convivial.¹³

Ecosystem Management

Human beings have long been aware of their adverse impacts on ecosystems and have been taking measures to combat these problems. However, traditional methods of ad-

addressing these problems are based on species-specific and sectoral approaches, which have often not achieved desired outcomes mainly because the interactions among system components, including human activities, have not been taken into consideration. In order to change this situation, the Global Environment Facility (GEF) considers it “an urgent need” to adopt “management systems embracing comprehensive and cross-sectoral approaches” and highly recommends “integrated ecosystem management” as “a particularly useful system.”¹⁴

As with various definitions of ecosystem, there are also various definitions of ecosystem management.¹⁵ There is also little agreement on “the new terminology, conceptual categories, and classifications” used to discuss it.¹⁶ Along with its various explanations, the term ecosystem management is expressed in different phrases, such as ecosystem-based management, integrated ecosystem management, and total ecosystem management, to name a few. Generally, the term “management” might be defined as the regulation of human activities and resources to achieve certain objectives.¹⁷ “Ocean management” means the coordination of various uses of the oceans and the protection of the marine environment.¹⁸ It is also defined as “the process by which specific resources or areas are controlled to achieve desired objectives.”¹⁹ Regarding the term “ecosystem management,” the Committee on the Scientific Basis for Ecosystem Management (CSBFEM) of the Ecological Society of America defined it as management based on the “best understanding of the ecological interactions and processes necessary to sustain ecosystem structure and function.”²⁰ Schlaepfer described it as processes in which decision making takes into account all major components of the affected ecosystems, including humans and the adjacent ecosystems.²¹ Both highlight interrelations between components of ecosystems. Schlaepfer further defines “ecosystem-based management” as a systemic process aimed at the sustainable use of natural resources largely through the integration of economic, ecological, social, and technological elements and the protection of ecosystems in the utilization of natural resources.²²

An important term associated with ecosystem management is “ecosystem approach.” The meanings of these two terms partly overlap. The term ecosystem approach has been variously defined in different settings; there exists no consensus on its exact meaning.²³ A number of associated terms in use include an ecosystem-based approach, ecosystem management approach, ecosystem process-oriented approach, etc.²⁴ However, these similar or overlapping terms all refer to a comprehensive, science-based approach to the conservation and management of environmental resources.

Among the numerous definitions of ecosystem approach, the one given by the Fifth Meeting of the Conference of the Parties (COP) to the Convention on Biological Diversity (CBD) is representative. The COP-5 interpreted an ecosystem approach, consistent with the definition of “ecosystem” provided in Article 2 of the CBD, as a strategy for the integrated management of natural resources that equitably promotes both conservation and utilization. An ecosystem approach focuses on “levels of biological organization, which encompass the essential processes, functions and interactions among organisms and their environment.” It recognizes that humans are an integral component of ecosystems. It takes adaptive measures to deal with the complex and dynamic nature of ecosystems, and adopts the precautionary principle. It does not preclude other existing conservation and management approaches, such as single-species conservation, protected areas, biosphere reserves, etc.; rather, it may integrate all these approaches as a holistic system.²⁵

Despite the variety of definitions, common features of ecosystem management and ecosystem approaches exist. For example, in line with its definition of ecosystem

management, the CSBFEM outlined the major elements of ecosystem management as follows:

- 1) long-term sustainability as fundamental value; 2) clear, operational goals;
- 3) sound ecological models and understanding; 4) understanding complexity and interconnectedness; 5) recognition of the dynamic character of ecosystems;
- 6) attention to context and scale; 7) acknowledgment of humans as ecosystem components, and 8) commitment to adaptability and accountability.²⁶

The COP-5 of the CBD also worked out some principles and operational guidance for application of the ecosystem approach.²⁷ Some of these principles form the theoretical basis for international regime building for ecosystem management as well as its implementation, and thus are further elucidated here.

First, the fundamental goal or value of ecosystem management is to maintain long-term sustainability of natural resources. Under the principle of intergenerational equity and sustainability, natural resources should be managed in a manner so as not to deny future generations the resources and opportunities enjoyed today.²⁸ Sustainability has been widely accepted as a goal of natural resource management in policy and law in recent years.²⁹ At the Canadian National Workshop on Objectives and Indicators for Ecosystem-Based Management, which was held in 2001, there was consensus that ecosystem-based management has two broad, overriding goals: (1) the sustainability of human usage of environmental resources, and (2) the conservation of species and habitats, including those ecosystem components that may not be utilized by humans.³⁰

Second, the planning and implementation of ecosystem management should be based on sound scientific understanding of the ecosystems, particularly the ecosystem complexity and the interconnections between ecosystem components. This requires the refocusing of scientific research and technical training at the ecosystem level, especially in developing countries. International cooperation in this respect includes joint scientific research, exchange of information, knowledge and experience, transfer of technology, etc. These issues have become focal points in many international fora in recent years.³¹

Third, the maintenance of the integrity of an ecosystem requires that management measures cover a wide range of components and processes, including not only the targeted resources, but also habitats, communities, and the related environment that support them. It means that the spatial scale of management has to extend across different biological units and jurisdictions to encompass an entire ecosystem.³² Ecosystem management becomes a legal transboundary issue where jurisdictional boundaries do not coincide with ecosystem boundaries. Sometimes it requires not only interagency coordination, but also international cooperation. In managing transnational ecosystems, for example, such cooperation is necessary. Some forms of international cooperation, such as joint management zones, have proved to be effective.³³

Fourth, since ecosystems are dynamic and each ecosystem has its own characteristics, the planning and implementation of ecosystem management should be based on specific conditions of the ecosystem concerned.³⁴ This would mean that there exists no universal method for implementing the principles of ecosystem management, no single way to implement ecosystem approaches. Under the general principles of ecosystem management, strategies may vary from one ecosystem to the next. At the international level, there is no single universal institution for planning or implementing ecosystem management strategies. Ecosystem management should be carried out at local community, national, or regional levels depending on relevant conditions.³⁵

Fifth, human activities and ecosystems are interactive; humans play a dominant role in many ecosystems.³⁶ As an integral part of ecosystems, human activities are, on the one hand, a major source of disturbance. On the other hand, humans can conserve and protect ecosystems. The central goal of ecosystem management is to improve the overall quality of human life at intergenerational time scales.³⁷ However, ecology-based approaches alone cannot achieve long-term sustainability of natural resources. It is recognized that in ecosystem management, humans cannot manage the ecosystem as such, but only the human activities that make use of it.³⁸ In one sense, this requires a harmonization between socioeconomic development and the environment. As the Brundtland Report pointed out, poverty inevitably leads to ecological disasters. In order to survive, poor people have to overexploit environmental resources, and the eroded environment further impoverishes them: "Poverty reduces people's capacity to use resources in a sustainable manner; it intensifies pressure on the environment."³⁹ To achieve sustainability, social and economic considerations should also be integrated into ecosystem management goals.⁴⁰ In a watershed ecosystem, for example, the ecosystem approach not only takes into account all of the biological resources within the watershed, but the economic health of the human communities concerned.⁴¹ In short, the interaction between social economic development, environmental protection, and ecosystem management indicates that the eradication of poverty is an essential part of effective ecosystem management. At the international level, this clearly implies the need for aid from economically developed countries to developing countries.

In summary, although the development of ecosystem approaches to environmental resource management is still in its infancy, the understanding of its implications still needs deepening, and the implementation of the approach is still limited in practice,⁴² it is increasingly being adopted by management agencies worldwide.⁴³ In the past, ecosystem management approaches were mainly applied to terrestrial resource management. In recent years, however, the concept of ecosystem management has been extended to coastal and ocean management. In ocean management, manifestations of this trend include the adoption of ecosystem approaches to marine management in national ocean law and policy and regional agreements, the emergence of the concept of LMEs, and the initiative of sixteen LME projects around the world.⁴⁴

LMEs and LME Management

LMEs

There are many kinds of ecosystems such as terrestrial ecosystems, forestry ecosystems, freshwater ecosystems, marine ecosystems, to name a few. All ecosystems overlap and interact. Every ecosystem is part of a larger ecosystem and all ecosystems belong to the biosphere. Marine ecosystems occupy the majority of the earth's surface area. Along with the increasing socioeconomic and environmental importance of the oceans on the one hand and the drastic deterioration of the marine environment on the other, the issue of marine environmental protection has occupied the world's attention for decades. In Agenda 21, a product of the 1992 United Nations Conference on Environment and Development, the concept of marine ecosystem is described as forming "an integrated whole that is an essential component of the global life-support system and a positive asset that presents opportunities for sustainable development."⁴⁵ The concept of LMEs emerged only in the 1980s and only recently has become a focal topic in international ocean governance.

LMEs were defined by Sherman and Alexander as

regions of ocean space encompassing coastal areas from river basins and estuaries on out to the seaward boundary of continental shelves and the seaward boundary of coastal current systems. They are relatively large regions on the order of 200,000 km² or larger, characterized by distinct bathymetry, hydrography, productivity, and trophically dependent populations.⁴⁶

To date, 64 LMEs have been identified around the world.⁴⁷ The salient features of LMEs can be summarized. First, LMEs geographically cover the portions of the world's oceans that are most important to humans. LMEs normally cover coastal states' territorial waters, exclusive economic zones, and, in case of the habitats of some straddling stocks and highly migratory species, the high seas beyond 200 nautical miles (nm) from shore. Most marine economic activities, such as fishing, aquaculture, shipping, and petroleum exploitation, etc. take place in these areas. As a result, LMEs are particularly vulnerable to overexploitation and pollution. Major stresses on these areas include overexploitation of fish and other natural resources such as mangrove trees, corals, and hydrocarbons, and pollution from both land-based and sea-borne sources. Environmentally, LMEs are "national and regional focal areas"⁴⁸ for prevention and restoration of the marine environment and resources from degradation and deterioration. Moreover, as a focal area of various sea uses, LMEs are also an arena for competing interests. Nationally, there are conflicts between various agencies as well as individuals. Internationally, conflicts occur not only between neighboring countries, but also between coastal states and high seas interests. In brief, LMEs are of great social, economic, and environmental significance for coastal states⁴⁹ and yet the most complicated part of ocean management.

LME Management

The Natural Characteristics of LMEs Require an Ecosystem-based Management. As mentioned above, the geographical scope of an LME ranges from river basins and estuaries on out to the seaward boundaries of continental shelves and coastal current systems. Not only does an LME normally cover several maritime zones, it also encompasses many component ecosystems and relates to other interconnected ecosystems. To be effective, the boundaries of LME management need to correspond with the natural boundaries of an LME. Since ecosystem components are interdependent and interactive, LME management not only must take into account the populations of exploited organisms, but also the unexploited species that may be dependent and associated, their habitats, and even the socioeconomic development of the area concerned. Such a holistic approach encompasses the entire ecosystem as an integrated management unit, including the full array of species, processes, structures, and their interrelationships.⁵⁰ It seeks to conserve and manage entire communities of organisms and their habitats as a whole, rather than certain species populations within a politically delimited space. The concept of LME management thus reflects a large-scale and holistic approach to assessment and control of marine environmental resources. The existing LME projects are using five linked modules to monitor, assess, and manage marine ecosystems: productivity and carrying capacity, fish and fisheries, pollution and ecosystem health; socioeconomic conditions; and pertinent governance regimes.⁵¹ These modules cover all the major aspects of the protection and management of an LME, representing a paradigm shift from a sectoral, species-specific approach to a holistic, ecosystem approach to the assessment and management of the marine environment and resources.⁵²

Ecosystem Approaches to LME Management as an International Legal Obligation. The origin of the movement towards an ecosystem approach to ocean management is said to be a proposal of the International Council for the Exploration of the Sea (ICES) at its first meeting in 1901. This advocacy was the consequence of the awareness of the limitations of marine resources and the adverse impacts of overexploitation. Since the mid-1970s, ICES has been giving increasing prominence to a multispecies approach to the management of marine living resources.⁵³ This approach has evolved into a broader concept of ecosystem approaches.⁵⁴ The movement towards an ecosystem approach to environmental resources was gradually promoted worldwide, and the concept of an ecosystem approach was gradually incorporated into a series of international legal instruments and “soft law” documents.

CCAMLR. The first global convention to adopt an ecosystem approach to ocean management was the 1980 Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR).⁵⁵ The impetus behind this Convention was that the large-scale krill fishery in the 1970s aroused concern for its harmful impact on the whole Antarctic marine ecosystem. Because krill forms the basis of the Antarctic food chain, its exploitation threatened to jeopardize other dependent and associated marine living resources in the area.⁵⁶

The CCAMLR provides that, in view of the importance of the integrity of the Antarctic ecosystem,⁵⁷ its objective is to conserve the Antarctic marine living resources⁵⁸, which are defined as “the populations of fin fish, molluscs, crustaceans and all other species of living organisms, including birds, found south of the Antarctic Convergence.”⁵⁹

The CCAMLR’s ecosystem approach to marine living resources conservation is defined primarily in sub-paragraphs (b) and (c) of paragraph 3 of Article 2 of the Convention.⁶⁰ First, sub-paragraph (b) requires the maintenance of the ecological relationships between all the organisms concerned in the Antarctic ecosystem. The conservation measures, therefore, are not only to focus on the harvested species but also involve the dependent and related populations. While regulating fishing for target species, for example, krill, not only should its impact on the populations of krill be considered, but also its impact on dependent or associated species such as whales and penguins who feed on krill. The dependent or associated species should be protected from the adverse impact of the harvesting of the target species. This provision gives the CCAMLR a multispecies approach that differs from the traditional single-species approach under which only the target species is considered when setting the catch limits.⁶¹ Second, sub-paragraph (c) provides that the Antarctic marine ecosystem is to be preserved from irreversible changes. This is the so-called precautionary principle. It means that any risk or threats of long-term adverse effects on the Antarctic marine ecosystem must be prevented or minimized without delay, even if sufficient and solid scientific evidence for such effects is not available.⁶² The precautionary principle plays an important role in the ecosystem approach of the CCAMLR.⁶³ One important aspect of the precautionary approach to the preservation of the whole Antarctic ecosystem is to set a “conservative (i.e. precautionary) krill catch limit”⁶⁴ so that enough is left to meet the needs of dependent and associated species.

The CCAMLR’s ecosystem approach is further reflected in its geographic scope of application, that is, the whole Antarctic area within the Antarctic Convergence, which is the natural ecological boundary of the Antarctic ecosystem.⁶⁵ Its jurisdictional boundary is therefore consistent with the ecosystem boundary. Furthermore, for any stocks or stocks of associated species which occur both within the CCAMLR Convention Area and in its adjacent marine areas, CCAMLR is to harmonize its conservation measures.⁶⁶ Lastly, CCAMLR provides mechanisms and measures to implement the ecosystem

approach to the conservation of the Antarctic marine ecosystem.⁶⁷ In short, the CCAMLR's ecosystem approach is innovative and has been recognized as setting the benchmark for a new international regime for the conservation of marine living resources.

UNCLOS. Although CCAMLR was negotiated during the time of the negotiation of the United Nations Convention on the Law of the Sea (UNCLOS),⁶⁸ and UNCLOS was concluded two years after CCAMLR,⁶⁹ UNCLOS does not explicitly provide an ecosystem-based management regime for marine living resources. Only once in the Convention text does each of the terms "ecosystem"⁷⁰ and "ecological balance"⁷¹ appear. This has led to controversy over whether UNCLOS contains legal principles or a legal regime for large marine ecosystem management and ecosystem-based management. Martin H. Belsky repeatedly advocates that the legal principles and regime for large marine ecosystem management are well established in UNCLOS and have become customary international law.⁷² This view is opposed by William T. Burke, who asserts that UNCLOS does not mandate ecosystem management,⁷³ and that the obligations provided in the fisheries provisions of UNCLOS, such as protection of associated species and a duty of states concerned to cooperate in utilization and conservation of transboundary species, are not customary international law.⁷⁴

Lewis M. Alexander points out that, although UNCLOS does not explicitly provide a legal regime for LME management, its objectives are "parallel to those of LME management"⁷⁵ and its relevant texts are "supportive of the LME concept."⁷⁶ Other scholars have similar opinions.⁷⁷ This opinion should be accepted.

First, the concept of ecosystem-based management coincides with the spirit and objectives of UNCLOS. One of the objectives of UNCLOS is to promote efficient utilization of marine resources, the conservation of marine living resources, and the protection and preservation of the marine environment.⁷⁸ Moreover, UNCLOS realizes that "the problems of ocean space are closely interrelated and need to be considered as a whole."⁷⁹ Reading these provisions together supports the view that an integrated ecosystem approach is the optimum manner to deal with the complicated issues of LME management. The last paragraph of the preamble of UNCLOS affirms that "matters not regulated by this convention continue to be governed by the rules and principles of general international law." This wording keeps UNCLOS open to accepting legal norms of ocean governance should they be generally accepted by nation states.

Second, although UNCLOS does not explicitly mandate an ecosystem-based management approach, it is supportive of such a management concept. The relevant provisions are Articles 61, 63, 64, 66, 67, 118, 119, 123, 145, 192, and 194 (1) (5), which, to a certain extent, embrace some attributes of ecosystem-based management.

- The recognition of the ecological integrity of the ocean.⁸⁰ UNCLOS not only recognizes the interrelation between harvested species and associated species, but also the ecological integrity and geographical interrelation of transboundary stocks. According to Articles 61 (3) (4) and 119 (1) of UNCLOS, when determining allowable catch and establishing conservation measures for living resources in EEZs and high seas, the interdependence of stocks and the effects on dependent and associated species are to be taken into account with a view to maintaining or restoring populations of such species above levels at which their reproduction may become seriously threatened. Articles 63, 64, 66, and 67 recognize the ecological and geographic integrity of transboundary stocks as well as the interrelation of conservation and management measures between EEZs and the high seas and require states concerned to cooperate in conservation and/or management of

such stocks. Especially in the case of highly migratory species, international co-operative arrangements for conservation and optimum utilization apply to the entire migratory range of the stocks. Article 64 is “in fact dealing with such resources in terms of ecosystem approaches.”⁸¹

- Not only ecological elements, but also socioeconomic factors are to be considered in the utilization and conservation of marine living resources and environment. For example, Articles 61 (3) and 119 (1) (a) provide that economic factors, including the economic needs of coastal communities and the special requirements of developing countries, are to be taken into account when determining allowable catch and establishing conservation and management measures.
- There are specific provisions on the protection of ecosystems and the ecological balance of the marine environment. Article 194 (5) explicitly provides for the protection and preservation of “rare and fragile ecosystems” and habitats of depleted, threatened, or endangered species and other forms of marine life. Article 145 expressly requires the protection of “the ecological balance of the marine environment” from harmful effects of activities in the deep seabed area.⁸²
- Other mechanisms and measures facilitate the ecosystem-based management of the ocean, for example, the general obligation of states to protect and preserve the marine environment;⁸³ international coordination and cooperation in conservation and preservation of marine living resources and environment;⁸⁴ utilization of best scientific evidence available and proper conservation and management measures,⁸⁵ which keeps the relevant regimes open to adopting new knowledge such as the theory of LMEs and management concepts such as ecosystem-based management.

The 1995 Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 Relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks⁸⁶ (hereinafter the Fish Stocks Agreement or the FSA), explicitly adopts an ecosystem approach to the conservation and management of marine living resources.⁸⁷ Had UNCLOS no implications for ecosystem-based management, there would be little legal basis for the FSA.⁸⁸ As Francisco Orrego Vicuna points out, on the basis of the general obligation to protect and preserve the marine environment in UNCLOS, a number of developments in international environmental law, including particularly the ecosystem management approach, “have been anticipated or actually accomplished.”⁸⁹ He further states that, “The concept of large marine ecosystem and ecosystem management were not alien to that Convention (UNCLOS).”⁹⁰

The FSA’s detailed regime governing highly migratory species was negotiated and approved on the basis of principles and concepts embraced in UNCLOS, including the ecosystem approach.⁹¹ Edward Miles argued that, with respect to fisheries management, the approach provided in Part V of UNCLOS “is deliberately partially ecosystemic in nature (i.e., target species must be treated in conjunction with associated and dependent species).”⁹² He noted that, “All necessary components of a changed fisheries management paradigm” can be found within UNCLOS.⁹³ Patricia Birnie is of the opinion that, despite the absence of specific terms such as “ecology,” the goals of the fisheries conservation regime of UNCLOS “can be interpreted as implying that such concepts should be applied” “in the light of subsequent advances of knowledge, and Agenda 21’s support.”⁹⁴ Lee A. Kimball even argued that CCAMLR’s provisions on ecosystem-based management, such as the protection of associated species and related environment, maintenance of the balance between predators and preys, and restoration of depleted species, build

substantially on the relevant articles in UNCLOS on fisheries.⁹⁵ Lewis M. Alexander opined that nothing in the LME concept is inconsistent with UNCLOS.⁹⁶

The basic contents of the provisions of UNCLOS on marine living resources and the environment had actually been in place by 1975. Since then new concepts and principles, including LMEs and ecosystem-based management, have emerged and many of them have been incorporated into the FSA. The relevant provisions of UNCLOS cannot be explained without taking the FSA into consideration. On the contrary, to interpret the relevant provisions of UNCLOS in 1970s terms might not be consistent with the objectives of UNCLOS concerning the conservation and management of marine living resources and environment.⁹⁷ According to Article 31 of the 1969 Vienna Convention on the Law of Treaties,⁹⁸ a treaty is to be interpreted in the light of its object and purpose, taking into account, together with the context, any subsequent agreement regarding the application of its provisions, any relevant subsequent practice, and any relevant rules of international law. In the Case Concerning Gabcíkovo-Nagymaros Project (Hungary/Slovakia), the International Court of Justice (ICJ) indicates that the interpretation and application of an old treaty should take into account new environmental norms and standards.⁹⁹ In his separate opinion, Judge Weeramantry further stressed that the standards to be applied are those prevalent at the time of the application of the treaty and not those in force at the time of the conclusion and early performance of the treaty.¹⁰⁰

Although UNCLOS does not explicitly set forth an ecosystem approach to marine environmental resource management, its objectives and relevant provisions can be interpreted as being supportive of such an approach. International regimes for more sophisticated ecosystem approaches to the conservation and management of the marine environment and resources gradually evolved after UNCLOS. Some instruments agreed upon at the 1992 United Nations Conference on Environment and Development (UNCED), especially Agenda 21 and the CBD, refer more specifically to the ecosystem approach, and this was carried forward by the FSA and the Code of Conduct for Responsible Fisheries of 1995.¹⁰¹

Agenda 21. The 1992 Declaration of the UNCED (the Rio Declaration), which is well recognized as a milestone of the development of international environmental law, not only reaffirms the 1972 Declaration of the United Nations Conference on the Human Environment (the Stockholm Declaration), but also moves beyond it to introduce many new principles,¹⁰² including ecosystem management. In its preamble, the Rio Declaration recognizes “the integral and interdependent nature of the Earth” and calls on states to “protect the integrity of the global environmental and developmental system.” Principle 7 requires states to “cooperate in a spirit of global partnership to conserve, protect and restore the health and integrity of the Earth’s ecosystem.” Moreover, the theme of the Declaration—the principle of sustainable development¹⁰³—establishes a policy basis for ecosystem-based management. The precautionary principle¹⁰⁴ is also very supportive of ecosystem approaches.

The preamble to Agenda 21 points out that “the continuing deterioration of the ecosystems” is one of the major issues with which humanity is confronted, and “better protected and managed ecosystems” cannot be achieved without integration of environment and development as well as international cooperation. Agenda 21 leaves no doubt that the marine environment, including the oceans and all seas and adjacent coastal areas, forms an integrated whole and is to be conserved and managed in an integrated manner. While confirming that UNCLOS provides an international basis for protection and sustainable development of the marine environmental resources, Agenda 21 moves beyond this and demands “new approaches to marine and coastal area management and

development, at the national, subregional, regional and global levels, approaches that are integrated in content and are precautionary and anticipatory in ambit.”¹⁰⁵ These principles as well as the program areas¹⁰⁶ laid out in Chapter 17 of Agenda 21 promote an ecosystem approach to ocean management.

While UNCED rejected the idea of including the LME concept in Agenda 21, ecosystem approaches are endorsed in Chapter 17 and when, read as a whole, the cross-sectoral, interdisciplinary, and regional elements which are intrinsic to LMEs are endorsed.¹⁰⁷

The holistic element of the UNCED mind-set gives particular weight to ecological awareness and to the ecosystem as a unit of ocean management.¹⁰⁸ The holistic approach to both marine and terrestrial ecosystems is firmly endorsed by Agenda 21.¹⁰⁹

The relevant principles contained in instruments adopted by more than 178 governments at the UNCED are by no means merely political statements, but are important “soft law” statements of ecosystem-based management and have become binding legal principles by being incorporated into legally binding international instruments such as the CBD and the FSA.

Convention on Biological Diversity. The CBD deals with biological diversity, which includes marine ecosystems.¹¹⁰ Being aware that the conservation of ecosystems is fundamental to the conservation of biological diversity,¹¹¹ the CBD and its relevant supplementary documents adopt an ecosystem approach to biodiversity conservation.¹¹² First, two out of the three core objectives of the CBD are related to ecosystem protection, i.e., the conservation of biological diversity and the sustainable use of its components.¹¹³ Second, the jurisdictional scope of the CBD covers both areas within and beyond the limits of national jurisdiction in consideration of the integrity of ecosystems.¹¹⁴ Accordingly, the CBD requires international cooperation beyond areas of national jurisdiction and on other matters of mutual interest,¹¹⁵ such as transboundary species and transboundary pollution, etc. Moreover, the CBD provides a set of specific regimes for the conservation of ecosystems as well as biodiversity,¹¹⁶ such as general measures for conservation and sustainable use, in-situ and ex-situ conservation, monitoring, etc. Particularly, Article 8 (d) and (f) specifically refer to the protection and restoration of ecosystems. In short, as the only legally binding global instrument that covers all ecosystems,¹¹⁷ the CBD adopts a holistic, multispecies approach to the conservation and management of biological resources and environment, which differs from the traditional, single-species approach.¹¹⁸

The Jakarta Mandate. It should be noted that, although the CBD is a global convention that deals with the general issues of biodiversity, it does not specifically refer to the protection of marine biodiversity as well as marine ecosystems.¹¹⁹ However, it undoubtedly applies to the conservation and management of marine ecosystems and biodiversity. Since September 1995, the marine environment has been on the agenda of the COP and the Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA) of the CBD. The COP and the SBSTTA have developed a series of recommendations and decisions on the implementation of the CBD, among which the Jakarta Mandate on Marine and Coastal Biodiversity¹²⁰ is of most significance. Adopted by the Second Meeting of the COP in November 1995, it is a program of action for implementing the CBD in the conservation and management of marine and coastal biodiversity.

The Jakarta Mandate identifies major impacts on marine and coastal ecosystems¹²¹ and makes detailed recommendations on how to deal with these problems. It focuses on five thematic areas: integrated marine and coastal area management; marine and coastal protection areas; sustainable use of coastal and marine living resources; mariculture; and

the introduction of alien species.¹²² With a central goal of achieving conservation and long-term sustainable use of marine and coastal ecosystems as well as biodiversity, the Mandate strongly recommends that ecosystem management approaches be widely adopted in various aspects of the above-mentioned areas.¹²³ The LME approach is highlighted in Paragraph 8 of the Annex to Recommendation I/8:

On the regional level, integrated management of marine and coastal ecosystems could be promoted through the Large Marine Ecosystem approach to monitor and evaluate ecosystem health. Through ensuring the integrity and productivity of large-scale ecosystems, continuous benefits can be derived from the vast array of biological resources they contain.¹²⁴

The Mandate indicates that it cannot be successfully implemented without collaboration of other relevant instruments and organizations.¹²⁵ Article 22 of the CBD makes it clear that, with respect to the marine environment, the CBD is to be implemented “consistently with the rights and obligations of States under the law of the sea”¹²⁶ and that there is to be a link between the CBD and other international instruments related to the ecosystem management of the marine environment and resources.¹²⁷ Here, “the law of the sea” not only refers to UNCLOS, but also includes other international conventions and agreements formulating the corpus of international law of the sea, such as the FSA, the Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas (the FAO Compliance Agreement),¹²⁸ and customary law of the sea.¹²⁹

The Fish Stocks Agreement. Agenda 21 called on states to convene an international conference to address the problems regarding high seas management of straddling fish stocks and highly migratory fish stocks.¹³⁰ The result of this process was the FSA.

The unity and the health of marine ecosystems are the underlying philosophy of the conservation and management measures set forth in the FSA. The preamble of the FSA points out that the states parties are “conscious of the need to avoid adverse impacts on the marine environment, preserve biodiversity, maintain the integrity of marine ecosystems and minimize the risk of long-term or irreversible effects of fishing operations.” Article 2 provides that the objective of the FSA is “to ensure the long-term conservation and sustainable use” of the fish stocks concerned. To this end, the FSA mainly adopts the following ecosystem approach.

The application scope of relevant conservation and management principles and measures of the FSA covers the full range of straddling and highly migratory fish stocks. Although the FSA regime applies mainly to straddling and highly migratory fish stocks on the high seas, the measures provided in Articles 6 and 7 are extended to fish stocks concerned within areas under national jurisdiction.¹³¹ Furthermore, coastal states are required to apply, *mutatis mutandis*, the general principles enumerated in Article 5 in areas under national jurisdiction.¹³² The starting point of the FSA regime is “the biological unity of the stocks concerned.”¹³³

The FSA adopts a series of principles related to the protection of marine ecosystems. These principles include, for example, ensuring the long-term sustainability of fish stocks and promoting the objective of their optimum utilization;¹³⁴ maintaining or restoring stocks at levels capable of producing the maximum sustainable yield; taking into account fishing patterns and the interdependence of stocks;¹³⁵ applying the precautionary approach;¹³⁶ assessing the impacts of fishing, other human activities, and environmental factors on target stocks, associated or dependent stocks, and species belonging to the

same ecosystem;¹³⁷ maintaining or restoring populations of such species above levels at which their reproduction may become seriously threatened;¹³⁸ minimizing pollution, waste, discards, catch by lost or abandoned gear, catch of nontarget species, and impacts on associated or dependent species, in particular endangered species;¹³⁹ protecting biodiversity in the marine environment;¹⁴⁰ and taking measures to prevent or eliminate overfishing and excess fishing capacity and to ensure that levels of fishing effort do not exceed those commensurate with the sustainable use of fishery resources.¹⁴¹ These principles not only include those already established in UNCLOS, but also those developed in the post-UNCLOS era, and therefore reflect the new concepts of marine conservation and management, including the ecosystem approach. It merits emphasizing that the wide application of the precautionary approach to conservation, management, and exploitation of fish stocks¹⁴² could play a very important role in the preservation and protection of marine ecosystems. As Moritaka Hayashi pointed out: “The ecosystem approach is taken fully into account in the precautionary approach.”¹⁴³

The FSA requires compatibility of conservation and management measures in the high seas and in areas under national jurisdiction.¹⁴⁴ The purpose of this is to ensure conservation and management of transboundary fish stocks in their entirety.¹⁴⁵ To this end, coastal states and states fishing on the high seas have a duty to cooperate in achieving such compatible measures. In determining compatible conservation and management measures, some ecological elements, including human elements, are to be taken into account: the biological unity and other biological characteristics of the stocks and the relationships between the distribution of the stocks, the fisheries, and the geographical particularities of the region concerned, including the extent to which the stocks occur and are fished in areas under national jurisdiction;¹⁴⁶ the respective dependence of the coastal states and the states fishing on the high seas on the stocks concerned;¹⁴⁷ and the harmful impact on the living marine resources as a whole.¹⁴⁸ With respect to highly migratory fish stocks, the FSA emphasizes that the states concerned should cooperate to ensure conservation and management of such stocks throughout their migratory range, both within and beyond the areas under national jurisdiction.¹⁴⁹

These mechanisms make the FSA an important international instrument in adopting an ecosystem approach to the conservation and management of the marine environment and resources.¹⁵⁰

The Code of Conduct for Responsible Fisheries. The Code of Conduct for Responsible Fisheries, which was unanimously adopted on 31 October 1995 by the FAO Council, is a global, non-legally-binding instrument establishing principles and standards for the conservation, management, and development of all fisheries.¹⁵¹ The thrust of the Code is sustainable utilization of fisheries resources in harmony with the environment, under which the ecosystem approach is widely adopted in various fisheries activities and the conservation of the living aquatic resources and their environment.

First, the Code adopts a series of general principles that are either directly related to, or supportive of, the ecosystem management approach. The first principle of the Code makes it clear that the right to fish carries with it the obligation to conserve aquatic ecosystems.¹⁵² The Code broadly endorses ecosystem management principles, such as: “management measures should not only ensure the conservation of target species but also of species belonging to the same ecosystem or associated with or dependent upon the target species”;¹⁵³ protection and rehabilitation of fisheries habitats in marine and fresh water ecosystems;¹⁵⁴ recognition of the transboundary nature of many aquatic ecosystems;¹⁵⁵ international cooperation in conservation and protection of living aquatic resources throughout their range of distribution, taking into account the need for compatible

measures in areas within and beyond national jurisdiction;¹⁵⁶ further development and application of selective and environmentally safe fishing gear and practices in order to maintain biodiversity and to conserve aquatic ecosystems;¹⁵⁷ and the application of the precautionary principle.¹⁵⁸ In addition, the Code provides guidelines for the application of these principles in various fisheries-related activities, including fisheries management,¹⁵⁹ fishing operations,¹⁶⁰ aquaculture development,¹⁶¹ and integration of fisheries into coastal area management.¹⁶² In terms of ecosystem management of fisheries resources and environment, the Code is an important, comprehensive international soft law document.¹⁶³

Other international documents also endorse an ecosystem approach to fisheries management: the 2001 Reykjavik Declaration on Responsible Fisheries in the Marine Ecosystem,¹⁶⁴ the 1992 Cancun Declaration on Responsible Fishing,¹⁶⁵ the 1995 Rome Consensus on Fisheries,¹⁶⁶ the 1995 Kyoto Declaration and Plan of Action,¹⁶⁷ the 1996 Rome Declaration on World Food Security and the World Food Summit Plan of Action,¹⁶⁸ and UN General Assembly Resolutions on Large-Scale Pelagic Driftnet Fishing.¹⁶⁹

In addition to all the above international instruments, the World Summit on Sustainable Development of 2002 encouraged the application of an ecosystem approach in ocean management by 2010.¹⁷⁰

The above-mentioned instruments are the major global documents related to the ecosystem approach to the conservation and management of the marine environment and resources. Besides these instruments, some other relevant global instruments are also applicable to the ecosystem management of the oceans, such as the 1979 Bonn Convention on the Conservation of Migratory Species of Wild Animals,¹⁷¹ the 1973 Washington Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES),¹⁷² the 1995 Global Program of Action for the Protection of the Marine Environment from Land-Based Activities,¹⁷³ the 1972 Stockholm Declaration on Human Environment,¹⁷⁴ the 1980 Draft World Charter for Nature,¹⁷⁵ and the UNEP Guidelines on Shared Resources.¹⁷⁶

At the regional level, the concept of ecosystem-based management has been adopted by some regional organizations as well as in some regional instruments, such as those emanating from the LME Projects¹⁷⁷ and the agreements on regional fisheries bodies.¹⁷⁸ The UNEP Regional Seas conventions and some other regional agreements¹⁷⁹ are also applicable to the ecosystem-based management of the seas and oceans.

Based on the above, it can be concluded that the obligation to adhere to the ecosystem-based management of the marine environment and resources has been established in international law.

International Practice. Many countries have made the commitment to apply ecosystem-based assessment and management of the marine environment and resources. Sixteen LME projects are underway in Asia, Africa, South America, and Europe, involving 126 countries.¹⁸⁰ Each project involves at least two littoral states that share the same regional sea. These projects are financially and technically supported primarily by the Global Environment Facility (GEF), the World Bank, the United Nations Industrial Development Organization (UNIDO), the Intergovernmental Oceanographic Commission (IOC), the World Conservation Union (IUCN), UNEP, UNDP, FAO, and the U.S. Department of Commerce's National Oceanic and Atmospheric Administration (NOAA). In these projects, LMEs are used as assessment and management units for the marine environment and resources, and scientific, technical, and financial assistance is provided to the developing countries concerned. The goal is to improve the long-term sustainability of the global marine environment and resources.¹⁸¹

At the national level, some countries, such as Canada, Australia, the United States, and the United Kingdom are engaging in developing and implementing an ecosystem approach to ocean management in national law and policy.

Canada has been a world leader in developing national oceans law. In December 1996, Canada passed the Oceans Act.¹⁸² The Act came into force in January 1997 and made Canada the first country to have comprehensive oceans management legislation. The Act refers to the development and implementation of a national oceans management strategy based on the principles of sustainable development, integrated management, and the precautionary approach.¹⁸³ In July 2002, more than five years after the law was enacted, Canada's Oceans Strategy, the Canadian government's policy statement for oceans management, was announced. At the heart of the Strategy is an integrated approach to oceans governance.¹⁸⁴

In December 1998, the release of Australia's Oceans Policy made Australia the first nation to produce a comprehensive oceans policy.¹⁸⁵ At the core of the Policy is a commitment to ecosystem-based management of the marine environment and resources. The planning, development, and management of Australia's oceans are based explicitly on LMEs. In order to achieve ecologically sustainable development of marine resources, the Policy requires that management be implemented through a new regional marine planning process. The development of Regional Marine Plans is to be based on identified LMEs and the integration of sectoral commercial interests and conservation requirements.

Since the late 1980s, a broader approach to natural resource management has been advocated in the United States.¹⁸⁶ Under the Clinton Administration, U.S. federal agencies began to implement ecosystem approaches to natural resource management. Although the U.S. federal government has not adopted any single, overarching legal instrument which specifically provides for ecosystem-based management of the marine environment and resources,¹⁸⁷ some of its existing legislation is supportive of these approaches.¹⁸⁸ For example, the Magnuson-Stevens Fishery Conservation and Management Act provides for the development of regional fishery management plans; it requires that, "To the extent practicable, an individual stock of fish shall be managed as a unit throughout its range, and interrelated stocks of fish shall be managed as a unit or in close coordination."¹⁸⁹ The National Coastal Monitoring Act¹⁹⁰ established national programs to monitor the environmental quality of coastal ecosystems; identify sources of degradation, and evaluate the effectiveness of government programs in abating degradation. The National Marine Sanctuaries Act authorizes the designation of marine sanctuaries to marine areas of ecological importance.¹⁹¹ The Coral Reef Conservation Act¹⁹² provides mechanisms to preserve, sustain, and restore the health of coral reef ecosystems. Although the current system of U.S. ocean governance is structured around sectoral management, area-based management, which can be made consistent with an ecosystem-based management, is adopted in some programs, for example, coastal zone management, the National Estuary Program, and the Marine Sanctuaries Program.¹⁹³

The U.S. National Oceanic and Atmospheric Administration (NOAA) highlights the harmonization of the development of the marine economy with the protection of the marine environment and resources. To achieve this goal, it commits "to implement integrated approaches to environmental management and ocean and coastal resources development for economic and social health."¹⁹⁴ In practice NOAA has initiated a number of ecosystem management-oriented programs.¹⁹⁵ Moreover, a high-level Commission on Ocean Policy¹⁹⁶ was established under the Oceans Act of 2000¹⁹⁷ to review "the state of marine-related issues and the effects of federal ocean-related laws and programs"¹⁹⁸ and make

recommendations for “coordinated, comprehensive, and long-range” national ocean policy.¹⁹⁹ Comprehensive ocean policy and management, the balance of economic and ecological health, and the health of marine ecosystems are to be highlighted in the study of the Commission.²⁰⁰ It is expected that the work of the Commission will lead to the adoption of more comprehensive and integrated approaches in the management of ocean and coastal environmental resources in the United States.

In the Irish Sea, which is a semi-enclosed regional sea with a range of stakeholders and activities, a pilot project was recently established to test the potential for an ecosystem approach to managing the marine environment.²⁰¹ The pilot project will seek ways of improving in practice the integration of nature conservation with the activities of other marine interest sectors, such as fisheries, oil and gas, and shipping. It involves the Government of Ireland, the Isle of Man, and the devolved administrations in the United Kingdom.

Difficulties and Problems of LME Management. The concept of ecosystem management has its critics, and the idea of LME management is not exempt from questions and doubts. Some authors opine that it creates difficult problems in application. The major problems in the adoption of LME management, as pointed out by these authors, are summarized below.

First, the understanding of marine ecosystems is lacking and the scientific basis for LME management is not sufficient. It is asserted that, “Relatively little is known about the dynamics of marine ecosystems.”²⁰² This is particularly true for the high seas where knowledge of stock abundance, distribution, and life histories of many species is mostly lacking.²⁰³ “The inadequacy of scientific understanding of complex relationships among species means that States have had difficulty in developing management measures that consider associated and dependent species except in a limited number of fisheries.”²⁰⁴ William T. Burke asserted that, “Remedying these handicaps to ecosystem management will have to wait until at least several decades in the 21st century.”²⁰⁵ Douglas Johnston went further on this point: “Even when better understood, they might not prove to be amenable to human control, and management may continue to be a futile quest.”²⁰⁶

Not only do some individual scholars doubt the feasibility of LME management, but some international organizations, such as FAO and the Parliamentary Assembly of the Council of Europe, have also been cautious. In 1980, an FAO Technical Report was pessimistic about states’ capabilities for ecosystem management because of insufficient understanding of ecosystems:

The management implication of the term “ecosystem management” presumes a reasonable understanding of the physical and chemical environment and biological species which describe an ecosystem, plus an understanding of the interactions among and between the species complex and their environment. Effective ecosystem management would also require an understanding of the flow of material energy and nutrients within the ecosystem. At present the totality of interactions is not sufficiently understood in any ecosystem to allow for comprehensive ecosystem management.²⁰⁷

Nearly two decades later, the European countries were still cautious about the practical applicability of ecosystem management, as reflected in a report of the Parliamentary Assembly of the Council of Europe.

“Large marine ecosystems” (LMEs) have been proposed, and aggressively promoted during the last decade, as potentially suitable management units for marine and coastal environment. Although the concept underlying LMEs has been theoretically elaborated in a number of publications, and is notionally introduced in a number of programmes, its practical applicability still requires verification in strictly scientific terms.²⁰⁸

Second, inconsistency between LMEs and maritime zones, especially exclusive economic zones (EEZs), may create jurisdictional problems. Few LMEs are limited to the EEZs or fisheries zones of a single state.²⁰⁹ The problem is that EEZs are politically delimited maritime zones, while LMEs are ecologically defined sea areas; thus, EEZ and LME boundaries mostly do not coincide, and particularly in the case of highly migratory species, the LMEs cross many EEZ boundaries. This makes it difficult to effectively manage LMEs.²¹⁰

That “Regimes based on ecosystems would tend to conflict or overlap with at least some of the jurisdictional regimes so carefully negotiated at UNCLOS III”²¹¹ is why LME as a management concept was not endorsed at the 1992 UNCED. In the preliminary sessions of UNCED, the LME concept was proposed as a major organizing principle for Chapter 17 of Agenda 21. However, this suggestion failed mainly because developing countries were reluctant to accept perceived limitations to their newly gained EEZ jurisdiction and surrender sovereign rights over stocks within their EEZs in the interests of ecosystem management at the regional scale.²¹² Furthermore, high seas fishing states did not want to give up their exclusive jurisdiction over their vessels on the high seas. William T. Burke pointed out that the LME as a management concept “is not intended to and does not resolve” the existing jurisdictional conflict between coastal states and high seas fishing states, but only “restates it in a different and not necessarily helpful way.”²¹³ Moreover, he argued that to “redefine” the limits of the coastal state jurisdiction in terms of “the undefined (perhaps undefinable in any specific sense except in particular instances, if then) and necessarily varying concept of an LME” causes “a pervasive uncertainty” to the present maritime jurisdictional system.²¹⁴ The jurisdictional problems caused by the LME management concept not only challenge the global diplomatic efforts to advocate a large marine ecosystem approach to fishery management,²¹⁵ but also become another major cause for some scholars to be pessimistic about its applicability and effectiveness. For example, Douglas Johnston argued: “Ecosystem-based fishery management may prove to be unworkable because of recently extended institutional investment in ‘politically defined’ ocean spaces.”²¹⁶ S. M. Garcia and M. Hayashi concluded: “It is clear that such a system of sequential and overlapping jurisdiction will make it difficult for ecosystem management to become as widely applied and effective rule as it should.”²¹⁷

As a compromise, it has been suggested that the geographical extent of ecosystems to be considered in ocean-use management plans needs to be defined “in a pragmatic manner,” based on “the stakeholder involvement” and “the artificial boundaries of the political and administrative systems already in place.”²¹⁸ This compromise is based on the fact that the geographical boundaries are in many circumstances difficult to rigorously define and are sometimes defined to fit various interests. For example, the ecosystems are generally “large scale and species specific” while fisheries management areas are normally defined “at smaller scales within national, provincial, regional, and municipal boundaries.”²¹⁹ In addition, the management-of-sub-regional-seas (MOSS) approach

to ocean and coastal management has been advocated by some experts. The CIDA-funded Gulf of Thailand Project and the GEF-funded Meso-American Barrier Reef System can be seen as experimental MOSS programs. The rationale behind this approach is that global and macroregional seas mechanisms are “generally too large, too clumsy, too expensive, and too politically divisive to be operationally effective” in ocean management.²²⁰

The best case for international cooperation in ocean management and ocean regime-building exists at the subregional seas level where the littoral states enjoy good relationships. The optimal LME management should take into account not only the natural characteristics of LMEs but also the socioeconomic and political elements of the human communities connected to the ecosystem. This synthesis of geographic, scientific, and political elements has been described as “the geo-political ecosystem (GPE).”²²¹

Third, not only can the LME management concept not resolve some existing problems of ocean management, but it may also magnify their complexity. An ecosystem approach covers larger geographical areas, involves more species, involves more political entities and more stakeholders, and requires more initial funding than less ambitious approaches.²²² In the context of marine management, the larger the LME, the less likely it is that it can be effectively managed.²²³ In the case of straddling stocks and highly migratory species over which coastal states and high seas fishing states often conflict, the requirement for ecosystem management may magnify the management difficulty.²²⁴

Fourth, the concept of ecosystem management may diversify existing uniform regimes. Ecosystem management

[T]hreatens to spawn highly diverse regimes, each negotiated largely on the basis of the specific variables associated with the ecosystem rather than on the basis of universal principles of law or ecology.²²⁵

Besides the above-mentioned problems, another major problem of LME management is that it overlaps or conflicts with existing marine management mechanisms. LMEs inevitably overlap with existing management areas of some international organizations or agencies such as UNEP (the Regional Seas Programs) and regional fishery bodies of both the FAO and non-FAO. Almost every regional sea area is more or less covered by various international agreements and programs and is governed by different intergovernmental institutions. However, the mushrooming of regional programs and institutions with overlapping and even conflicting functions and goals has also led to problems. Repetition and competition among some regional programs and institutions is one of the major issues and this can result in a waste of management resources and inefficiency of ocean management. A survey of existing regional marine programs and institutions unveils both geographical and functional overlaps and duplication of ocean management mandates and tools.

There are three, mainly parallel, governance regimes for regional seas. The first is fisheries management promulgated by FAO regional fishery organizations and numerous other regional fishery bodies.²²⁶ The second is marine environmental protection fostered by the UNEP Regional Seas Program initiated in 1974 and by the International Maritime Organization (IMO) regional mechanisms. There are now more than 140 coastal states and territories participating in 14 of these regional programs. There are also three partner programs (the Arctic, OSPAR for the North-East Atlantic, and HELCOM for the Baltic). There are other programs of this kind. For example, the Partnerships in Environmental Management for the Seas of East Asia (PEMSEA), involving eleven countries

since 1994, is a GEF project implemented by UNDP and executed by IMO.²²⁷ The third is the LME Projects as mentioned above. In addition to the spatial overlaps of these programs, the functional duplication among them and the implementing institutions occur mainly between: (1) Regional Seas Programs vs. LME projects in marine pollution and ocean governance, and (2) LME projects vs. regional fishery bodies in marine living resource management.

Although there are many programs and institutions, the marine environment and fisheries resources continue to decline. The problem is probably not a lack of regimes and institutions, but the insufficient capacity and political will to cooperatively implement the existing regimes. With regards to the necessity for the coordination of international marine-related institutions, Lee A. Kimball pointed out that the reason is not only to avoid duplication and overlap among institutions and enhance efficiency, but a far more compelling reason is to adopt an integrated approach to the complexity of ecosystems.²²⁸

There are certainly many other difficulties and problems in the application of LME management, involving science, technology, society, economy, politics, law, and other dimensions. There exist no clear-cut answers to these problems. However, states and other practitioners have been exploring various solutions and have gained some experience. The above-mentioned principles and guidance for ecosystem management are part of the crystallization of such experience and are applicable to LME management. For example, in regard to the insufficiency of understanding of marine ecosystems, the response is undoubtedly to strengthen scientific research and technical training, especially for developing countries, and the exchange of information, knowledge, and transfer of technology. Regarding jurisdictional problems, international cooperation is required in principle. Solutions may include the establishment of international joint management zones, comanagement, etc. As to the overlap of international marine management mechanisms, coordination of different institutions is the apparent response. The question of how to coordinate marine regional fishery bodies and regional seas conventions has been on the agenda of UNEP and FAO.²²⁹ It has also been proposed that the Regional Seas Program be restructured to facilitate its collaboration with other relevant institutions and change from a sectoral approach to a comprehensive approach.²³⁰ The problem of diversification of existing uniform regimes is a matter of regionalization, which has been clearly endorsed by UNCLOS, the FSA, Agenda 21, and other international instruments and has long been implemented to some degree in most, if not all, sea areas throughout the world. In relation to regionalization in ocean management, Lewis M. Alexander has pointed out that it is “a process” and “an alternative” “regardless of whether it is likely to be particularly effective.”²³¹

As a new way of ocean management, it is expected that LME management will encounter difficulties and problems. However, these difficulties and problems cannot halt the worldwide trend towards LME management. On the other hand, however, these multidimensional, complex problems will not be resolved without the concerted efforts of relevant sectors and parties at local, national, regional, and global levels.

Conclusion

The recent conceptualization and definition of LMEs has aroused an international campaign for LME management. From a scientific perspective, although human understanding of LMEs is not sufficient or complete, the knowledge obtained so far shows that a multispecies or a comprehensive ecosystem approach to the management of the marine environment and resources has a greater probability of being more effective than a

species-specific approach. The major contribution of the natural scientific theory of LMEs is that it provides the scientific evidence for a more rational approach to the management of the marine environment and resources. An ecosystem approach is theoretically the optimal tool to deal with the complexity of LMEs.

From a legal perspective, although there exists no specific global legal instrument on LME management, an ecosystem approach to natural (including marine) resources and environmental management is obligated by a number of international instruments, which are applicable to LME management. In addition, an ecosystem approach to ocean and coastal management has also been adopted in some national legislation and ocean policy documents.

The adoption of an ecosystem approach to LME management is not only a scientific and legal issue, but also, to a great extent, a political choice.

The adoption of an ecosystem approach to LME management is consistent with the general trend in developments in international ocean management. The international maritime communities are now in an age of adjusting and harmonizing the political maritime boundaries and ecological marine boundaries, aiming at a more rational protection of the marine environment and resources. After a process of "consolidation" and "harmonization" of the regimes for the sea areas under national jurisdiction in the 1980s, recent developments in the law of the sea have been characterized by a similar process of "redefinition and clarification" of the high seas regime, most particularly the "reordering" of the high seas fisheries.²³² One important mark of this process is the emergence of a number of international instruments that adopt ecosystem approaches to the conservation and management of resources and the environment. The LME management approach requires that the managed areas coincide with the ecological domains of marine resources and their environment and not be constrained by the limits of artificial national maritime boundaries.²³³ The transboundary nature of LME management requires the harmonization of different jurisdictions.

Some major problems of LME management require political solutions. Traditional international law of the sea adopted a zonal approach in marine management under which sea areas were divided into various zones within which states exercise different jurisdictions and adopt different systems of resource management. The major deficiency of the zonal approach is that political boundaries are not consistent with ecosystem boundaries. This inconsistency has become the root of many maritime conflicts, such as conflict between coastal interests and high seas interests and conflict between interests of development and interests of conservation, etc. It has also led to the failure and inefficiency of marine resource conservation in many sea areas, the result of which is the decline and deterioration of the marine environment and resources. In order to make up the deficiencies of the zonal approach to marine environmental protection, UNEP launched the Regional Seas Program. In this program, marine environmental protection is geography-based, with an attempt to attract full participation of all littoral states concerned. But such a regional approach has not proved to be as effective as expected. One of the major problems is that, in some regions, some of the coastal states elect not to join the regional arrangements or relevant agreements and this undermines the effectiveness of the regional mechanisms.²³⁴

Although the LME management approach is ecosystem-based, science-driven, and holistic, with an attempt to tackle the deficiencies of the zonal approach, it may also share some common deficiencies with the Regional Seas Program. For example, in the Yellow Sea LME project, the Democratic People's Republic of Korea (North Korea) has declined full participation.²³⁵

An ecosystem approach to LME management involves many more elements than the traditional sectoral and single-species approach, and is much more complicated. Therefore, the difficulties and problems encountered are also tougher. The major challenges with which LME management seeks to cope also constitute the major barriers for its successful implementation. Inherent difficulties in harmonizing jurisdictional conflicts are mainly of political nature. One important objective of an LME regime is to tackle the problems resulting from political boundaries, but in the final analysis, it has to depend on political solutions. The successful application of an ecosystem approach to LME management, to a great extent, relies on collective political will and the mutual cooperation of the states concerned.

Notes

1. A. G. Tansley, "The Use and Abuse of Vegetational Concepts and Terms," *Ecology* 16 (1935): 284–307.

2. J. Major, "Historical Development of the Ecosystem Concept," in *The Ecosystem Concept in Natural Resource Management*, ed. V. G. M. Dyne (New York and London: Academic Press, 1969), 9. See also N. L. Christensen et al., "The Report of the Ecological Society of America Committee on the Scientific Basis for Ecosystem Management," *Ecological Applications*, 6 (1996): 670. This report is also available at: <http://www.sdsc.edu/~ESA/ecmtext.htm>.

3. Tansley, *supra* note 1, at 299.

4. F. B. Golley, *A History of the Ecosystem Concept in Ecology—More Than the Sum of the Parts* (New Haven and London: Yale University Press, 1993), 9.

5. For example, Article 1(3) of the 1980 Convention on the Conservation of the Antarctic Marine Living Resources (CCAMLR) provides: "The Antarctic marine ecosystem means the complex of relationships of Antarctic marine living resources with each other and with their physical environment." Article 2 of the Convention on Biological Diversity (CBD) defines an ecosystem as "a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit."

6. Nordic Council of Ministers, Workshop on the Ecosystem Approach to the Management and Protection of the North Sea, Oslo, Norway, June 15–17, 1998, at 41. This report is also available at: <http://odin.dep.no/md/html/conf/workshop/1998/report.html> and *Envirosphere Consultants Limits*, "Ecosystem: In Review of Terms and Definitions Relevant to Ocean and Marine Resources Management under the Oceans Act," Report to Fisheries and Oceans Canada, Marine Ecosystems Conservation Branch, Ottawa, 1999, at 1 and 4.

7. G. Likens, *An Ecosystem Approach: Its Use and Abuse* (Oldendorf/Luhe Germany: Ecology Institute, 1992), 10.

8. See R. V. O'Neill et al., *A Hierarchical Concept of Ecosystems* (Princeton, NJ: Princeton University Press, 1986), 68–69 and B. G. Hatcher, "Coral Reef Ecosystems: How Much Greater Is the Whole than the Sum of the Parts?" *Coral Reefs* 16 (1997): S83.

9. See Global Environment Facility, *Operational Program # 12: Integrated Ecosystem Management*, April 20, 2000, available at: http://gefweb.org/Operational_Policies/Operational_Programs/OP_12_English.pdf.

10. For more discussion on ecosystem service and the relation between ecosystem health and human health, see, for example, *Understanding and Solving Environmental Problems in the 21st Century: Toward a New, Integrated Hard Problem Science*, ed. R. Costanza and S. E. Jorgensen (Oxford, UK: Elsevier Science, 2002), 101–138, 167–219.

11. B. D. Haskell et al., "What Is Ecosystem Health and Why Should We Worry about It?" in *Ecosystem Health: New Goals for Environmental Management* (Washington, DC: Island Press, 1992), 8–9. See also R. Costanza and M. Mageau, "What Is a Healthy Ecosystem?" in *The Gulf of Mexico Large Marine Ecosystem: Assessment, Sustainability, and Management*, ed. H. Kumpf, K. Steidinger, and K. Sherman (England: Blackwell Science, 1999), 386–393. For other defini-

tions of ecosystem health, see P. L. Angermeier and J. R. Karr, "Biological Integrity versus Biological Diversity as Policy Directives: Protecting Biotic Resources," *Bioscience* 44 (1994): 690–697; and R. E. Sparks, "Need for Ecosystem Management of Large Rivers and Their Flood Plains," *Bioscience* 45 (3) (1995): 169–182.

12. The following are examples of some suggested guidelines. (1) Health should not depend on criteria based on the presence, absence, or condition of a single species. (2) Health should not depend on a census or even inventory of large numbers of species. (3) Health should reflect our knowledge of normal succession or expected sequential changes that occur naturally in ecosystems. (4) While the optimal health measures should be single-valued (monotonic) and vary in a systematic and discernible manner, ecosystem health does not have to be measured as a single number. Single numbers compress a large number of dimensions (one for each type of items) to a point that geometrically has zero dimensions. (5) Health measures should have a defined range. (6) Health criteria should be responsive to change in data values but should not show discontinuities even when values change over several decades. (7) Health measures should have known statistical properties, if these are relevant. (8) Criteria for health assessment must be related and hierarchically appropriate for use in ecosystems. (9) Health measures should be dimensionless or share a common dimension. (10) Health measures should be insensitive to the number of observations, given some minimum number of observations. See D. J. Schaeffer, E. E. Herricks and H. W. Kerster, "Ecosystem Health: Measuring Ecosystem Health," *Environmental Management* 12 (1988): 445–455. See also Costanza and Mageau, *supra* note 11, at 393–402.

13. T. Hancock, "Towards Healthy and Sustainable Communities: Health, Environment and the Economy at the Local Level," a presentation at the Third Colloquium on Environmental Health, Quebec, November 22, 1990. There are other definitions of a healthy ecosystem. For example, an interim working definition of a healthy ecosystem offered by the first meeting of experts on the Jakarta Mandate on Marine and Coastal Biological Diversity in March 1997 is "one whose parameters do not vary outside predetermined limits from a predetermined level within a given period of time," and a harmful effect was defined as one that violates the conditions for a healthy ecosystem. See *Results of the first meeting of experts on the Jakarta Mandate on Marine and Coastal Biological Diversity*, held in Jakarta, Indonesia, 7–10 March, 1997, [IV. Additional Issues: A) Defining a healthy ecosystem], available at: http://darwin.bio.uci.edu/~sustain/bio65/indonesia/jak_man.html.

14. See Global Environment Facility, *supra* note 9.

15. Christensen et al., *supra* note 2, at 668.

16. H. J. Cortner et al, *Institutional Barriers and Incentives for Ecosystem Management*, Gen. Tech. Rep. PNW-GTR-354 (Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, 1996), 35.

17. L. M. Alexander, "Management of Large Marine Ecosystem: A Law of the Sea-Based Governance Regime," in *The Gulf of Mexico Large Marine Ecosystem: Assessment, Sustainability, and Management*, ed. H. Kumpf, K. Sreidinger, and K. Sherman (Malden, MA: Blackwell Science, 1999), 512. There are some other definitions of management, for example, "Management is a continuous, interactive, adaptive, participatory process comprised of a set of related tasks, all of which must be carried out to achieve a desired set of goals and objectives, however those goals and objectives are established and specified." See "ICM Basics: What Is Management?" available at: http://www.icm.noaa.gov/story/icm_mgt.html.

18. L. Juda and R. H. Burroughs, "The Prospects for Comprehensive Ocean Management," *Marine Policy* 14 (1) (1990): 23–35.

19. B. Cicin-Sain and R. W. Knecht, *The Future of U.S. Ocean Policy: Choices for the New Century* (Washington, DC, Covelo, California: Island Press, 2000), 14.

20. Christensen et al, *supra* note 2, at 668–669.

21. R. Schlaepfer, *Ecosystem-Based Management of Natural Resources: A Step towards Sustainable Development*, IUFRO Occasional Paper No. 6, 1997, at 9 and 16, available at: <http://iufro.boku.ac.at/publications/occ6/occ-p6.htm>.

22. *Ibid.*, at 19.

23. Nordic Council of Ministers, *supra* note 6, at 45.

24. There are many other related terms, such as a bioregional approach; bioregional planning; ecoregion-based conservation; watershed management approach; holistic, intersectoral, and interactive approach; ecosystem approach that integrate the conservation of biological diversity and the sustainable use of biological resources; ecosystem approach that integrate the conservation and sustainable use of biological diversity as well as socioeconomic considerations; and precautionary ecosystem management approach.

25. Secretariat of the Convention on Biological Diversity, *From Policy to Implementation: Decisions from the Fifth Meeting of the Conference of the Parties to the Convention on Biological Diversity*, Nairobi, Kenya, 15–16 May, 2000 (Montreal: Secretariat of the Convention on Biological Diversity, 2000), 36, available at: <http://www.biodiv.org/decisions/default.asp?lg=0&m=cop-05&d=06>. See also J. Patlis, “Biodiversity, Ecosystems, and Endangered Species,” in *Biodiversity and the Law*, ed. W. J. Snape (Washington, D. C. and Covelo, California: Island Press, 1996), 46–47.

26. Christensen et al., *supra* note 2, at 669–670.

27. Secretariat of the Convention on Biological Diversity, *supra* note 25, at 37–41. For more discussion on ecosystem principles, goals, and policies, see, for example, J. Gordon and J. Coppock, “Ecosystem Management and Economic Development,” in *Thinking Ecologically: The Next Generation of Environmental Policy*, ed. M. R. Chertow and D. C. Esty (New Haven and London: Yale University Press, 1997), 39; M. E. Jensen and R. Everett, “An Overview of Ecosystem Management Principles,” in *Ecosystem Management: Principles and Applications*, General Technical Report PNW-GTR-318, ed. M.E. Jensen and P. S. Bourgeron (U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, 1994), 6; UNEP, *Ecosystem-based Management of Fisheries: Opportunities and Challenges for Coordination between Marine Regional Fisheries Bodies and Regional Seas Conventions*, UNEP Regional Seas Reports and Studies No. 175 (Nairobi: UNEP, 2001); The U.S. Congress, *Ecosystem Management: Joint Oversight Hearing before the Subcommittee on Oversight and Investigations Committee on Natural Resources and the Subcommittee on Specialty Crops and Natural Resources Committee on Agriculture and the Subcommittee on Environment and Natural Resources, Committee on Merchant Marine and Fisheries, House of Representatives, One Hundred Third Congress, Second Session on Ecosystem Management and a Report by the General Accounting Office, “Ecosystem Management – Additional Actions Needed to Adequately Test a Promising Approach,” Hearing held in Washington D.C., September 20, 1994* (Washington: U.S. Government Printing Office, 1995); L. Kimball, *International Ocean Governance: Using International Law and Organizations to Manage Marine Resources Sustainably* (Gland, Switzerland and Cambridge: IUCN, 2001), 46; A. T. Charles, *Sustainable Fishery Systems* (Oxford, UK: Blackwell Science, 2001), 225–233; J. Brunnee and S.J. Toope, “Environmental Security and Freshwater Resources: A Case for International Ecosystem Law,” in *Yearbook of International Environmental Law* 5 (New York: Oxford University Press, 1994): 41–76; J. Brunnee and S. J. Toope, “Environmental Security and Freshwater Resources: Ecosystem Regime Building,” *American Journal of International Law* 91(1997): 26–59; U.S. National Marine Fisheries Service, *Ecosystem-based Fisheries Management: A Report to Congress by the Ecosystem Principles Advisory Panel*, 1999, available at: <http://www.st.nmfs.gov/st2/Eco-bas-fis-man.pdf>; *Proceedings of a Workshop on the Ecosystem Considerations for the Eastern Scotian Shelf Integrated Management (ESSIM) Area*, ed. R. O’Boyle, 2000, available at: <http://www.mar.dfo-mpo.gc.ca/science/rap/internet/pro2000-14.pdf>; and *Proceedings of the National Workshop on Objectives and Indicators for Ecosystem-based Management*, ed. G. Jamieson and R. O’Boyle, 2001, available at: http://www.dfo-mpo.gc.ca/csas/Csas/Proceedings/2001/PRO2001_09e.pdf.

28. See the World Commission on Environment and Development, *Our Common Future* (New York, Oxford: Oxford University Press, 1987), 43.

29. See Christensen et al., *supra* note 2, at 667.

30. Jamieson and O’Boyle, *supra* note 27, 2001, at 9–19. There are some other opinions on ecosystem objectives. For example, Henrik Gislason et al. opine that the ecosystem objectives for ocean management are maintenance of: (1) ecosystem diversity; (2) species diversity; (3) genetic

variability within species; (4) directly impacted species; (5) ecologically dependent species; (6) trophic level balance. H. Gislason et al., "Symposium Overview: Incorporating Ecosystem Objectives within Fisheries Management," *ICES Journal of Marine Science*, 57 (2000): 468, 472, available at: <http://www.idealibrary.com/links/doi/10.1006/jmsc.2000.0741/pdf>.

31. See, for example, Reports on the work of the United Nations Open-Ended Consultative Process established by the General Assembly in its resolution 54/33 in order to facilitate the annual review by the Assembly of developments in ocean affairs, available at: http://www.un.org/Depts/los/consultative_process/consultative_process.htm.

32. Global Environment Facility, supra note 9.

33. For example, the Jamaica–Colombia Joint Regime Area. For some other examples of maritime joint management/development zones, see E.M. Borgese, *The Oceanic Circle: Governing the Seas as A Global Resource* (Tokyo, New York, Paris: United Nations University Press, 1998), 123–129.

34. Global Environment Facility, supra note 9.

35. See Secretariat of the Convention on Biological Diversity, supra note 25, at 36.

36. The human component of the ecosystem includes not only the human themselves, but also "their artifacts and manufactured goods (economics), and their institutions and cultures." See U.S. National Marine Fisheries Service, supra note 27, at 13.

37. See Nordic Council of Ministers, supra note 6, at 25–26; United States Department of Agriculture, Forest Service, *An Ecological Basis for Ecosystem Management*, General Technical Report RM-246 (Fort Collins, Colorado, 1994), 3; Principle 1 of the Rio Declaration recognizes: "Human beings are at the centre of concerns for sustainable development. They are entitled to a healthy and productive life in harmony with nature."

38. FAO, *Towards Ecosystem-Based Fisheries Management*, a background paper prepared by FAO for the Reykjavik Conference on Responsible Fisheries in the Marine Ecosystem, 2001, Para. 28, available at: <ftp://ftp.fao.org/fi/document/reykjavik/default.htm>.

39. The World Commission on Environment and Development, supra note 28, at 49.

40. Global Environment Facility, supra note 9.

41. U.S. Fish & Wildlife Service, Ecosystem Conservation, available at: <http://ecosystems.fws.gov/>

42. Royal Holloway Institute for Environmental Research, University of London, Ecosystem Approach Survey 2000, available at: <http://www1.rhnc.ac.uk/rhier/craig.htm#Assessment>.

43. Global Environment Facility, supra note 9.

44. A list of LME projects is available at: <http://na.nefsc.noaa.gov/lme/project.htm>.

45. Chapter 17, Para.1, Agenda 21 (1992).

46. K. Sherman and L. M. Alexander, *Variability and Management of Large Marine Ecosystem* (Boulder, Colorado: Westview Press, 1986), 99. See also L. M. Alexander, "Large Marine Ecosystems: A New Focus for Marine Resources Management," *Marine Policy* 17 (1993): 186–198; and K. Sherman, "Sustainability, Biomass Yields, and Health of Coastal Ecosystems: An Ecological Perspective," *Marine Ecology Progress Series* 112 (1994): 277–301.

47. Information on LMEs is available at: <http://www.edc.uri.edu/lme/clickable-map.htm>.

48. "Large Marine Ecosystems," August 20, 1998, available at: <http://www.people.fas.harvard.edu/~henricks/LME.html>.

49. For a description of the importance of marine and coastal ecosystems, see, for example, A. C. De Fontaubert, D. R. Downes, and T. S. Agardy, *Biodiversity in the Seas: Implementing the Convention on Biological Diversity in Marine and Coastal Habitats* (Gland and Cambridge: IUCN, 1996), 6.

50. See J.F. Franklin, "The Fundamentals of Ecosystem Management with Applications in the Pacific Northwest," in *Defining Sustainable Forestry*, ed. G. H. Aplet et al., (Washington, DC: Island Press, 1993), 127–144.

51. See A. M. Duda and K. Sherman, "A New Imperative for Improving Management of Large Marine Ecosystems," *Ocean and Coastal Management*, 45 (2002): 811–814; K. Sherman, "Modular Approach to the Monitoring and Assessment of Large Marine Ecosystems," in *The Gulf of Mexico Large Marine Ecosystem: Assessment, Sustainability, and Management*, ed. H.

Kumpf, K. Sreidinger, and K. Sherman (Malden, MA: Blackwell Science, 1999), 34; K. Sherman and A. M. Duda, "Toward Ecosystem-based Recovery of Marine Biomass Yield," *Ambio*, 30 (3) (2001): 168–169; K. Sherman, "Why Regional Coastal Monitoring for Assessment of Ecosystem Health?"; K. Sherman and A. M. Duda, "An Ecosystems Approach to Global Assessment and Management of Coastal Waters," in *Baltic Sea Regional Project: Project Implementation and Procurement Plan, Volume 2, Part A*, ed. J. Thulin, June 2002, Annex 5, at xxii–xxv; Annex 6, at 17–21, available at: http://www.ices.dk/projects/balticsea/unzip/vol.2_A_1.doc; Large Marine Ecosystem (LME) Approach to the Global International Water Assessment (GIWA), Working Document of the Technical Workshop for Establishing a Regular Process for the Global Assessment of the Marine Environment, Bremen, Germany, 18–20 March, 2002, available at: http://www.unep.org/DEWA/water/MarineAssessment/reports/germany_report/LME-GIWA.doc; L. Juda, "Considerations in Developing a Functional Approach to the Governance of Large Marine Ecosystems," *Ocean Development and International Law*, 30 (1999): 89–125; L. Juda and T. Hennessey, "Governance Profiles and the Management of the Uses of Large Marine Ecosystems," *Ocean Development and International Law*, 32 (2001): 43–69; K. Sherman, "Large Marine Ecosystem Monitoring, Assessment, and Management Across the Global North-South Divide," a paper presented at the Global Environment Facility Second Biennial International Waters Conference, Dalian, China, September 25–29, 2002, at 7–10, available at: <http://www.iwlearn.net/event/presentations/iwc2002/agenda.php>; and A Framework for Monitoring and Assessing Socioeconomics and Governance of Large Marine Ecosystems, NOAA Technical Memorandum NMFS-NE-158, ed. J. Sutinen, 2000, available at: <http://www.nefsc.noaa.gov/nefsc/publications/tm/tm158/tm158.pdf>. For more information on the five modules, see: <http://www.edc.uri.edu/lme/intro.htm>.

52. For a discussion on the similarities and differences between the LME management approach and integrated coastal and ocean management, see S. Olsen, "Linking Integrated Coastal Management with Large Marine Ecosystems Management," in *The Gulf of Mexico Large Marine Ecosystem: Assessment, Sustainability, and Management*, ed. H. Kumpf, K. Sreidinger and K. Sherman (Malden, MA: Blackwell Science, 1999), 626–633.

53. K. Sherman, "Introduction to Part One: Case Studies of Perturbations in Large Marine Ecosystems," in *Biomass Yields and Geography of Large Marine Ecosystems*, ed. K. Sherman and L. M. Alexander (Colorado and London: Westview Press, 1989), 3.

54. See, for example, the ICES Strategic Plan, February 2002, available at: <http://www.ices.dk/iceswork/strategic%20plan-final.pdf>.

55. CCAMLR, 1980 reprinted in 19 *International Legal Materials* 841 (1980).

56. J. A. Gulland, "The Antarctic Treaty System as A Resource Management Mechanism," in *The Antarctic Treaty: Law, Environment and Resources*, ed. G. Triggs (Cambridge: Cambridge University Press, 1987), 120.

57. The preamble of CCAMLR.

58. Article 2 (1) of CCAMLR.

59. Article 1 (2) of CCAMLR.

60. Article 2 (3) reads:

Any harvesting and associated activities in the area to which this Convention applies shall be conducted in accordance with the provisions of this Convention and with the following principles of conservation: (a) prevention of decrease in the size of any harvested population to levels below those which ensure its stable recruitment. For this purpose its size should not be allowed to fall below a level close to that which ensures the greatest net annual increment; (b) maintenance of the ecological relationships between harvested, dependent and related populations of Antarctic marine living resources and the restoration of depleted populations to the levels defined in sub-paragraph (a) above; and (c) prevention of changes or minimisation of the risk of changes in the marine ecosystem which are not potentially reversible over two or three decades, taking into account the state of available knowledge of the direct and indirect impact of harvesting, the effect of the introduction of alien species, the effects of associated activities on the marine ecosystem and of the effects of

environmental changes, with the aim of making possible the sustained conservation of Antarctic marine living resources.

61. S. Lyster, *International Wildlife Law: An Analysis of International Treaties Concerning with the Conservation of Wildlife* (Cambridge: Cambridge University Press, 1994), 158.

62. Principle 15 of the 1992 Rio Declaration which provides for the precautionary principle reads:

In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.

63. For a discussion on the linkages between the precautionary principle and ecosystem management, see S.M. Kaye, *International Fisheries Management* (The Hague, London, Boston: Kluwer International, 2001), 273–274.

64. CCAMLR Scientific Committee, Ecosystem Approach, available at: <http://www.ccamlr.org/pu/e/sc/eco-app-intro.htm>.

65. Article 1 (1) of CCAMLR reads:

This Convention applies to the Antarctic marine living resources of the area south of 60° South latitude and to the Antarctic marine living resources of the area between that latitude and the Antarctic Convergence which form part of the Antarctic marine ecosystem.

The Antarctic Convergence is where warmer sub-Antarctic waters flowing south meet the colder Antarctic waters in an upwelling zone of considerable biological productivity, forming a natural biological frontier which separates distinct marine communities on either side. Its coverage extends beyond the boundary of the Antarctic Treaty area at 60° South latitude and includes an important area between the Convergence and 60° South latitude where many of the known concentrations of krill are situated. See R. Baird, “Fishing and the Southern Ocean: The Development of Fisheries and the Role of CCAMLR in their Management,” *University of Tasmania Law Review* 16(2) (1997): 168 and B. Mitchell and J. Thinker, *Antarctic and Its Resources* (London: Earthscan, 1980), 67.

66. See Article 11 of CCAMLR.

67. See particularly Articles 7, 9, 10, 11, 14, 15, and 24 of CCAMLR.

68. United Nations Convention on the Law of the Sea, 1982 reprinted in 21 *International Legal Materials* 1261 (1982).

69. CCAMLR was negotiated starting in 1976, was concluded in May 1980, and came into force in April 1982. UNCLOS was negotiated starting in December 1973, was concluded in December 1982, and entered into force in November 1994.

70. Article 194 (5) of UNCLOS reads: “The measures taken in accordance with this Part shall include those necessary to protect and preserve rare or fragile ecosystems as well as the habitat of depleted, threatened or endangered species and other forms of marine life.”

71. See Article 145 (a) of UNCLOS.

72. See, for example, M.H. Belsky, “Legal Regimes for Management of Large Marine Ecosystems and Their Component Resources,” in *Large Marine Ecosystems: Stress, Mitigation and Sustainability*, ed. K. Sherman, L. M. Alexander and B. D. Gold (Washington, DC: the American Association for the Advancement of Science Press, 1993), 227–236 and M.H. Belsky, “Using Legal Principles to Promote the Health of the Ecosystem,” *Tulsa Journal of Comparative & International Law* 3 (1996): 183–204.

73. W. T. Burke, “Compatibility and Protection in the 1995 Straddling Stock Agreement,” in *Law of the Sea: The Common Heritage and Emerging Challenges*, ed. H. N. Scheiber (The Hague, London, Boston: Martinus Nijhoff Publishers, 2000), 125–126.

74. W. T. Burke, “The Law of the Sea Convention and Fishing Practices of Nonsignatories, with Special Reference to the United States,” in *Consensus and Confrontation: The United States and the Law of the Sea Convention*, ed. J. M. Van Dyke (Honolulu: The Law of the Sea Institute, University of Hawaii, 1984), 315, 332–333. See also W.T. Burke, *The New International Law of*

Fisheries: UNCLOS 1982 and Beyond (Oxford: Clarendon Press, 1994), 81; W. T. Burke, M. Freeberg, and E. L. Miles, "United Nations Resolutions on Driftnet Fishing: An Unsustainable Precedent for High Seas and Coastal Fisheries Management," *Ocean Development and International Law* 25 (1994): 147; W. T. Burke, "UNCED and the Oceans," *Marine Policy* 17 (6) (1993): 531–532; W. T. Burke, "'Customary Law as Reflected in the LOS Convention': A Slippery Formula," in *The International Implications of Extended Maritime Jurisdiction in the Pacific*, ed. J. P. Craven, J. Schneider, and C. Stimson (Honolulu: The Law of the Sea Institute, University of Hawaii, 1989), 402–409.

75. Alexander, *supra* note 17, at 513.

76. *Ibid.*, at 512.

77. See, for example, P. Birnie, "Are Twentieth-Century Marine Conservation Conventions Adaptable to Twenty-First Century Goals and Principles? (Part I)," *The International Journal of Marine and Coastal Law*, 12 (3) (1997): 307–339, particularly 313, 241, 319, 321, 338; F. Orrego Vicuna, *The Changing International Law of High Seas Fisheries* (Cambridge: Cambridge University Press, 1999), 43, 289; E. L. Miles, "The Approaches of UNCLOS III & Agenda 21—A Synthesis," in *Sustainable Development and Preservation of the Oceans: The Challenges of UNCLOS and Agenda 21*, ed. M. K. Atmadja, T. A. Mensah, and B. H. Oxman (Honolulu: The Law of the Sea Institute, William S. Richardson School of Law, University of Hawaii, 1997), 18, 27, 28; L. A. Kimball, "United Nations Convention on the Law of the Sea: A Framework for Marine Conservation," in IUCN, *The Law of the Sea: Priorities and Responsibilities in Implementing the Convention* (Part I) (Gland, Switzerland: IUCN, 1995), 77, 103; M. Hayashi, "The 1995 UN Fish Stocks Agreement and the Law of the Sea," in *Order for the Oceans at the Turn of the Century*, ed. D. Vidas and W. Østreng (The Hague, London, Boston: Kluwer Law International, 1999), 48–49; and E. Hey, *The Regime for the Exploitation of Transboundary Marine Fisheries Resources: The United Nations Law of the Sea Convention Cooperation between States* (Dordrecht, Boston, London: Martinus Nijhoff Publishers, 1989), 54.

78. Para. 4 of the preamble of UNCLOS.

79. Para. 3 of the preamble of UNCLOS. This is considered to be one of the two fundamental principles on which the new law of the sea is built. The other fundamental principle is the principle of the common heritage of mankind. See E. M. Borgese, *supra* note 33, at 133.

80. See Committee on the Environment, Regional Planning and Local Authorities, Parliamentary Assembly, Council of Europe, *The Oceans: State of the Marine Environment and New Trends in International Law of the Sea*, Report Doc. 8177, 1998, available at: <http://assembly.coe.int/Documents/WorkingDocs/doc98/edoc8177.htm>. See also Parliamentary Assembly, Council of Europe, *Oceans* (Belgium: Council of Europe Publishing, 1999), 125.

81. Orrego Vicuna, *supra* note 77, at 43.

82. Article 145 of UNCLOS is reflected in Paragraphs 5(g) and 7 of Section 1 of the Annex to the 1994 Agreement on the Implementation of Part XI of UNCLOS, and Part V of the Regulations on Prospecting and Exploration for Polymetallic Nodules in the Area of July 2000. The latter document is available at: <http://www.isa.org.jm/en/default.htm> (ISBA/6/C/12).

83. Article 192 of UNCLOS.

84. See, for example, Articles 61(2) (5), 63, 64, 66, 67, 118, 123, 194, and 197 of UNCLOS. In this connection, the requirement of Article 123 for the coordination and cooperation of states bordering enclosed or semi-enclosed seas in the conservation and management of living resources in these seas is particularly important because some of the LMEs are defined as such seas. See L. M. Alexander, *supra* note 17, at 513.

85. See, for example, Article 61(2) of UNCLOS.

86. Reprinted in 34 *International Legal Materials* 1542 (1995).

87. See, particularly, the preamble and Articles 5, 7, 8 of the FSA. For some discussion on this point, see, for example, Orrego Vicuna, *supra* note 77; and A. Tahindro, "Comments in Light of the Adoption of the 1995 Agreement for the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks," *Ocean Development and International Law*, 28 (1997): 1–58.

88. With regard to the relationship between the FSA and UNCLOS, Article 4 of the FSA provides: "Nothing in this Agreement shall prejudice the rights, jurisdiction and duties of States under the Convention. This Agreement shall be interpreted and applied in the context of and in a manner consistent with the Convention."

89. Orrego Vicuna, *supra* note 77, at 289.

90. *Ibid.*

91. *Ibid.*, at 43. See also A. Tahindro, *supra* note 87, at 6–7.

92. Miles, *supra* note 77, at 18.

93. *Ibid.*, at 28.

94. Birnie, *supra* note 77, at 313–314.

95. L. Kimball, "Environmental Law and Policy in Antarctica," in *Greening International Law*, ed. P. Sands (New York: The New Press, 1994), 131.

96. Alexander, *supra* note 17, at 515.

97. See D.R. Christie, "The Conservation and Management of Stocks Located Solely within the Exclusive Economic Zone," in *Developments in International Fisheries Law*, ed. E. Hey (The Hague, Boston: Kluwer Law International, 1999), 407; Alexander, *supra* note 17, at 515; and A.C. De Fontaubert, "Legal and Political Considerations," in *The Status of Natural Resources on the High-Seas*, ed. WWF/ IUCN (Gland, Switzerland: WWF/ IUCN, 2001), 79, available online at: <http://www.panda.org/resources/publications/water/highseas.pdf>.

98. Vienna Convention on the Law of Treaties, 1969 reprinted in 8 *International Legal Materials* 679 (1969).

99. [1997] *I.C.J. Reports* 7, at 78, paragraph 140 reads:

Throughout the ages, mankind has, for economic and other reasons, constantly interfered with nature. In the past, this was often done without consideration of the effects upon the environment. Owing to new scientific insights and to a growing awareness of the risks for mankind—for present and future generations—of pursuit of such interventions at an unconsidered and unabated pace, new norms and standards have been developed, set forth in a great number of instruments during the last two decades. Such new norms have to be taken into consideration, and such new standards given proper weight, not only when States contemplate new activities but also when continuing with activities begun in the past. This need to reconcile economic development with protection of the environment is aptly expressed in the concept of sustainable development.

100. Separate opinion of Vice-President Weeramantry, [1997] *I.C.J. Reports* 7, at 113–115.

101. The Code is available at: www.fao.org/fi.agreem/codecond/ficonde.asp.

102. Examples of such new principles related to environmental protection include, among others, the principle of sustainable development (Principle 3), the principle of common but differentiated responsibilities (Principle 7), public participation (Principle 10), the precautionary principle (Principle 15), the polluter pays principle (Principle 16), environmental impact assessment (Principle 17), and a vital role for indigenous people and women in environmental management (Principles 20 and 22), etc.

103. The meaning of sustainable development is expressed in Principle 3 of the Rio Declaration: "The right to development must be fulfilled so as to equitably meet developmental and environmental needs of present and future generations."

104. Principle 15 of the Rio Declaration is set out at *supra* note 62.

105. Paragraph 1 of Chapter 17 of Agenda 21.

106. The seven program areas laid out in Chapter 17 of Agenda 21 are: (a) integrated management and sustainable development of coastal areas, including exclusive economic zones; (b) marine environmental protection; (c) sustainable use and conservation of marine living resources of the high seas; (d) sustainable use and conservation of marine living resources under national jurisdiction; (e) addressing critical uncertainties for the management of the marine environment and climate change; (f) strengthening international, including regional, cooperation and coordination; and (g) sustainable development of small islands.

107. T. L. Laughlin, "Chapter 17 of Agenda 21: Implementing Data and Information Aspects," *Marine Policy* 17 (6) (1993): 558.

108. D. M. Johnston, "UNCLOS III and UNCED: A Collision of Mind-Set?" in *Ocean Law and Policy in the Post-UNCED Era: Australian and Canadian Perspectives*, ed. L. K. Kriwoken et al. (London, The Hague, Boston: Kluwer Law International, 1996), 13.

109. D. Freestone, "The Conservation of Marine Ecosystem under International Law," in *International Law and the Conservation of Biological Diversity*, ed. M. Bowman and C. Redgwell (London, The Hague, Boston: Kluwer Law International, 1996), 94. See also L. Juda, "Rio Plus Ten: The Evolution of International Marine Fisheries Governance," *Ocean Development and International Law*, 33 (2002): 111–112.

110. Article 2 of the CBD provides: "Biological diversity means the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems."

111. See paragraph 11 of the preamble of the CBD.

112. See Secretariat of the Convention on Biological Diversity, *supra* note 25, at 35. The COP Decision V/6 is also available at: <http://www.biodiv.org/decisions/default.asp?lg=0&m=cop-05&d=06>. Sam Johnston mentions that the ecosystem approach forms the underlying philosophy of CBD. See S. Johnston, "The Convention on Biological Diversity: The Next Phase," *Review of European Community and International Environmental Law*, 6 (3), (1997): 219. See also N. Matz, "The Interaction between the Convention on Biological Diversity and the UN Convention on the Law of the Sea," in *Marine Issues: From A Scientific, Political and Legal Perspective*, ed. P. Ehlers et al. (The Hague, London, New York: Kluwer Law International, 2002), 207–210.

113. Article 1 of the CBD.

114. Article 4 of the CBD.

115. Article 5 of the CBD.

116. See especially Articles 6 through 10 of the CBD.

117. M.M. Goote, "Convention on Biological Diversity: The Jakarta Mandate on Marine and Coastal Biological Diversity," *International Journal of Marine and Coastal Law*, 12 (3) (1997): 378.

118. See Canadian Institute for Environmental Law and Policy, *Biodiversity Law and Policy in Canada: Review and Recommendations* (Toronto: Canadian Institute for Environmental Law and Policy, 1996), 27.

119. In this connection, David Freestone mentioned: "Nowhere else in the Convention is specific reference made to the protection of marine biodiversity. . ."; "the particular problems of the conservation of marine ecosystems and biodiversity have been largely overlooked by the Convention." See D. Freestone, "The Conservation of Marine Ecosystems under International Law," in *International Law and the Conservation of Biological Diversity*, ed. M. Bowman and C. Redgwell (London, The Hague, Boston: Kluwer Law International, 1996), 91, 106.

120. Available at: <http://www.biodiv.org/programmes/areas/marine/>.

121. Impacts on marine and coastal ecosystems are identified as five main categories: "chemical pollution and eutrophication; fisheries operations; global climate change; and alterations of physical habitat and invasions of exotic species." Available at: <http://www.biodiv.org/programmes/areas/marine/>.

122. Available at: <http://www.biodiv.org/recommendations/default.asp?lg=0&m=sbstta-01>.

123. See, for example, Para. 6 of Annex to Recommendation I/8 (Integrated Marine and Coastal Area Management):

Current sectoral approaches to the management of marine and coastal resources have generally not proven capable of conserving marine and coastal biological diversity. New models are needed to move planners toward multiple-use, systems-oriented modes of management, based on precautionary approaches and ecosystem management principles. Wide adoption and implementation of integrated marine and coastal area management are necessary for effective conservation and sustainable use of marine and coastal biological diversity.

124. Available at: <http://www.biodiv.org/recommendations/default.asp?lg=0&m=sbstta-01&r=08>.

125. See, for example, Paragraphs 12 (e) (f), 16 (I) (a), 18 (a) (b) of Recommendation I/8, available at: <http://www.biodiv.org/recommendations/default.asp?lg=0&m=sbstta-01&r=08> and Paragraphs 10, 11, 12, 13 of Decision II/10, available at: <http://www.biodiv.org/decisions/default.asp?lg=0&dec=II/10>.

126. Article 22 of the CBD provides:

(1) The provisions of the Convention shall not affect the rights and obligations of any contracting Party deriving from any existing international agreement, except where the exercise of those rights and obligations would cause a serious damage or threat to biological diversity.

(2) Contracting Parties shall implement this Convention with respect to the marine environment consistently with the rights and obligations of States under the law of the sea.

127. For a discussion on the implementation of the CBD in marine environment, See A. C. De Fontaubert, D. R. Downes, and T. S. Agardy, *Biodiversity in the Seas: Implementing the Convention on Biological Diversity in Marine and Coastal Habitat* (Gland, Switzerland and Cambridge: IUCN, 1996).

128. The FAO Compliance Agreement, 1993 is reprinted in 33 *International Legal Materials* 968 (1994).

129. C. C. Joyner, "Biodiversity in Marine Environment: Resource Implications for the Law of the Sea," *Vanderbilt Journal of Transnational Law*, 28 (1995): 650. See also A. Rengifo, "Protection of marine biodiversity: A new generation of fisheries agreements," *Review of European Community and International Environmental Law*, 6 (3) (1997): 318; and *Australia's Ocean Policy*, Background Paper 2, available at: <http://www.oceans.gov.au/aop/develop/series/bgpaper2/chap18.html>.

130. Paragraph 49 of Chapter 17 of Agenda 21.

131. Article 3(1) of the FSA.

132. Article 3(2) of the FSA.

133. Orrego Vicuna, *supra* note 77, at 176.

134. Article 5 (a) of the FSA.

135. Article 5 (b) of the FSA.

136. Article 5 (c) of the FSA. The detailed provisions on the precautionary approach are contained in Article 6 and Annex II of the FSA. For more information on this point, see, for example, FAO, *Precautionary Approach to Fisheries*, FAO Fisheries Technical Paper, No. 350 (Rome: FAO, 1995).

137. Article 5 (d) of the FSA.

138. Article 5 (e) of the FSA.

139. Article 5 (f) of the FSA.

140. Article 5 (g) of the FSA.

141. Article 5 (h) of the FSA.

142. See Article 6 (1) of the FSA.

143. Hayashi, *supra* note 77, at 48–49. For more discussion on the precautionary principle in the FSA, see, for example, J. Ellis, "The Straddling Stocks Agreement and the Precautionary Principle as Interpretive Device and Rule of Law," *Ocean Development and International Law* 32 (2001): 289–311.

144. See Articles 7 and 16 of the FSA.

145. Article 7(2) of the FSA.

146. Article 7(2) (d) of the FSA.

147. Article 7(2) (e) of the FSA.

148. Article 7(2) (f) of the FSA.

149. Article 7(1) (b) of the FSA.

150. See, for example, L. Juda, "The 1995 United Nations Agreement on Straddling Fish Stocks and Highly Migratory Fish Stocks: A Critique," *Ocean Development and International Law*, 28 (1997): 160. For an in-depth analysis of some shortcomings of the FSA, see Burke, *supra* note 73, at 105–126, particularly 109–115.

151. Although the Code is voluntary, some of its contents are based on relevant rules of international law, including those reflected in UNCLOS.
152. See Article 6(1) of the Code.
153. Article 6(2) of the Code.
154. See Article 6(8) of the Code.
155. See Article 6(4) of the Code.
156. See Article 6(12) of the Code.
157. See Article 6(6) of the Code.
158. See Article 6(5) of the Code.
159. See, for example, Article 7.
160. See, for example, Articles 8(5), 8(7), 8(8) etc.
161. See, for example, Article 9.
162. See Article 10 of the Code. For a list of specific provisions related to the conservation of living aquatic ecosystems in the Code, see S. M. Garcia and I. De Lerva Moreno, "Global Overview of Marine Fisheries," a paper presented at Reykjavik Conference on Responsible Fisheries in the Marine Ecosystem, Reykjavik, Iceland, 1–4 October, 2001, at 17–18, available at: <http://ftp.fao.org/fi/document/reykjavik/default.htm>.
163. For a discussion on the influence of the Code on the application of ecosystem approach to marine fisheries management, see, for example, L. Juda, *supra* note 109, at 116–118. More information on the Code is available at: <http://www.fao.org/fi/agreem/codecond/codecon.asp>.
164. Available at: <http://www.intfish.net/materials/2001/0111refish.htm>.
165. The Cancun Declaration is available at: <http://www.oceanlaw.net/texts/cancun.htm>.
166. The Rome Consensus is available at: <http://www.oceanlaw.net/texts/summaries/rome.htm>.
167. The Kyoto Declaration and Plan of Action are available at: <http://www.oceanlaw.net/texts/kyoto2.htm>.
168. Available at: <http://www.fao.org/docrep/003/w3613e/w3613e00.htm>.
169. Available at: http://www.un.org/Depts/los/general_assembly/general_assembly_resolutions.htm.
170. World Summit on Sustainable Development—Plan of Implementation, September 5, 2002, available at: http://www.johannesburgsummit.org/html/documents/summit_docs/2309_planfinal.doc.
171. Reprinted in 19 International Legal Materials 15 (1980).
172. CITES is reprinted in 12 International Legal Materials 1085 (1973).
173. The Global Program of Action is available at: <http://www.gpa.unep.org/documents/about-GPA-docs.htm>.
174. The 1972 Stockholm Declaration is reprinted in 11 International Legal Materials 1416 (1972).
175. The Draft World Charter for Nature is reprinted in UNEP, Handbook of Environmental Law, at 85 and is available at: <http://sedac.ciesin.org/pidb/texts/world.charter.for.nature.1982.html>.
176. UNEP, Shared Natural Resources (Environmental Law Guidelines and Principles No. 2), 1991.
177. See, for example, the BCLME Strategic Action Program (SAP) and the BCLME Transboundary Diagnostic Analysis (TDA), available at: <http://www.ioinst.org/bclme/resources/index.htm> and Strategic Action Programme for the South China Sea (Draft Version 3, February 24, 1999), available at: http://www.unep.org/unep/regoffs/roap/easrcu/publication/eas_publications.htm.
178. Besides the above-mentioned CCAMLR, and other regional fisheries bodies such as the International Council for the Exploitation of the Sea (ICES) and the North Pacific Marine Science Organization (PICES) have an ecosystem-based mandate. Some other RFBs which have incorporated an ecosystem approach into their work are the Commission for the Conservation of Southern Bluefin Tuna (CCSBT), North Atlantic Salmon Conservation Organization (NASCO), General Fisheries Commission for the Mediterranean (GFCM), Inter-American Tropical Tuna Commission (IATTC), International Baltic Sea Fisheries Commission (IBSFC), International Pacific Halibut Commission (IPHC), International Whaling Commission (IWC), North Pacific Anadromous Fish Commission (NPAFC) and South Pacific Commission (SPC). See UNEP, Ecosystem-based Management, *supra* note 27, at 9, 18–22. For more information on RFBs, see <http://www.fao.org/fi/body/rfb/index.htm>.

179. For example, the 1990 Protocol Concerning Specially Protected Areas and Wildlife (the SPAW Protocol) to the Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region (the Cartagena Convention); the 1986 Convention for the Protection of the Natural Resources and Environment of the South Pacific Region; the 2000 Convention on the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean (see particularly the Preamble, Articles 5, 12 and 13); and the 2001 Convention on the Conservation and Management of Fishery Resources in the South-East Atlantic Ocean (see particularly the Preamble, Articles 1 and 3).

180. See A.M. Duda and K. Sherman, *supra* note 51, particularly at 798, 806, and 829. See also *supra* note 44.

181. "Oceans and the World Summit on Sustainable Development: A Large Marine Ecosystems Strategy for the Assessment and Management of International Coastal Waters," available at: <http://www.edc.uri.edu/lme/intro.htm>. For more detailed information on the LME projects, see Intergovernmental Oceanographic Commission Reports of meetings of experts and equivalent bodies: IOC-IUCN-NOAA Ad Hoc consultative meeting on large marine ecosystems (LMEs), First Session, Paris, France, 23–24 January 1997; Intergovernmental Oceanographic Commission Reports of meetings of experts and equivalent bodies: IOC-IUCN-NOAA consultative meeting on large marine ecosystems (LMEs), Second Session, Paris, France, 15–16 March, 1998; Intergovernmental Oceanographic Commission Reports of meetings of experts and equivalent bodies: IOC-IUCN-NOAA consultative meeting on large marine ecosystems (LMEs), Third Session, Paris, France, 13–14 June, 2000, available at: <http://ioc.unesco.org/iocweb/iocpub/iocdoc/ggelme03.doc>; Large Marine Ecosystem (LME) Approach to the Global International Water Assessment (GIWA), *supra* note 51; and GEF Pipeline List: <http://www.gefonline.org/pipelinelist.cfm>.

182. Available at: <http://laws.justice.gc.ca/en/O-2.4/84810.html>.

183. See paragraphs 29–30 of the Oceans Act of Canada.

184. For more information on Canada's Oceans Strategy, see http://www.dfo-mpo.gc.ca/canwaters-eauxcan/oceans/index_e.asp; and [http://www.dfo-mpo.gc.ca/media/backgrou/2002/hq-ac77\(a\)_e.htm](http://www.dfo-mpo.gc.ca/media/backgrou/2002/hq-ac77(a)_e.htm).

185. Information on Australia's Ocean Policy is available at: http://www.oceans.gov.au/the_oceans_policy_overview.jsp. See also A. Bergin and M. Haward, "Australia's New Oceans Policy," *International Journal of Marine and Coastal Law*, 14 (3) (1999): 387–398; S. Bateman, "Australia's Oceans Policy and the Maritime Community," *Maritime Studies*, 108 (1999): 10–17; G. Wescott, "The Development and Initial Implementation of Australia's 'Integrated and Comprehensive' Oceans Policy," *Ocean and Coastal Management*, 43 (2000): 853–878; and E. N. Eadie, "Evaluation of Australia's Oceans Policy as An Example of Public Policy-making in Australia," *Maritime Studies*, 120 (2001): 1–13.

186. See R. C. Malone, *The Federal Ecosystem Management Initiative in the United States*, available at: <http://www.state.nv.us/nucwaste/yucca/malone01.htm>.

187. See T. D. Smith, "United States Practice and the Bering Sea: Is It Consistent with a Norm of Ecosystem Management?" *Ocean and Coastal Law Journal* 1 (1995): 163. A list of major US federal coastal and ocean-related legislation is available at: <http://icm.noaa.gov/country/usa/usa.html>.

188. For a discussion on this point, see Smith, *supra* note 187, at 155–163.

189. Sec. 301 (a)(3) of Magnuson-Stevens Fishery Conservation and Management Act, 1976, Pub.L. No. 94-265, 90 Stat. 331.

190. Pub.L. No. 92-532, 106 Stat. 4293.

191. Pub.L. No. 92-532, 86 Stat. 1061.

192. Pub.L. No. 106-562, 114 Stat. 2800.

193. B. Cicin-Sain and R. W. Knecht, *The Future of U.S. Ocean Policy: Choice for the New Century* (Washington, D. C., Covelo, California: Island Press, 2000), 287.

194. U.S. Department of Commerce National Oceanic and Atmospheric Administration Strategic Plan: A Vision for 2005 (September, 1998), available at: http://www.osp.noaa.gov/docs/NOAA_current_Strategic_Plan.pdf.

195. See, for example, Department of Commerce National Oceanic and Atmospheric Ad-

ministration, Ecosystem Management: Federal Agency Activities, CRS Report for Congress, 1994, available at: <http://www.ncseonline.org/NLE/CRSReports/biodiversity/biodv-4b.cfm#INTRO> and Office of Policy and Strategic Planning, NOAA, Ecosystem Approaches to Management of Marine and Coastal Resources: Selected Examples from the National Oceanic and Atmospheric Administration (Washington, DC, USA, 1995).

196. Information on the Commission is available at: <http://www.oceancommission.gov/>.

197. Pub.L. No. 106-562, 114 Stat. 644.

198. The U.S. Commission on Ocean Policy, Developing a National Ocean Policy: Mid-term Report of the U.S. Commission on Ocean Policy, September, 2002, at 5, available at: http://oceancommission.gov/documents/midterm_report/midterm_report.html.

199. See Sections 2 and 4 of the Oceans Act of 2000.

200. The U.S. Commission on Ocean Policy, Interim Report, *supra* note 198, at 11–12.

201. For more information on the Irish Sea pilot, see http://www.jncc.gov.uk/Marine/irishsea_pilot/default.htm.

202. Johnston, *supra* note 108, at 13–14.

203. W. T. Burke, “UNCED and the Oceans,” *Marine Policy* 17 (6) (1993): 531–532.

204. Christie, *supra* note 97, at 405.

205. Burke, *supra* note 203, at 532. See also A. Merla, *A Commitment to the Global Environment: The Role of GEF and International Waters* (the last paragraphs), online at: <http://www.oieau.fr/cieedd/contributions/at2/contribution/gef.htm>.

206. Johnston, *supra* note 108, at 16.

207. *Report of the ACMRR Working Party on the Scientific Basis of Determining Management Measures*, FAO Fisheries Tech. Paper No.236, UN Doc. FIRM/R22336, 1980, at 20. See also W. T. Burke, *The New International Law of Fisheries*, *supra* note 74, at 59.

208. Parliamentary Assembly, Council of Europe, *Oceans*, *supra* note 80, at 120.

209. L. M. Alexander, “Regional Approach to Large Marine Ecosystems,” in *Large Marine Ecosystems: Stress, Mitigations, and Sustainability*, ed. K. Sherman, L. M. Alexander, and B. D. Gold (Washington, D.C: AAAS Press, 1993), 226.

210 J. Morgan, “Large Marine Ecosystems in the Pacific Ocean,” in *Biomass Yields and Geography of Large Marine Ecosystems*, ed. K. Sherman and L. M. Alexander (Colorado: Westview Press, 1989), 381.

211. Johnston, *supra* note 108, at 16.

212. See Alexander, *supra* note 17, at 514 and Burke, *supra* note 203, at 531.

213. Burke, *supra* note 203, at 531.

214. *Ibid.*, at 532.

215. *Ibid.*, at 522.

216. D. M. Johnston, “The Challenge of International Ocean Governance: Institutional ethical and Conceptual Dilemmas,” a paper prepared for discussion at ACORN II conference held at Canberra, May 31– June 2, 2002, at 19.

217. S. M. Garcia and M. Hayashi, “Division of the Oceans and Ecosystem Management: A Contrastive Spatial Evolution of Marine Fisheries Governance,” *Ocean & Coastal Management* 43 (2000): 473. With regards to the jurisdictional problems of LME management, in 1993 Francisco Orrego Vicuna argued:

(LMEs do) not claim jurisdiction but to ensure an appropriate management within the perspective of environmentally sustainable activities. It should be pointed out in this regard that the concept of LMEs is not related to questions of exercise of jurisdiction in a juridical sense, but to the rational management of biological realities, a distinction that has not always been clear and that many times has conduced to unnecessary difficulties in the negotiations on marine affairs.

See Orrego Vicuna, “Toward An Effective Management of High Seas Fisheries and the Settlement of the Pending Issues of the Law of the Sea,” *Ocean Development and International Law* 24 (1) (1993): 86–87. However, this argument ignores the fact that, because different maritime zones are under different jurisdictions and governed by different regimes, no marine management

activity can be divorced from jurisdictional issues, especially in a transboundary context that involves different jurisdictions. In fact, the jurisdictional problem caused difficulties in the negotiation of the FAS's relevant regime. In view of this reality, some years later Orrego Vicuna admitted: "Possibly the greatest challenge of international law as applied to high seas fisheries was how to introduce the concept of ecosystem management within a context involving different national jurisdictions and international arrangements . . . the views of States and other entities were . . . sharply divided." See Orrego Vicuna, "The International Law of High Seas Fisheries: From Freedom of Fishing to Sustainable Use," in *Governing High Seas Fisheries: The Interplay of Global and Regional Regimes*, ed. O. S. Stokke (Oxford: University Press, 2001), 35. Although a solution was finally adopted by the FSA, one might argue that its practicability and effectiveness is another thing.

218. H. Gislason et al., "Symposium Overview: Incorporating Ecosystem Objectives within Fisheries Management," *ICES Journal of Marine Science* 57 (2000): 472, available at <http://www.idealibrary.com/links/doi/10.1006/jmsc.2000.0741/pdf>.

219. Ibid. For some examples of the geographic scopes of LME projects, see the Project Brief of the Yellow Sea LME, at A20-22, and the Yellow Sea Large Marine Ecosystem Preliminary Transboundary Diagnostic Analysis, February 2002, at 9; Benguela Current Large Marine Ecosystem Transboundary Diagnostic Analysis (BCLME Project Documet, Annex H), October 1999, at 12-13, available at: http://www.gefweb.org/council/gef_c15/workprogram.htm (C 20-21).

220. D. M. Johnston, "Southeast Asia: Lessons Learned," in *Maritime Regime Building: Lessons Learned and Their Relevance for Northeast Asia*, ed. M. J. Valencia (The Hague, Boston, London: Martinus Nijhoff Publishers, 2001), 77.

221. See Ibid., at 78-79 and B. Hatcher, "Optimizing the Structure of International Marine Environment Programmes," in *UNEP/ GPA Discussion Forum*, June 28, 2000.

222. J. Patlis, "Biodiversity, Ecosystems, and Endangered Species," in *Biodiversity and the Law*, ed. W. J. Snape (Washington, DC and Covelo, California: Island Press, 1996), 45. See also Merla, *supra* note 205.

223. Johnston, *supra* note 216, at 41.

224. Burke, *supra* note 203, at 532.

225. Johnston, *supra* note 108, at 13-14.

226. Information on FAO fisheries bodies and programs is available at: <http://www.fao.org/>. FAO Fisheries Global Information System is available at: <http://www.fao.org/fi/figis/about.jsp>. For a list of regional marine fishery bodies, see UNEP, *Ecosystem-based Management*, *supra* note 27, at 26.

227. Information on PEMSEA is available at: <http://www.pemsea.org/>.

228. See L. A. Kimball, *Regional Ocean Governance*, DOALOS/UNITAR Briefing on Developments in Ocean Affairs and the Law of the Sea Twenty Years After the Conclusion of the U.N. Convention on the Law of the Sea, 26 September, 2002, available at: http://www.un.org/Depts/los/convention_agreements/convention_20years/PresentationLeeKimball.pdf.

229. See UNEP, *Ecosystem-based Management*, *supra* note 27.

230. Borgese, *supra* note 33, at 145-160.

231. Lewis M. Alexander, "Comments" in *Regionalization of the Law of the Sea*, Proceedings of Law of the Sea Institute Eleventh Annual Conference, University of Hawaii, Honolulu, Hawaii, November 14-17, 1977, ed. D.M. Johnston (Cambridge, MA: Ballinger Publishing Company, 1978), 276, also 44, and 3-16.

232. See Orrego Vicuna, "Toward an Effective Management," *supra* note 217, at 90.

233. Ibid., at 86.

234. For detailed information on the status of participation of States concerned in these regional agreements before 2001, see UNEP, *Status of Regional Agreements Negotiated in the Framework of the Regional Seas Programme*, Rev. 5 (2001). Updated information is available at the websites of the Regional Seas Programs.

235. See Para. 44 of the Project Brief of the Yellow Sea LME Project, at 8, available at: http://www.gefweb.org/COUNCIL/GEF_C15/WorkProgram.htm (C-21, Part II).