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Governance Profiles and the Management of the Uses of Large Marine Ecosystems

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Interest in the management of the environment and its resources on an ecosystem basis has been increasing in both terrestrial and marine contexts. The emergence of the concept of large marine ecosystems (LMEs) is one important example of this development. LMEs have been examined through five linked modules: (1) productivity of the ecosystem; (2) fish and fisheries; (3) pollution and ecosystem health; (4) socioeconomic conditions; and (5) governance. The first three focus on natural systems, while the last two concentrate on human interactions with those systems. To date the first three have received the greatest attention but as attention has turned to development and implementation of management strategies, greater consideration has being given to the human dimension of LMEs represented by the latter two modules. This article focuses on governance, a matter that is of fundamental importance because it shapes the pattern of human use of the natural environment.

Efforts to promote ecosystem-based management occur within different governance frameworks; these frameworks and their associated dynamics must be understood in the same fashion that the structure and interplay of the elements of the natural ecosystem need to be comprehended. Just as natural science employs baseline studies to gauge change over time, this paper asserts the need for similar studies relevant to governance aspects of ecosystem use. After identifying and describing the roles of three major and generic governance institutions, we suggest the development in each LME of a governance profile that outlines and analyzes the existing governance framework. Moreover, we propose to consider governance change over time to assess whether such shifts represent movement in the direction of greater ecosystem focus.

Keywords large marine ecosystems, marine ecosystem management, ocean governance

The ecosystem paradigm is emerging as the dominant approach to managing the environment and its natural resources.[1] This shift from the treatment of individual resources to the broad perspective of total ecosystem has taken hold in a number of fields such as forestry and fisheries and has also become an important management approach in the U.S. federal government and in international organizations. This paper considers the application of this approach to the governance of large marine ecosystems (LMEs).

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The concept of LMEs was developed by Sherman and Alexander and is used to refer to "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."[2] Utilizing such criteria, some 50 LMEs have been identified.[3] Consideration of LMEs as management units follows from a substantial body of scientific investigation that examines the interaction of fish species with one another and with the physical environment that they inhabit, as well as the effects on them of human activities.[4]

In his exposition of the LME concept, Sherman has outlined five linked modules with which to assess LME sustainability: productivity of the ecosystem, fish and fisheries, pollution and ecosystem health, socioeconomic conditions, and governance.[5] The first three modules center on natural systems, while the latter two focus on the human uses of the LME and its resources. To date, research has been devoted primarily to the first three modules, but as attention turns from conceptualization of system dynamics to development of management strategies, it becomes increasingly clear that attention must be given to the human dimension of LMEs, represented by the socioeconomic and governance modules.

Governance

The focus of the present study is on governance, by which we mean the formal and informal arrangements, institutions, and mores that structure:

- how resources or an environment are utilized,
- how problems and opportunities are evaluated and analyzed,
- what behavior is deemed acceptable or forbidden, and
- what rules and sanctions are applied to affect the pattern of use.[6]

Human behavior and patterns of conduct critically affect the state of the natural world.[7] Governance is crucially important because attempts to manage resources and the environment are really about managing human behavior and encouraging patterns of conduct which accord with the operation of the natural world.[8]

It is important to observe that the concept of governance is not equivalent to government but includes also other mechanisms and institutions that serve to alter and influence human behavior in particular directions.[9] There are three key, general mechanisms of governance: the marketplace, the government, and nongovernmental institutions and arrangements. These mechanisms interact with one another in an ongoing, continuing pattern of dynamic interrelationships. Through the pressures they generate, they individually and cumulatively impact use behaviors (Figure 1). Failure to heed the signals from these institutions may lead to sanctions that range from economic loss, to incarceration or monetary penalties, or to expulsion or alienation from the community.

The marketplace, through the profit incentive, for example, certainly affects how the environment is utilized, what resources are exploited, and the manner in which these resources are exploited. Indeed, the current controversy over the policies of the World Trade Organization and how its policies in support of trade liberalization affect the environment reflects this concern.[10] Of course, consumers frequently have an array of choices as to what to buy. Should purchase decisions of a sufficient number of consumers incorporate not only considerations of inherent product quality but also the process by

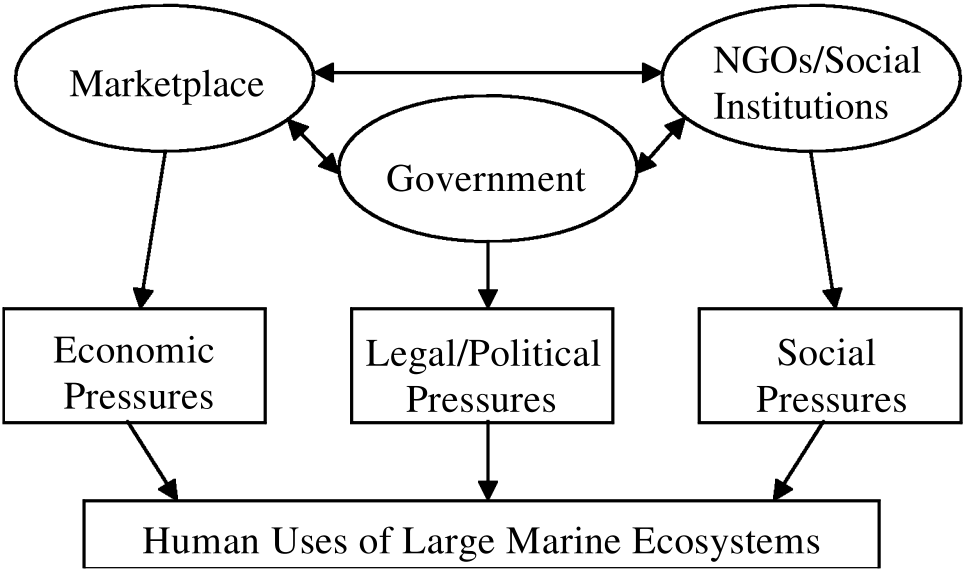

Figure 1. Three key governance mechanisms.

which desired goods are produced and sensitivity to associated ecolabeling, then marketplace outcomes may be more supportive of natural ecosystem protection than had been the case in earlier periods.[11] Additionally, efforts to attach monetary value to ecosystem services,[12] which have been regarded in the past as free, could serve to give a more concrete sense of value to those services and encourage the internalization of the costs of such services,[13] impelling more careful consideration of the natural environment. In a variety of ways the marketplace could make significant contributions to ecosystem protection.[14]

Government policy and regulation, whether at a local, regional, or national level, is well recognized as a mechanism that can affect human behavior. Tax policies can provide incentives for particular types of conduct and, through government spending patterns, a substantial portion of society's resources may be directed so as to promote specific objectives.[15] Regulatory efforts, such as zoning and permitting, can channel efforts along desired paths and, with their potential for unpleasant consequences in the form of fines or even imprisonment, can discourage undesired behavior. But in the long run, and perhaps most importantly, through education and outreach government may encourage environmental and ecosystem awareness.

Nongovernmental organizations (NGOs) are becoming more evident in political activity at local, national, and international levels; there is a proliferation of NGOs that actively and purposefully seek to influence public policy relating to a very wide range of issues.[16] NGOs are a recognized force and play multiple roles in affecting behavior and public policy. They may serve as advocates of particular courses of action for government (e.g., stop licensing nuclear reactors) or of societal behavioral patterns (e.g., reject the use of furs) or seek to encourage or discourage enactment of particular pieces of legislation. In democratic and pluralistic societies, nongovernmental groups play important constituency roles, affecting both governmental and marketing decisions with attendant ramifications for the natural environment. They also frequently harness scientific and technical expertise to monitor environmental impacts and change, as well as compliance with mandated expectations, and they thereby generate information relevant to decisions that will be made. In regard to environmental matters, many of them seek to educate the wider public on the workings of natural systems and the particular issues at hand and, in doing so, help shape the framework in which problems and opportunities are analyzed and evaluated.

In traditional political usage, NGOs are exemplified by environmental organizations such as the Sierra Club and the World Wildlife Fund or trade associations such as the Chamber of Commerce or the National Association of Manufacturers that have purposeful political agendas which, through explicit strategies, seek to influence public attitudes, governmental policy, and the marketplace so as to achieve particular goals. But for the purposes of the present analysis, NGOs should be thought of more broadly and include bodies that may be less overtly political in nature, ranging from community associations to fraternal organizations to families and religious groups.[17] All of these may serve as agents of socialization and thus shape human perceptions, preferences, and attitudes. While they may not issue edicts that are legally binding in the way that law is in civil society or explicitly seek to change governmental or economic policy, they do influence ideas and patterns of thought and often generate meaningful social pressures that encourage adherence to particular norms of behavior. Accordingly, these nongovernmental institutions and arrangements can affect ecosystem use patterns.[18]

On the natural system side, Sherman and his colleagues have identified three "driving forces" that impact LMEs: natural variability, overfishing, and pollution, with varying combinations of the three influencing each of the 50 identified LMEs.[19] The relative importance of each and the nature of the mix of driving forces need to be identified so as to develop responses appropriate to the problems identified in individual LMEs. Likewise, the above-identified human aspect driving forces, the marketplace, government, NGOs, arrangements, and practices, also need to be understood in context.

The mix, character, and influence of these three mechanisms will vary from LME to LME and need to be understood empirically rather than assumed. Different governments, for example, have varying degrees of "reach," that is, effective control in both functional and spatial terms. Some governments try to directly influence a much wider range of human activities than others. Some have real control throughout the territory of the state, while others have authority that may have limited impact once the capital city is left behind. Further, governments range from those that are highly centralized and unitary in nature to those much more decentralized and federal in nature, with consequent significant power in the hands of local governments. In traditional societies, poor communication networks and limited capability for monitoring and enforcement may be the order of the day, and socially and culturally determined constraints may be of greater significance than government in influencing behavior.

Moreover, operations of the market and economic systems in different localities may well not correspond to or behave in ways that North Americans or Western Europeans, for instance, take as a given. Economies that are subsistence or locally based in nature may have significantly different characteristics than those that are export oriented, and the social and ecological implications of economic actions may be weighted differently or even ignored.[20]

Ecosystems and Governance

Ecosystems present special challenges for those concerned with management of natural resources and the wider environment. In most of the identified LMEs, governance involves institutions, interests, and people of more than one state since the boundaries of LMEs typically do not coincide with those of state jurisdiction. Yet, the reality is that the ongoing availability of many desired goods and services significantly valued by stakeholders depends on the continued functioning of transboundary ecosystems.

The divergence between "ecologically defined space" and "politically defined space"[21] gives rise to a host of management problems and might provide either a rationale for international cooperation or, alternatively, in situations in which international cooperation is weak or has not been forthcoming, an abandonment of national efforts because if such efforts are undercut by the actions of those in other jurisdictions they will be rendered ineffective anyway. Accordingly, achievement of an appropriate level of regional cooperation to foster effective management is an important objective.

Aside from this spatial incongruity, additional difficulties are often caused by the mismatch in time frames of policy makers and the need for long-term efforts and commitment to the goal of ecosystem protection.[22] A program to improve water quality, for example, may have to be pursued for many years before significant effect is demonstrated, yet office holders have to justify their actions and their use of public resources every election cycle. Education and greater public knowledge of ecosystem concepts and dynamics can contribute to a more consistent public policy approach and increase public support for needed longer term efforts, but educational efforts may be time consuming.

Further, the areas encompassed by LMEs are subject to multiple human uses, each of which may be monitored and regulated by different government agencies with specific and limited functional areas of responsibility. Accordingly, no particular agency will have responsibility for the "big picture," the totality of what occurs within the spatial framework. Likewise, private stakeholders tend to focus on their particular uses rather than on that big picture. The need for a system, as opposed to a use, perspective was recognized in the classic 1969 report of the Stratton Commission.[23] The governmental and stakeholder fragmentation seen in the United States, rather than being unique to the United States, is seen in other governments and in international organizations as well.[24]

Approaches to Ecosystem-Based Management

Despite the obstacles faced by ecosystem-based management approaches, a 1994 report by the U.S. General Accounting Office (GAO) noted strong and growing support among officials, scientists, and policy analysts to move away from management based on individual uses of land units or protection of individual natural resources in favor of an ecosystem management approach.[25] The report notes that the four primary U.S. federal land management agencies (National Park Service, Bureau of Land Management, Fish and Wildlife Service, and the Forest Service) are already using or intend to use an ecosystem approach to managing lands and natural resources. But as indicated in that report, the ecosystem approach has different meanings to the disparate groups supporting its utilization.[26]

Based on a review of the scientific and policy studies on ecosystem management, the GAO report provides a flow chart for ecosystem management (Figure 2). While the indicated steps may be of guidance to government agencies, they may have more limited utility in the wider context of efforts to achieve ecosystem-based management. In particular, the linking of the box of "understanding ecosystems' ecologies" to that of "making management choices" fails to give necessary attention to the fundamental importance of the governance structures that shape human behavior in relation to the environment. This is a significant point of deficiency. Further, the GAO model may be critiqued for its focus on government and governmental policy as the driving forces of ecosystem-based management. It is suggested that a wider consideration of governance as outlined above is more appropriate.

A recent study by the U.S. National Research Council, *Our Common Journey: A Transition Toward Sustainability,*[27] utilizes a pressure-state-response model and clearly notes that human use of the environment has effects on that environment. But the reasons for and the factors that structure the uses of the environment are not considered.[28]

To effect change in the pattern of human use it is necessary not only to consider *how* the environment is used and with what effects, but also *why* it is used in that particular manner. Accordingly, it is necessary to explicitly consider governance mechanisms and issues that serve to structure the pattern of behavior as the key link between ecosystem ecology and human use and subsequent management choices.

Governance Needs

As suggested above, a wide perspective of governance is required because values and expectations underlie human uses of the marine environment.[29] Questions about sustainability, ecosystems, and ecosystem management are not simply questions about science; they are about values.[30] Indeed, definitions of sustainability and ecosystems themselves reflect the values underlying them.[31] Moreover, it is important to note that different environmental policies have varied distributive effects on societies that raise questions of equity.[32] Management occurs within an institutional setting that, more or less, successfully recognizes the different values and expectations of a variety of user groups and those of the wider public. Miller and Kirk have noted the difficulty or even impossibility of reconciling competing values.[33] But values and expectations are subject to change over time, with consequent modifications of behavior, which brings us back to the mechanisms that shape those values and expectations.

Governance of LMEs requires consideration of a substantial amount of data as well as comprehension of a variety of relationships within the natural environment and also the effect of human uses on that environment. Those who make decisions regarding the use of the natural environment and its resources need to be aware of and sensitive to the pattern of interaction resulting from their decisions if the sustainability of the environment that supports human needs is to be maintained. In this regard, there is a clear need, which has been frequently noted, for integrating science into public policy.[34] While there is a need for greater awareness of what people want or expect from natural systems, there is also a requirement for a better understanding of the capability of those systems to deliver desired goods and services and what is needed to maintain the viability of those underlying systems.[35]

Scientific understanding can assist in identifying internal natural system needs, the requirements of desired resources and conditions, and the limits to system productivity.[36] Such considerations must be incorporated into decisions relating to human use of the environment. While productivity may sometimes be "tweaked" as through the use of fertilizers and pesticides in agriculture, there are still limits to productivity and, further, there are questions relating to the environmental, economic, and social costs, as well as the benefits that are generated by the "tweaking" of nature.

In efforts to advance ecosystem-based management, contributions from both the natural and social sciences are needed, and, further, these inputs need to be integrated. Fundamentally, the natural sciences can provide an understanding of the functioning of natural systems, the interrelationship and dynamics of system components, and the impacts of human use on the operation and changing states of those natural systems. They may also be able to suggest the human use implications of system changes.

On the social science side, the focus is on use management and efforts to modify use patterns to advance purposes such as system sustainability. Social scientists need to understand how the natural environment is utilized and why it is used as it is. The management goal is to affect human behavior vis-à-vis the ecosystem, and to do this it is necessary to comprehend: (1) the linkages between action and effect in the natural system, and (2) how the environment is perceived by users and what motivates particular behavioral patterns. What needs to be understood is not simply the reason for a use, such as fishing, but also the rationale for the employment of specific methods of utilization. Such an understanding would enhance the potential for achieving needed behavioral change.

To integrate natural science and social science perspectives and to foster ecosystem sustainability, it is important to organize data on the interplay of human activities with natural processes to illuminate interrelationships and encourage thinking about what Pernetta and Mee termed "causal chains."[37] In what follows we use several interaction matrices that can serve as diagnostic tools and provide a framework for analysis and consideration of management problems and possibilities. The use of such matrices encourages the systematic and more holistic,[38] as opposed to purely sectoral,[39] consideration of actions.

The following analysis is not meant to provide an input/output model that predicts outcomes or a manner of automatically determining choices or policies. Rather, it seeks to promote understanding of relationships and to encourage the utilization of adaptive management approaches[40] that take full advantage of experience and learning.

Some introductory comments are needed on the matrices. First, the authors recognize that a variety of matrices have been used by others in conjunction with generic coastal or ocean use.[41] Perhaps more than these earlier perspectives, however, the current study considers their use in the context of ecosystem-based governance.

Second, we recognize that the nature of interaction among uses or the interplay between a particular use and the natural environment may often be site specific. That is, the same actions occurring in different natural settings may not have the same impacts on the physical environment or on the potential for creating conflict-of-use situations. The effects of the disposal of wastes in different marine environments, for example, may vary due to factors such as natural flushing action in open as opposed to enclosed sea areas. And conflict-of-use situations are affected by variables such as population densities, regional patterns of customary use, and degree and nature of economic and social dependence on ocean and coastal resources.

Third, the matrices used in this study are rudimentary and are used solely to illustrate needed types of data and approaches. Clearly, it is necessary that broad categories of activity be subdivided appropriately. In the case of fishing, for example, operations are conducted in many different ways around the world and even among fishermen of a particular state. Commercial, industrial, artisanal, recreational fishing, and the use of different gear and techniques, while all coming under the general rubric of fishing, may each have varying impacts on the biomass, the physical environment, and other human uses, and accordingly must be assessed differentially. While this study uses simple, two-dimensional matrices, as noted below, actual utilization of coastal/ocean areas typically involves more than two uses and requires consideration of the cumulative, interactive effects of multiple uses. In this context it is necessary to evaluate the following conditions.

(a) *The compatibility of particular uses, given their inherent nature and requirements, in relation to other uses (compatible, conditionally compatible, or incompatible).* Compatibility implies either that the uses do not interfere with one another or, possibly, that they may serve to enhance one or both of the uses through positive externalities. Incompatibility indicates detrimental effects of one use on another or both on each other through negative externalities. Conditional compatibility refers to situations in which potential negative externalities may be limited to acceptable levels through use limitations or restrictions. In many cases judgments regarding compatibility of use are situational rather than absolute in character, involving considerations of factors such as the amount of available space, the geographical layout of the area, and cultural and individual values.

(b) *The effect of particular human uses on the natural environment and the operation of ecosystems.* It is indisputable that human activities affect the workings of natural systems and, in some cases, can overwhelm and radically alter or completely destroy them. As in the case of use conflict, consideration must be given to the dynamics of particular ecosystems, taking into account existing stress and resilience. System specifics such as water currents, tidal flows, and natural flushing action may be of significance in evaluating behavioral patterns. Complicating matters is the fact that while sometimes effects are relatively quickly demonstrable, often they are of an insidious and cumulative nature, becoming manifest only after a substantial period of time. Yet judgments must be made as to the degree of impact (substantial, moderate, or inconsequential) of some use on the functioning of the natural environment, both short term and long term, and its consequent effect on sustainability.

Among the considerations which affect determinations of compatibility and degree of environmental impacts are the following.

(a) *The nature of the use and the degree to which it puts stress on natural systems and limits future alternatives.* Some uses are inherently more demanding of the natural environment, have more substantial and lasting effects than others (disposal of toxic wastes as opposed to recreational boating), and have greater potential to interfere with other human uses.

(b) *The level of activity of a particular use (high, moderate, or low).* The amount or frequency of activity needs to be considered as an independent variable, since at low levels of use, uses may be compatible and environmental impacts may be insignificant, while this might not be the case with high levels of activity.

(c) *The cumulative impact of varied uses.* Is there some type of synergy at work that magnifies the impacts of uses examined individually? The importance of cumulative impacts is increasingly recognized, as seen in the 1991 Protocol on Environmental Protection to the Antarctic Treaty,[42] but the phenomenon presents substantial problems for analysts and policy makers.[43]

(d) *The normative characterization (desirable, undesirable, or indifferent) of use interplay and environmental effect.* For example, is the by-catch of turtles in shrimp fishing normatively acceptable? Is the destruction of mangroves acceptable to the end of increasing shrimp production? Normative characterizations are determined largely in a cultural context, but local and regional ways of doing things are increasingly subject to outside pressures associated with trade, economic development, and imported technology and values. The varied and changing cultural context is a factor that once more underscores the need for a site-specific analysis of human interaction with the environment. There should be an awareness that difficult problems could be encountered should different states or communities share ecosystems but not traditions, values, and priorities.

The problems of evaluating and operationalizing the elements discussed above are substantial. As suggested by McGlade, "fuzzy logic" may be of assistance in this regard.[44] But beyond the matter of assessing each of the four elements, the difficult question remains as to how the data will be aggregated.[45] Whatever device or procedure is used to organize and evaluate data, there can be no escape from a significant element of subjectivity. Moreover, values and preferences aside, the fact is that decisions will be made under conditions of imperfect knowledge and uncertainty, and that raises questions regarding the controversial concept of precaution.[46]

With all these considerations in mind, there remain two basic reasons supporting the need for governance efforts: (1) incompatible human uses of LME space and resources that result in mutual interference, and (2) human uses of the LME environment that interfere with natural processes and limit the potential for future use of that environment. Two matrices directly address these matters.

1. *Use Interaction Matrix (Matrix 1).* The concept of conflict of use is basic to the fields of coastal zone management[47] and land use planning; as ocean uses increase and intensify, that concept has been similarly recognized as relevant in sea or ocean use

Matrix 1. Use interaction.

Human uses

Human uses	Shipping/ ports	Fishing	Aquaculture	Industrial siting	Recreation	Waste disposal	Housing	Military uses	Agriculture	Forestry
Shipping/ ports										
Fishing										
Aquaculture										
Industrial siting										
Recreation										
Waste disposal										
Housing										
Military uses										
Agriculture										
Forestry										

scale:

|-----------|----------|-----------|-----------|----------|-----------|----------|-----------|-----------|

1 2 3 4 5 6 7 8 9 10

compatible conditionally compatible incompatible

management.[48] Often incompatibility is demonstrated in practice as sectorally based decisions are implemented and negative externalities are generated. In the face of such experience, planners and coastal managers, accordingly, have resorted to devices such as zoning to keep apart activities that have significant incompatibilities.[49]

Clearly, those who make decisions must have some understanding of how different uses of the same area interplay and, not surprisingly, matrices have been employed in an effort to understand interactions among uses. The example of use interaction shown in Matrix 1 is extremely simplistic and in actual practice would require much greater detail and sophistication. As noted earlier, a category such as fishing would have to be subdivided in a variety of ways, taking into account descriptors such as the scale of fishing, the gear used, and the time of the year. In his description of a "marine interaction model," Vallega[50] has provided a detailed breakdown of sea uses that could be modified and expanded for employment in an LME use interaction matrix. Utilized data would have to be site specific if the matrix were to serve a useful purpose for local decision makers.

2. *Use/Ecosystem Effects Interaction Matrix (Matrix 2).* The notion that human use alters the natural environment is not new. What is relatively new is the degree to which an environment and its natural process may be affected by human actions. If sustainability of ecosystems is a matter of concern to decision makers, then it is necessary for those decision makers to consider the nature and character of the effects of human use on natural systems. The purpose of Matrix 2 is to highlight such impacts and to encourage an understanding of relationships between human behavior and ecosystem processes.

It may well be that the effects of human use are not well understood or fully documented,[51] and a degree of precaution may be required to avoid irreversible damage or long-term costs as decisions are made. Indeed, it would be useful for decision makers if some explicit assessment could be made as to data availability and the degree of understanding of natural processes that could be factored into decisions about the application of precaution. Consideration of interplay based on experience may be suggestive of priorities for future study where data or understanding is deemed insufficient.

To a considerable extent, human use of and effects on the ocean/coastal natural environment have been generally described. For instance, water quality has been monitored and evaluated, wetland loss has been studied, the introduction of alien species has been described, and coastal demographic changes have been documented. But in addition to studying changing conditions of the environment, greater consideration must be given to the practical consequences of those changes. The scientific community needs to highlight, in terms understandable to lay people, the consequences of those changes for human well-being, a step that goes beyond observing the relationships of the type noted in Matrix 2.

A finding of depleted oxygen in coastal waters, for example, needs to be related to the practical, down-the-line potential consequences of fewer opportunities for commercial and recreational fishermen, since such findings serve to motivate public concern and lead to action. Accordingly, we need a matrix that reflects the impact, that is the feedback implications, of ecosystem effects listed in Matrix 2 on outcomes of interest to stakeholders and the wider public. An expanded and more sophisticated version of Matrix 3 would encourage consideration of the impacts of observed ecosystem alterations on the potential for future human uses of the environment and its resources. The interdependent relationship between human use and environmental alteration is ongoing and needs to be monitored continuously.

Matrix 2. Effects of human use on ecosystems.

Ecosystem alterations

Human use	Oxygen depletion	Eutrophication	Habitat destruction	Turbidity increase	Coastal erosion	Change in biodiversity	Pathogen contamination	Introduction of alien species	Change in water temperature
Fishing									
Aquaculture									
Dredging									
Navigation									
Military uses									
Waste disposal									
Recreation									
Industrial siting									
Agriculture									
Forestry									
Off-shore oil									

scale:

|-----------|----------|-----------|-----------|----------|-----------|----------|-----------|-----------|

1 2 3 4 5 6 7 8 9 10

inconsequential moderate substantial

Matrix 3. Impacts of ecosystem alterations on human uses.

Human uses

Ecosystem alterations	Shipping/ ports	Fishing	Aquaculture	Industrial siting	Recreation	Waste disposal	Housing	Military uses	Agriculture	Forestry
Oxygen depletion										
Algae blooms										
Eutrophication										
Habitat destruction										
Turbidity increase										
Coastal erosion										
Change in biodiversity										
Pathogen contamination										
Introduction of alien species										
Change in water temperature										

scale:

|----------|----------|----------|----------|----------|----------|----------|----------|----------|

1 2 3 4 5 6 7 8 9 10

inconsequential moderate substantial

As noted elsewhere, site specificity is important in the relationships that Matrices 2 and 3 highlight. In regard to coastal management the need for a "vulnerability assessment" of specific environmental conditions has been noted[52] since variance in a number of natural conditions may alter the significance of possible threats. Indeed, the recognition of special areas under the terms of the 1973 International Convention for the Prevention of Pollution from Ships[53] and designation by the International Maritime Organization of Particularly Sensitive Sea Areas,[54] the establishment of marine sanctuaries under the terms of the U.S. Marine Protection, Research, and Sanctuaries Act,[55] and provision for special area management plans under the terms of the U.S. Coastal Zone Management Act[56] indicate recognition of vulnerabilities of particular areas.

Governance Profiles

As conflict of use and negative environmental consequences of human use become more obvious at a variety of levels, collective responses by society begin to emerge; in short, governance efforts evolve. This analysis urges the development of a baseline "governance profile" for each LME that describes the institutions, arrangements, and values at the core of existing governance in the area encompassed.

Just as natural ecosystems vary from one another, so too do governance systems. The literature on natural ecosystems evidences problems with concepts of scale.[57] For analytical purposes and on the basis of designated scientific criteria, the authors of this study take as a given the LME, as described by Sherman and his colleagues, as the appropriate ecological level for consideration. Having done so it is necessary to recognize that governance has scale problems of its own: spatially, governance mechanisms may extend over very small geographical areas such as neighborhoods and range all the way to global arrangements. The appropriate scale of governance needs to be related to the particular ecosystem and its uses. But this need presents a challenge because smaller ecosystems are nested within larger ecosystems.

Governance arrangements already exist in areas encompassed by LMEs; they are not, however, presently organized around the concept of LMEs. Institutional, sociocultural, and economic factors are of substantial significance in the use and management of the natural environment, and as with the natural environment, they are also site specific. In seeking to move toward governance arrangements that are more appropriate for ecosystem-based management, it is necessary to understand how existing institutional, economic, and cultural systems operate, their implications for the natural environment and its resources, and how needed change may emerge given societal structures and norms.[58]

Development of governance baselines will allow for future comparisons and assessment of whether a "systems" perspective is advancing. In this context it is necessary to identify some indicators that would provide evidence of such a perspective. What might we expect to see in governance arrangements if such an ecosystem outlook were to increase in importance? What is being contemplated are indicators that serve, directly or indirectly, to signal transition toward an ecosystem-based orientation. Further, it is recognized that change is reflected in multiple indicators through their individual and their cumulative effects.[59] Indicators as used in relation to governance may relate to process or to result; the former refers to changes in the way in which decisions are made, institutions work, and values are prioritized, while the latter focus on whether the process changes, in fact, have led to better results in terms of actual outcomes.[60] The focus of this study is on process, since process change precedes result change. In regard to process, it is suggested that change may be anticipated in the following five interrelated areas:

1. perceptions and attitudes
2. institutions
3. processes and procedures
4. policies and programs
5. public participation

First, one would expect change in how situations are perceived and how problems are assessed and treated by governments, with indications of a shift away from sectoral to broader, more holistic approaches. Evidence of sensitivity of economic activity to ecological concerns would be apparent in terms of changes in product line, production processes, and marketing. Likewise, among nongovernmental groups and the general public as well, attitudinal change would be discerned. For example, greater awareness and understanding of the phenomena of negative spillovers or externalities would be seen, with increasing comprehension that particular uses have impacts on other uses. Accordingly, one would expect to see a widening of the "stakeholder" community in regard to particular uses as other users increasingly recognize that their own interests are interrelated with and affected by the action of others. The great concern of fishermen with the impact of offshore oil development on living resources, seen in recent decades, was not apparent when the legal regime for offshore oil and gas development was established by the Congress of the United States in 1953. Fishermen did not act as stakeholders concerned with the potential for oil spills in the early 1950s, but they did later when use conflicts became more visible.[61]

Second, as externalities become increasingly manifest, one would expect the adaptation of existing governance arrangements and institutions so as to provide for "appropriate reach," that is, for a better fit between jurisdiction and the extent of ecosystems. One would anticipate greater degrees of coordination and representation in relevant decision making. At the international level there might be efforts toward harmonization of law, participation in regional institutions and efforts, creation of treaty regimes, and provision for dispute settlement. Within governmental bodies interagency memoranda of understanding, interagency committees, task forces, and consultation will increase and expanded roles will emerge for NGOs, providing technical, scientific, and/or political advice. Negotiated rule making with the intimate involvement of nongovernmental groups and governmental agencies, as opposed to more traditional top-down, government-imposed rule making may be in evidence.[62] The phenomenon of ecolabeling provides an example of how the changing attitude of consumers can influence the marketplace and, through that influence, alter patterns of ecosystem use.

Third, one would anticipate changes in processes and procedures so as to encourage forethought and precaution before actions are taken to minimize detrimental effects to the ecosystem and its resources. Included in this category would be requirements for data collection and analysis, environmental impact assessment, and notification and consultation. Such requirements would force consideration of broader system concerns.

Fourth, as the problems associated with sectoral approaches to problems become apparent, efforts are made to overcome them. One approach that may be utilized is the adoption of legislation and the development of governmental programs that reach across sectoral divides and force consideration of externalities. The National Environmental Policy Act[63] provides one such legislative example, as the requirement for the use of an environmental impact statement mandates attention to the subject of externalities.

In the United States, major federal, state, and local programs have the potential to impact LMEs. Such programs now encompass all of the coastal watershed leading to areas of fisheries and marine habitat. Watershed management emerged through the passage of section 6217 of the Coastal Zone Act Reauthorization Amendments of 1990 that mandate efforts to control non–point source pollution in coastal waters. Coastal states are required to use a watershed planning and control approach to deal with sources of pollution from agriculture, forestry, urban development, marinas, recreational boating, and hydromodifications. Plans must address the preservation and restoration of wetlands and riparian areas. States are to develop enforceable management measures to treat these sources of pollution.[64]

The National Estuary Program, established in 1987, complements the above efforts by providing funding to states to develop a comprehensive planning process to improve water quality and enhance living resources. There are currently 30 estuary programs in the United States, including four in the Gulf of Maine watershed.[65]

Coastal habitat issues have recently come to the forefront and have been addressed through the Sustainable Fisheries Act of 1996, which built on the Magnuson Fisheries Conservation and Management Act and required the National Marine Fisheries Service to specify "essential fish habitat" for all managed species and fisheries. Each fishery management council must amend its fishery management plans to identify and describe the essential fish habitat for each managed species; identify the fishing- and nonfishing-related threats to the habitat; and develop management and conservation alternatives for that habitat.[66] It would be worthwhile to explore such legislative or programmatic mandates relevant to LME management to understand how they may alter traditional agency activities and how they may serve to contribute to more holistic management approaches.

Fifth, one might expect provisions for greater public participation in the governance process, in regard to the shaping, implementing, and modifying of governance regimes and norms. Such participation is needed to obtain informational and attitudinal inputs, to allow for representation of views of different stakeholders, to secure needed understanding and support for decisions, and to provide assistance in implementation and assessment. For example, public meetings that allow for a two-way flow of information between users and managers[67] and educational efforts aimed at enhancing public understanding of objectives and means are among the measures that could contribute to effective public participation and build support for needed efforts.

The next matrix directly considers governance aspects of LMEs and, in more sophisticated form, may contribute to the development of the suggested governance profile.

3. *Governance/use matrix (Matrix 4).* Traditionally, governance arrangements have developed along sectoral lines on an ad hoc, piecemeal basis. As noted in the classic 1969 report of the Stratton Commission,[68] in governmental contexts, a problem is brought to light one way or another and some department or agency is given the responsibility to address that particular problem. Over time, responsibilities are spread among levels of government and among departments over a host of activities and areas. Eventually, interactional problems become evident since decisions are being taken without due regard to externalities. The lack of coordination leads to mutual interference, inefficiencies, and uncoordinated management.

While substantial attention has been given to mapping ecosystems, the mapping of governance systems also deserves attention. There is no question that the nature and character of governance systems affect the pattern of use of coastal/ocean areas and, more generally, what has been termed "ecosystem health."[69] As long noted by political scientists and office holders, institutional arrangements can be instruments of delay and introduce the element of political and bureaucratic "turf" into all decisions.[70] But the

Matrix 4. Governance/use: Example of Gulf of Maine.

Governance units

Uses	General-purpose regional Intergovernmental (a) International	 (b) National	Single-purpose regional Intergovernmental	National government (a) U.S.	 (b) Canada	State/provincial Governments	Local authorities	NGOs	Market place
	GOM Council	Canada Atlantic Action Plan	NAFO	NOAA	DFO	Maine, MA, NH, Nova Scotia, New Brunswick	Halifax Port Authority	Save Casco Bay	
Shipping									
Fishing									
Aquaculture									
Industrial siting									
Military uses									
Recreation									
Waste disposal									
Mining									
Housing									
Agriculture									
Forestry									
Offshore oil/gas									

scales:

Interest:	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
	inconsequential				**moderate**				**substantial**	
Influence:	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
	inconsequential				**moderate**				**substantial**	

interplay of different elements of government and governance, however, can also play a positive role by widening perspectives and forcing consideration of externalities.

It is helpful (and sometimes horrifying) to know who is responsible for what and how the elements of governance, like those of ecosystems, interrelate and interact. They, too, are part of the "working environment" and must be taken into account as efforts are made to provide for effective use and protection of ecosystems. A fuller and more sophisticated version of Matrix 4, which as shown utilizes examples from the Gulf of Maine for illustrative purposes, could yield a basic governance profile indicating networks of influence, jurisdiction, responsibilities, and interests. The dimensions of governance include (a) levels of governance (e.g., international, national, regional, or local); (b) sectoral areas (e.g., fisheries, offshore mining, waste disposal, recreation); and (c) stakeholders (e.g., fishermen, corporations, real estate interests, or port authorities). As is the case with particular LMEs, governance arrangements have site-specific characteristics that need to be recognized and understood.

Relating to levels of governance, one issue that needs consideration is the level at which a problem should be addressed. The principle of subsidiarity suggests that authority belongs at the lowest level capable of effective action.[71] In fact, the European Union in its Integrated Coastal Zone Management Programme has adopted this principle and calls for problems to be addressed in the order of local, regional, national, and Community levels.[72] In this context, different levels of governance share responsibility and coordination is provided at higher levels. What is the appropriate level of governance to oversee particular uses? Clearly, problems exist in regard to the need for a considerable degree of both vertical (between levels) and horizontal (at the same level) consistency.[73]

It is apparent from our discussion of ecosystems that they present substantial challenges to resource managers. The most fundamental of these challenges is that ecosystem management must be able to cope with the uncertainty associated with the complexity of ecosystems as natural systems and the organizational and institutional complexity of management. We may think of these institutional structures and processes as the ecology of governance.[74] Adaptive management seems to be the most promising approach to coping with the uncertainty facing many decision makers as they try to manage such systems. Adaptive management involves learning by doing; that is, by treating programs and policies as experiments. By "linking science and human purpose, adaptive management provides reliable knowledge that serves as a compass for a sustainable future."[75] But the establishment of adaptive management is by no means easy in real world institutions. Lee notes the significant institutional constraints affecting the establishment and operation of ecosystem management (Table 1).

Perhaps the most fundamental observation about the institutional environment of ecosystem management is made by Lee, who observed that social learning is most needed in large-scale ecosystems whose governance presents challenges for science, management, and politics. He noted the need to "study how human institutions deal with the interdependence created when human boundaries cut across ecological continuities. . . . What makes an ecosystem 'large' is not acreage but interdependent use: the large ecosystem is socially constructed."[76] And just as ecosystems have a number of dynamic parts operating at a variety of levels, so do the policy and institutional elements of the governance system reflecting a dynamic system of interdependence and complexity.

The issue of governance complexity is raised by Ostrom in her groundbreaking research on institutional analysis and design. She argues that "any governance system that is designed to regulate complex biological systems must have as much variety in the actions that it can take as there exists in the system being regulated."[77] In her research on

Table 1
Institutional conditions affecting adaptive management

There is a mandate to take action in the face of uncertainty. But experimentation and learning are at most secondary objectives in large marine ecosystems. Experimentation that conflicts with primary objectives will often be pushed aside or not proposed.

Decision makers are aware that they are experimenting anyway. But experimentation is an open admission that there may be no positive return. More generally, specifying hypotheses to be tested raises risk of perceived failure.

Decision makers care about improving outcomes over biological time scales. But the costs of monitoring, controls, and replication are substantial, and they will appear especially high at the outset when compared with the costs of unmonitored trial and error. Individual decision makers rarely stay in office over times of biological significance.

Preservation of pristine environments is no longer an option, and human intervention cannot produce desired outcomes predictably. In addition, remedial action crosses jurisdictional boundaries and requires coordinated implementation over long periods.

Resources are sufficient to measure ecosystem-scale behavior. But data collection is vulnerable to external disruptions, such as budget cutbacks, changes in policy, and controversy. After changes in the leadership, decision makers may not be familiar with the purposes and value of an experimental program.

Theory, models, and field methods are available to estimate and infer ecosystem-scale behavior. But interim results may create panic or a realization that the experimental design was faulty. More generally, experimental findings will suggest changes in policy; controversial changes have the potential to disrupt the experimental program.

Hypotheses can be formulated. And accumulating knowledge may shift perceptions of what is worth examining via large-scale experimentation. For this reason, both policy actors and experimenters must adjust the trade-offs among experimental and other policy objectives during the implementation process.

Organization culture encourages learning from experience. But the advocates of adaptive management are likely to be staff, who have professional incentives to appreciate a complex process and a career situation in which long-term learning can be beneficial. When there is tension between staff and policy leadership, experimentation can become the focus of an internal struggle for control.

There is sufficient stability to measure long-term outcomes; institutional patience is essential. But stability is usually dependent of factors outside the control of experimenters and managers.

Source. Kai N. Lee, Compass and Gyroscope: Integrating Science and Politics for the Environment, Island Press, Washington, DC, 1993, p.85

the governance of natural resources around the world, she found that "the most notable similarity among the successful systems is the sheer perseverance of institutions which have the capacity to modify their rules over time according to a set of collective choice and constitutional choice rules in environments which are complex, uncertain, and interdependent."[78]

Ostrom found that all of the sustainable management institutions had clearly defined boundaries, a congruence between appropriation and provision of rules and local conditions, collective choice arrangements, monitoring; graduated sanctions, conflict resolution mechanism; minimum recognition of rights to organize, and nested enterprises.[79] She views what we have termed the ecology of governance in the following manner:

> The problem that we face is not pitting one level of government against another as a solitary source for authoritative decisions. Rather, the problem is developing institutional arrangements at multiple levels that enhance the likelihood that individual incentives lead participants toward sustainable uses of biodiversity rather than imprudent uses. Given the diversity of biological scales involved, Ashby's rule of requisite variety commends a variety of institutional arrangements at diverse scales. One key to understanding how to craft nested institutional arrangements at many levels is the analysis of how actions at one level change the incentives of actors at another level.[80]

Ostrom has developed an analytical framework for analyzing institutions that refers to a range of costs to be considered when designing such institutions. Coordination costs, the information costs of time and place and scientific information, and the strategic costs of free riding and rent seeking are fundamental factors in her approach to institutional analysis. She suggests that overall institutional performance be judged by the criteria of efficiency, fiscal equivalence, redistribution accountability, and adaptability.[81]

Conclusions

Much attention has been given to the natural science aspects of LMEs. If sustainability of those systems and their resources is to be enhanced, then greater systematic attention will have to be given to human interactions with those systems and the governance arrangements that shape the pattern of human uses.

Just as the natural features of LMEs are studied, so too must the human use and governance arrangements be examined. Baseline studies have been conducted of natural systems that allow for later comparisons to evaluate the degree and nature of change over time. And various indicators are used or have been suggested to determine ecosystem health and stability. In addition, it would be useful to develop baseline studies of governance in each LME that could provide a benchmark with which to appraise change, allow assessment of progress over time in promoting sustainable uses of LMEs, and provide guidance for additional needed change. To that end, this paper suggests the use of a "governance profile" as a basic part of the strategy of advancing ecosystem-based management and as an indicator of "progress" toward an ecosystem orientation.

Governance profiles may be utilized to understand the human context in which use of resources and the natural environment proceeds. They recognize the unique systems of human use, institutions, values, culture, and priorities in each LME and provide needed understanding to encourage behavioral patterns that could accord with natural system sustainability. If we understand how human systems operate and the motivating forces behind them, it is more likely than in the absence of such understanding that human activities may be modified to protect ecosystem integrity and thereby provide sustainable social benefits. The use of matrices, more sophisticated than those used in this paper, together with appropriate analyses can highlight significant relationships between human uses and ecosystem effects and may provide a useful tool to educate the wider public.

In looking to the future and considering how ecosystem-based management efforts may be improved, it is necessary to take the current governance system as a given and as the point of departure. Changes will be needed in terms of institutions, mores, and values if there is to be a shift away from sectoral approaches to management of natural systems and their resources. Movement toward ecosystem-sensitive management does not have to be total and all at once but can result from cumulative, incremental change over time. Identification of incremental modifications would be desirable since such changes are easier to adopt and implement than more radical changes and, cumulatively, may still have substantial effects. As suggested by consideration of five identified areas—perceptions and attitudes, institutions, processes and procedures, policies and programs, and public participation—change is already occurring "on the ground" as high-level discussions continue on the need for and theory of ecosystem-based management.

Notes

1. See, for example, United Nations Development Programme et al., *A Guide to World Resources 2000-2001: People and Ecosystems, The Fraying Web of Life* (Washington, DC: World Resources Institute, 2000) summary online www.wri.org/wri/wr2000/pdf/summary.pdf; Global Environmental Facility, *Draft Operational Program #12: Integrated Ecosystem Management*, November 4, 1999 online at www.gefweb.org/operprog/OP12rev8nov4.pdf; Norman Christensen et al., "The Report of the Ecological Society of America Committee on the Scientific Basis for Ecosystem Management," 6 *Ecological Applications* 665–691 (1996); D. Scott Slocombe, "Implementing Ecosystem-based Management," 43 *BioScience* 612–622 (1993); and Timothy Hennessey and Dennis Soden, "Ecosystem Management: The Governance Approach," in Dennis Soden and Brent Steele (eds.), *Handbook of Global Environmental Policy and Administration* (New York: Marcel Decker, 1989), pp. 29–48.

2. Kenneth Sherman, "Sustainability, Biomass Yields, and Health of Coastal Ecosystems: An Ecological Perspective," 112 *Marine Ecology Progress Series* 277–301 (1994) and Lewis M. Alexander, "Large Marine Ecosystems: A New Focus for Marine Resources Management," 17 *Marine Policy* 186–198 (1993).

3. A map showing these LMEs, together with information on them, is found online at www.edc.uri.edu/lme. The Large Marine Ecosystems of the World Web Page is cosponsored by the National Oceanographic and Atmospheric Administration, the World Conservation Union (IUCN), the University of Rhode Island (URI), the International Council for the Exploration of the Seas (ICES), and the International Oceanographic Commission (IOC) of the United Nations Educational, Scientific, and Cultural Organization (UNESCO).

4. See the contributions of the many authors in: Kenneth Sherman et al. (eds.), *Variability and Management of Large Marine Ecosystems* (Boulder: Westview, 1986); *Biomass Yields and Geography of Large Marine Ecosystems* (Boulder: Westview Press, 1989); *Large Marine Ecosystems: Patterns, Processes, and Yields* (Washington, DC: American Association for the Advancement of Science, 1990); *Food Chains, Yields, Models, and the Management of Large Marine Ecosystems* (Boulder: Westview Press, 1992); *Large Marine Ecosystems: Stress, Mitigation and Sustainability* (Washington, DC: American Association for the Advancement of Science, 1993); *The Northeast Shelf Ecosystem* (Cambridge, MA: Blackwell Science, 1996); *Large Marine Ecosystems of the Indian Ocean* (Malden, MA: Blackwell Science, 1998); *Large Marine Ecosystems*

of the Pacific Rim (Malden, MA: Blackwell Science, 1999); and H. Kumpf et al. (eds.), *The Gulf of Mexico Large Marine Ecosystem* (Malden, MA., Blackwell Science, 1999).

5. Kenneth Sherman, "Large Marine Ecosystems: Assessment and Management from Drainage Basin to Ocean," Paper to the Joint Stockholm Water Symposium/EMECS Conference (1997).

6. Lawrence Juda, "Considerations in Developing a Functional Approach to the Governance of Large Marine Ecosystems," 30 *Ocean Development and International Law* 89–125 (1999).

7. The Science Advisory Board of the Environmental Protection Agency observes that "the primary drivers of ecological change are anthropogenic factors" which include human population characteristics, consumption per capita, globalization of the economy, technology, education, and environmental laws and policies. Ecological Processes and Effects Committee, Science Advisory Board, *Ecosystem Management - Imperative for a Dynamic World*, EPA-SAB-EPEC-95-003 (March 1995).

8. John C. Pernetta and Lawrence Mee, in *The Global International Water Assessment, GIWA*, at p. 4 note that: "Clearly, the first step in promoting a response to complex environmental problems is to understand the causal chain between perceived problems and their societal root causes," www.giwa.net/giwa_doc/article.htm.

9. On the distinction between government and governance, see James N. Rosenau, "Governance, Order, and Change in World Politics," in J.N. Rosenau and Ernst-Otto Czempiel (eds.), *Governance Without Government: Order and Change in World Politics* (Cambridge: Cambridge University Press, 1992) and Oran Young, "The Effectiveness of International Governance Systems," in O. Young et al. (eds.), *Global Environmental Change and International Governance* (Hanover, NH: University Press of New England, 1996). See also Mark Sproule-Jones, *Governments at Work: Canadian Parliamentary Federalism and its Public Policy* (Toronto: University of Toronto Press, 1993). For another discussion of instruments to affect behavior in regard to marine resources, see R. Greiner et al., "Incentive Instruments for the Sustainable Use of Marine Resources," 43 *Ocean & Coastal Management* 11–28 (2000).

10. For background on this controversy, see Thomas J. Schoenbaum, "International Trade and Protection of the Environment: The Continuing Search for Reconciliation," 91 *American Journal of International Law* 268–313 (1997).

11. Note that ecolabeling has been controversial, sometimes being criticized as a type of neoprotectionism. See Atsuko Okubo, "Environmental Labeling Programs and the GATT/WTO Regime," 11 *Georgetown International Environmental Law Review* 599–646 (1999); Elliot B. Staffin, "Trade Barrier or Trade Boon? A Critical Evaluation of Environmental Labeling and its Role in the 'Greening' of World Trade," 21 *Columbia Journal of Environmental Law* 205–286 (1996); and Samuel L. Lind, "Eco-Labels and International Trade Law: Avoiding Trade Violations While Regulating the Environment," 8 *International Legal Perspectives* 113–153 (1996). The Food and Agriculture Organization has become increasingly concerned with this subject as it relates to fisheries products and held a technical consultation on the subject in October 1998. See, for example, FAO, *Issues Related to the Feasibility and Practicability of Developing Globally Acceptable, Non-Discriminatory Technical Guidelines for Eco-Labelling [sic] of Products from Marine Capture Fisheries*, FI:EMF/98/2 accessible on line at www.fao.org/WAICENT/FAOINFO/FISHERY/FAOCONS/ecolab/fi-emf2f.htm.

12. See Robert Costanza et al., "The Value of the World's Ecosystem Services and Natural Capital," 387 *Nature* 253–260 (1997) and Frances Cairncross, *Costing the Earth: The Challenge for Governments, The Opportunities for Business* (Boston: Harvard Business School Press, 1992). For a nontechnical introduction to the economics of ecosystem valuation see the Ecosystem Valuation website at www.ecosystemvaluation.org. In regard to the marine and coastal environment, see also, The Independent World Commission on the Oceans, *The Ocean Our Future* (Cambridge: Cambridge University Press, 1998), chapter 4, "Valuing the Oceans," pp. 97–137.

13. In an examination of conditions under which international trade could contribute to ecologically sustainable development, Thomas Andersson, Carl Folke, and Stefan Nyström noted that: "Internalization means that the costs of environmental damage are included in the price of those goods and services which cause the damage." Among the methods they identify to internal-

ize environmental costs are laws and regulations, markets for emission rights, environmental charges and taxes, and better defined property rights. *Trading with the Environment: Ecology, Economics, Institutions and Policy* (London: Earthscan Publications, 1995), pp. 22–23. Note that Principle 16 of the 1992 Rio Declaration adopted at the United Nations Conference on Environment and Development calls on national authorities to promote the internalization of environmental costs. See also, Paul S. Kibel, "National Incentives to Protect Natural Resources: Preserving Their Place in International Trade," 29 *Environmental Law Reporter* 10411–10417 (1999).

14. For consideration of a number of particulars in this regard, see Global Environment Facility, *Valuing the Global Environment* (Washington, DC: Global Environment Facility, 1998) pp. 43–65 and Robert Stavins and Bradley Whitehead, "Market-Based Environmental Policies," in Marian R. Chertow and Daniel C. Esty, *Thinking Ecologically: The Next Generation of Environmental Policy* (New Haven: Yale University Press, 1997) pp. 105–117.

15. A classic examination underscoring the relationship of the government's budget to public policy efforts is found in Aaron Wildavsky, *The Politics of the Budgetary Process*, 4th edition (Boston: Little, Brown and Company, 1984). Wildavsky observes, at p. 4, that: "If one looks at politics as a process by which government mobilizes resources to meet pressing problems, then the budget is a focus of these efforts."

16. Steve Charnovitz, "Two Centuries of Participation: NGOs and International Governance," 18 *Michigan Journal of International Law* 183–286 (1997); Thomas Princen and Matthias Finger, *Environmental NGOs in World Politics* (London: Routledge, 1994); Thomas G. Weiss and Leon Gordenker (eds.), *NGOs, the UN & Global Governance* (Boulder: Lynne Reinner, 1996); Lee A. Kimball, "Major Challenges of Ocean Governance: The Role of NGOs," in D. Vidas and W. Østreng (eds.), *Order for the Oceans at the Turn of the Century* (Kluwer Law International, 1999) pp. 389–405; and Grant J. Hewison, "The Role of Environmental Nongovernmental Organizations in Ocean Governance," in E. M. Borgese, Norton Ginsburg, and Joseph Morgan (eds.), *Ocean Yearbook 12* (Chicago: University of Chicago Press, 1996), pp. 32–51.

17. One example of theological concerns with the environment is seen in Marlise Simons, "Eastern Orthodox Leader Preaches Environment," *The New York Times*, December 6, 1999, p. A10. The article focuses on Patriarch Bartholomew of Constantinople, the spiritual leader of some 200 million Orthodox Christians, who maintains that polluting is a "sin" and a "sacrilege."

18. A thoughtful consideration of and analytical approach for assessment of what are termed "context variables," that is, socioeconomic and political factors at community and individual and household levels that influence program outcomes is found in R. Pollnac and R. Pomeroy, *Evaluating Factors Contributing to the Success of Community Based Coastal Resource Management Projects: A Baseline Independent Method*, (Manila: International Center for Living Aquatic Resources Management: Anthropology Working Paper Number 54, January 1996).

19. Kenneth Sherman, "Achieving Regional Cooperation in the Management of Marine Ecosystems: The Use of the Large Marine Ecosystem Approach," 29 *Ocean & Coastal Management* 165–185 (1995).

20. Andersson et al., *Trading with the Environment*, supra note 13, observe at p. 43 that many local societies know how to utilize resources and ecosystems in a sustainable manner, but globalization can undercut traditional institutions and property rights and reduce the significance of social restraints to sustainable use of local resources.

21. "Ecologically defined space" is used to indicate the area over which natural ecosystems extend, while "politically defined space" refers to the geographical area encompassed by particular governance systems. Juda, "A Functional Approach to the Governance of Large Marine Ecosystems," supra note 6, p. 93.

22. Lawrence Juda and R. H. Burroughs, "The Prospects for Comprehensive Ocean Management," 14 *Marine Policy* 23–35 (1990); R. H. Burroughs and Virginia Lee, "Narragansett Bay Pollution Control: an Evaluation of Program Outcome," 16 *Coastal Management* 363–377 (1988); and Timothy Hennessey and Dennis Soden, "Ecosystem Management: The Governance Approach," in Dennis Soden and Brent Steele (eds.), *Handbook of Global Environmental Policy and Administration* (New York: Marcel Decker, 1989) pp. 29–48.

23. Commission on Marine Science, Engineering and Resources (Stratton Commission), *Our Nation and the Sea: A Plan for National Action.* (Washington, DC: Government Printing Office, 1969).

24. See, for example, The Independent World Commission on the Oceans, *The Ocean Our Future*, *supra* note 12; Jean-Pierre Levy, "Towards an Integrated Marine Policy in Developing Countries," 12 *Marine Policy* 326–342 (1988); United Nations Economic and Social Council, *Development of Marine Areas Under National Jurisdiction: Problems and Approaches in Policy-Making, Planning and Management*, E/1987/69 (8 May 1987). *Agenda 21* points to the need to strengthen the coordination among UN organizations with marine and coastal responsibilities. See chapter 17, para. 17.17 sedac.ciesin.org/pidb/texts/a21/a21-17-oceans.html. Note also the creation by the UN Administrative Committee on Coordination of a Subcommittee on Oceans and Coastal Areas. Online at ioc.unesco.org/soca.

25. GAO, *Ecosystem Management: Additional Actions Needed to Adequately Test a Promising Approach*, GAO/RCED-94-111 (August 1994).

26. Ibid., p. 38. In this regard, the report dryly notes that "there is not enough agreement on the meaning of the concept to hinder its popularity."

27. National Research Council, *Our Common Journey: A Transition Toward Sustainability* (Washington, DC: National Academy Press, 1999).

28. Ibid., pp. 235–236

29. Andersson et al., *Trading with the Environment*, supra note 13, note in this regard at pp. 40–41: "Our world view, values, knowledge and institutions influence to a great extent the way in which society relates to nature and the environment. If people believe they rule and are separate from nature then a 'conquering' technology will develop which strives to create a society independent of nature. If people regard themselves as part of nature and recognize their dependence on its support then a more collaborative type of technology, known as ecotechnology will develop." They further hold at p. 42 that "experience suggests that ethical rules for sustainable behavior develop when people are directly confronted with the consequences of their actions."

30. On this point see Marc L. Miller and Jerome Kirk, "Marine Environmental Ethics," 17 *Ocean & Coastal Management* 237–251 (1992). A report of the National Research Council observes that determining what to sustain is not only a biological question but one of values as well. National Research Council, Committee on Science and Policy for the Coastal Ocean, *Science, Policy, and the Coast: Improving Decisionmaking* (Washington, DC: National Academy Press, 1995), p. 43.

31. Valerie Normand and Debra Salazar, "Assessing the Meaning of Ecosystems Management in the North Cascade," in Dennis Soden, Berton Lee Lamb, and John Tennert (eds.), *Ecosystems Management: A Social Science Perspective* (Dubuque, IA: Kendall-Hunt, 1998).

32. James F. Hammitt notes that: "Concerns about social equity arise because environmental polices can alter the allocation of health, environmental quality, and financial costs across the citzenry. The natural sciences cannot resolve these 'value' issues. They can be elucidated by the social sciences, but ultimately value choices must be resolved through the political system." J. F. Hammitt, "Data, Risk, and Science," in Chertow and Esty, *Thinking Ecologically: The Next Generation of Environmental Policy*, supra note 12, at p. 151.

33. Miller and Kirk, "Marine Environmental Ethics," supra note 30, p. 246.

34. See, for example, National Research Council, *Improving Interactions Between Coastal Science and Policy: Proceedings of the Gulf of Maine Symposium* (Washington, DC: National Academy Press, 1995) and Michael Healey and Timothy Hennessey, "The Utilization of Scientific Information in the Management of Estuarine Ecosystems," 23 *Ocean & Coastal Management* 167–191 (1994).

35. Lynton Caldwell has noted that: "Not all human preferences are realizable in the real world; possibilities are not infinite, and basic relationships between man and nature are not negotiable. Nature does not bargain, and the biosphere is not a marketplace." L. Caldwell, *Between Two Worlds: Science, The Environmental Movement, and Policy Choice* (New York: Cambridge University Press, 1990) p. 4.

36. It has been noted that if sustainability of natural systems is the goal of ecosystem management, then it is not possible to set some arbitrary, desired level of commodity output since it is the natural system that determines what output levels are consistent with system sustainability. On this point, see Jerry F. Franklin, "Ecosystem Management: An Overview," in Mark Boyce and Alan Haney (eds.), *Applications for Sustainable Forest and Wildlife Resources* (New Haven: Yale University Press, 1997) and Norman Christensen et al., "The Report of the Ecological Society of America Committee on the Scientific Basis for Ecosystem Management," supra note 1.

37. Pernetta and Mee, *The Global International Waters Assessment*, supra note 8 emphasize the importance of causal chain analysis. According to them: "A causal chain is a series of statements that demonstrate and summarize, in a stepwise manner, the linkages between problems and their underlying or 'root' causes. Uncertainties accompanying each linkage should be clearly stated. The analysis also permits barriers to resolving the problems to be investigated. A causal chain presents the nature of the problem itself, including the effects and transboundary consequences, and then probes the linkages between problems and its societal causes. In its practical application, it can serve as a model into which regionally relevant information may be inserted."

38. The authors are aware of the common overuse of this term. It has been noted that "holistic" came into vogue in the period of the UN Conference on Environment and Development in 1992 and is currently seen in statements on the environment "with the monotonous routine of applying vinaigrette dressing to salads." Pernetta and Mee, *The Global International Waters Assessment*, supra note 8, p. 2. The term remains useful, however, in distinguishing a more general, systemic viewpoint than that associated with sectoral approaches to problems.

39. A recent report to the World Commission on Water for the 21st Century notes the problem of sectoral approaches in relation to water resources, observing that: "The current institutional system is fragmented, largely because water institutions have been driven by the concerns of other sectors. This led, for example, to creation of institutions managing water for agricultural use, for hydropower, for navigation, etc. Thus sectors may be planning on using the same water without co-ordinating with each other." M. Catley-Carson et al., *Report of the Thematic Panel on Institutions, Society and the Economy and Its Implications for Water Resources*, p. 2. Accessible through www.watervision.org. The problem of sectoralism is a major problem faced by efforts to promote ecosystem-based management.

40. Kai N. Lee, "Appraising Adaptive Management," 3(2) *Conservation Ecology,* online at www.consecol.org/vol3/iss2/art3 (1999); Mark Imperial et. al., "The Evolution of Adaptive Management for Estuarine Ecosystems: The National Estuary Program and its Precursors," 20 *Ocean & Coastal Management* 147–180 (1993); Kai N. Lee, *Compass and Gyroscope: Integrating Science and Politics for the Environment* (Washington, DC: Island Press, 1993); and C. Walters, *Adaptive Management and Renewable Resources* (New York: Macmillan 1986).

41. See, for example, Alistair Couper, *The Times Atlas of the Oceans* (New York: Van Nostrand Reinhold Company, 1983); J. E. Halliday, J. E. and H. D. Smith, "The Integration of Coastal and Sea Use Management," in H. D. Smith, (ed.), *Advances in the Science and Technology of Ocean Management* (London: Routledge, 1991) pp. 165–178; Adalberto Vallega, *Sea Management: A Theoretical Approach* (London: Elsevier Applied Science, 1992); and Porter Hoagland et al., *Marine Area Governance and Management in the Gulf of Maine* (Woods Hole Oceanographic Institution, Marine Policy Center, 1996).

42. 30 *International Legal Materials* 1461–1486 (1991). Article 3(2)(c)(ii) directs that prior assessments of activities required under this protocol are to take "full account of . . . the cumulative impacts of the activity, both by itself and in combination with other activities in the Antarctic Treaty area."

43. On the problem of cumulative effects of multiple uses, see William Odum, "Environmental Degradation and the Tyranny of Small Decisions," 32 *BioScience* 728–729 (1982); Peter M. Douglas et al., "Managing the Cumulative Impacts of Development: An Opportunity for Integration?" in National Research Council, *Improving Interactions between Coastal Science and Policy: Proceedings of the California Symposium* (Washington, DC: National Academy Press, 1995) pp. 184–205; and Frances Irwin and Barbara Rodes, *Making Decisions on Cumulative*

Environmental Impacts: A Conceptual Framework (Washington, DC: World Wildlife Fund, 1992).

44. Jacqueline McGlade, "SimCoast: An Expert System for Integrated Coastal Zone Management and Decision-Making," paper presented at the NOAA-NMFS Workshop on Biological and Physical Changes within the Northeast Shelf Ecosystem of the USA, September 17–19, 1997 and "Intelligent Knowledge Based Systems for the Analysis of Coastal Zones: Design Logic of SIMCOAST," in ASEAN-EU Workshop Report, *Interdisciplinary Scientific Methodologies for the Sustainable Use and Management of Coastal Resource Systems* (University of Warwick, 1995).

45. Arild Underdal, "Integrated Marine Policy: What? Why? How?" 4 *Marine Policy* 159–169 (1980).

46. There is a growing body of literature on the subject of precaution and the precautionary principle. See, for example, David Freestone and Ellen Hey (eds.), *The Precautionary Principle and International Law: The Challenge of Implementation* (Boston: Kluwer Law International, 1996); Food and Agriculture Organization, *Precautionary Approach to Capture Fisheries and Species Introductions* (Rome: FAO Technical Guidelines for Responsible Fisheries, 2, 1996); Harald Hohman, *Precautionary Legal Duties and Principles of Modern International Environmental Law* (London: Graham & Trotman/Martinus Nijhoff, 1994); John M. Macdonald, "Appreciating the Precautionary Principle as an Ethical Evolution in Ocean Management," 26 *Ocean Development and International Law* 255–286 (1995); and S. M. Garcia, "The Precautionary Principle: Its Implications in Capture Fisheries Management 22 *Ocean & Coastal Management* 99–125 (1994).

47. John Clark, *Coastal Zone Management Handbook* (Boca Raton: Lewis Publishers, 1996).

48. Vallega, *Sea Management: A Theoretical Approach*, *supra* note 41 and Tundi S. Agardy, *Marine Protected Areas and. Ocean Conservation* (Austin: R. G. Landes Company, 1997), pp. 65–69.

49. Jens C. Sorensen and Scott T. McCreary, *Coasts: Institutional Arrangements for Managing Coastal Resources and Environments* (Washington, DC: National Park Service, 1990) and Hilary Sargent, "Group Seeks Zoning Rules for Oceans," *Wall Street Journal*, May 10, 2000, pp. NE1,4.

50. Vallega, *Sea Management: A Theoretical Approach*, supra note 41.

51. In its ongoing efforts to study ecosystems, the H. John Heinz III Center finds that of the three ecosystem types studied by it to date (croplands, forests, and coasts and oceans), "coasts and oceans suffer most from a lack of comprehensive and consistent information on key ecosystem goods, services, and properties," and the Center maintains that "there is no consistent information or solid scientific consensus on the key aspects of the arrangement and configuration of coastal and shoreline habitat areas." H. John Heinz III Center, *Designing a Report on the State of the Nation's Ecosystems*, www.us-ecosystems.org/index.html.

52. Laurens et al., "Indicators for Environmental Issues in the European Coastal Zone," *Intercoast Network*, Fall 1997, pp. 3–4, 31.

53. 12 *International Legal Materials* 1319–1444 (1973).

54. G. Peet, "Particularly Sensitive Sea Areas—A Documentary History," 9 *International Journal of Marine and Coastal Law* 469–506 (1994) and A. Blanco-Bazan, "The IMO Guidelines on Particularly Sensitive Sea Areas (PSSAs)," 20 *Marine Policy* 343–349 (1996).

55. P. L. 92-532 (October 13, 1972).

56. 16 *U.S.C.* 1453.

57. See, for example, Norman Christensen et al., "The Report of the Ecological Society of America Committee on the Scientific Basis for Ecosystem Management," supra note 3.

58. Juda, "Functional Approach to Management of Large Marine Ecosystems," supra note 6.

59. On the subject of indicators and their use in regard to sustainable development, see National Research Council, *Our Common Journey: A Transition Toward Sustainability*, supra note 27, pp. 233-274.

60. For varying views of effectiveness and how it might be assessed, see Oran Young, "The Effectiveness of International Governance Systems," in O. Young et al. *Global Environmental*

Change supra note 9, pp. 1–27; Oran Young (ed.), *The Effectiveness of International Environmental Regimes* (Cambridge: MIT Press, 1999); Olav Schram Stokke and Davor Vidas, "Effectiveness and Legitimacy of International Regimes," in O. S. Stokke and D. Vidas (eds.), *Governing the Antarctic* (Cambridge, England: Cambridge University Press, 1996), pp. 13–31; and John Vogler, *The Global Commons: A Regime Analysis* (Chichester, England: John Wiley & Sons, 1995), pp. 153–182.

61. Lawrence Juda, "Ocean Policy, Multi-Use Management, and the Cumulative Impact of Piecemeal Change: The Case of the United States Outer Continental Shelf," 24 *Ocean Development and International Law* 355–376 (1993).

62. See, for example, the Negotiated Rulemaking Act of 1990, P.L.101-648 (November 29, 1990).

63. National Environmental Policy Act, Public Law 91-190 (January 1, 1970).

64. Mark T. Imperial and Timothy Hennessey, "An Ecosystem-Based Approach to Managing Estuaries: An Assessment of the National Estuary Program," 24 *Coastal Management* 115–139 (1996).

65. Ibid.

66. P.L. 104-247.

67. It is recognized that in a variety of situations users and managers may be the same people. Lee notes that those who harvest resources such as fishermen or farmers "are usually those who know most, in a day to day sense, about the conditions of the ecosystem. Their reports constitute much of the information that can be obtained at reasonable cost." Citing several studies Lee maintains that such harvesters "see themselves as stewards of the resources upon which they rely, a claim that frequently turns out to be well-founded." Lee, "Appraising Adaptive Management," supra note 40.

68. The Stratton Commission, *Our Nation and the Sea*, supra note 23.

69. Robert Costanza et al. (eds.), *Ecosystem Health: New Goals for Environmental Management* (Washington, DC: Island Press, 1992).

70. Anthony Downs, *Inside Bureaucracy* (Boston: Little, Brown and Company, 1967).

71. Konrad Von Moltke, "Institutional Interactions: The Structure of Regimes for Trade and Environment," in Oran Young (ed.), *Global Governance* (Cambridge, MA: MIT Press, 1997), pp. 247–272.

72. European Union, "Overview of the Programme: Integrated Coastal Zone Management Demonstration Programme," europa.eu.int/en/comm/dg11/iczm/overview.html.

73. Underdal, "Integrated Marine Policy," supra note 45 and Biliana Cicin-Sain and Robert W. Knecht, *Integrated Coastal and Ocean Management* (Washington, DC: Island Press, 1998).

74. This terminology is used by Timothy Hennessey in "Governance and Adaptive Management for Estuarine Ecosystems: The Case of Chesapeake Bay," 22 *Coastal Management* 119–145 (1994).

75. Kai N. Lee, *Compass and Gyroscope*, supra note 40, p. 9.

76. Ibid., p. 11.

77. Elinor Ostrom, "Designing Complexity to Govern Complexity," in S. Hannah and M. Munusinghe (eds.), *Property Rights and the Environment: Social and Ecological Issues* (Washington, DC: The Beijer Institute of Ecological Economics and the World Bank, 1995), p. 34.

78. Ibid., p. 34.

79. Ibid., pp. 35–40.

80. Ibid., p. 41. Ashby's Law of Requisite Variety states that diversity of scale must be matched by diversity of scale in self-organizing systems. See Ross Ashby, "Principles of Self-Organizing Systems," in H. Van Foerster and Z.W. Zopf (eds.), *Principles of Self-Organization* (New York: Macmillan, 1962), pp. 255–278.

81. Elinor Ostrom, Larry Schroder, and Susan Wynne, *Institutional Incentives and Sustainable Development* (Boulder: Westview Press, 1993).