Mallory Sea

Essay Topic 5a

ENVSCI702

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Restructuring Governance Systems to Better Reflect Key Principles of Ecosystem-Based Management

Introduction

Human utilization of environmental resources has historically led to increased stresses on ecological systems, both at land and sea, with surges in human population growth and subsequent exploitation leading to a decreased ability of systems to recover from resulting pressures (Folke et al. 2005; MA 2005; Scheffer et al. 2009). The Millennium Ecosystem Assessment (MA 2005) has confirmed intensified resource use, showing that ecosystem altercation rates have increased more rapidly in the past half-century than at any other point in human existence. Coastal ecosystems are specifically vulnerable to the demands of increased human presence along coastlines (Small and Cohen 2004) and are subject to multiple uses (recreational, cultural, and economic, etc.) at ecosystem expense. One management scheme presently gaining popularity to address the complex relationship between exploitation and maintenance of natural resources is ecosystem-based management (EBM), an interdisciplinary strategy which focuses on an entire system and the connections between its various components rather than taking a single species or single issue approach (Pikitch et al. 2004; Cárcamo et al. 2013; Long et al. 2015). EBM acknowledges humans as a vital component of the larger social-ecological system, including stakeholders in the organization, implementation, and management of resources. Importantly, EBM has a strong focus

on managing human activity (Gavaris 2009) and reflects the values of those affected by management outcomes.

While holistic approaches to managing natural resources offer promising solutions to wicked problems, the increasing demands of human development will necessitate institutional changes that better sustain natural resources and ecosystem services vital to human existence. Through analysis of current social and ecological literature, it is found that EBM lacks support from current systems of governance, and that institutional changes must be made for the successful implementation of EBM. The defining principles of EBM (as expressed through commonly cited themes in recent literature) will be discussed below, as well as changes to governance systems that will better allow for adaptive policies reflecting the dynamic nature of ecosystems.

Key EBM Principles

Before analyzing the ability of legal systems to internalize EBM approaches, it is first necessary to define principles central to EBM. EBM literature highlights several definitions and goals of holistic ecosystem management, with little apparent consensus on defining features; consequently, implementation of such management schemes is "taking place in many different forms with various combinations of principles" (Long et al. 2015, p. 54), with no globally accepted framework. Older literature sets the foundation for management of entire systems (e.g. Holt and Talbot 1978), yet exerts a central focus on ecological rather than social aspects of system management. Recognition and incorporation of social objectives appeared later (see Mangel et al. 1996), and better reflects currently accepted EBM attitudes, with the management of human activity now central to theory. Relevant social ideas such as communication and stakeholder participation were also introduced at this time.

Long et al. (2015) used frequency analysis to create a list of principles that permeate the current EBM literature (see Fig. 1). Principles (15 in total) appearing in over 50% of analyzed articles were deemed "Key Principles" and notably include the consideration of: 1. ecosystem connections, 2. appropriate spatial and temporal scales, and 3. adaptive management.

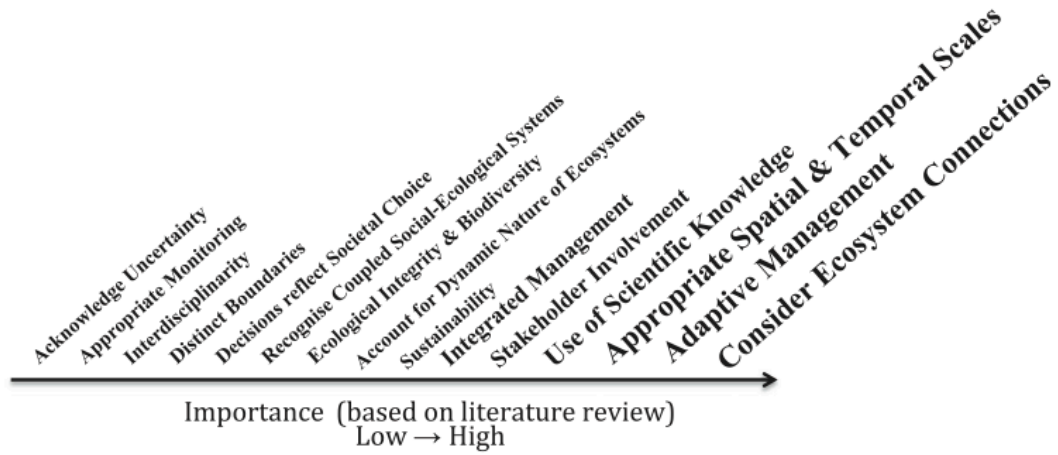

Fig. 1: Key principles of Ecosystem-Based Management, as determined by frequency analysis of recent peer-reviewed literature. Greater font size corresponds to increased significance. Figure from Long et al. 2015.

It should be noted that some themes such as the consideration of cumulative impacts and application of the precautionary approach were not prevalent enough to be identified as key EBM principles, yet the frequency of their occurrence in the literature has increased in recent years (Long et al. 2015), highlighting the evolving nature of EBM and its defining features through time. Key EBM principles are likely to change in the future as successful (and unsuccessful) attempts at managing entire ecosystems will influence perceptions of important management principles in the relevant scientific literature. In addition to identifying these key principles, a basic understanding of complex ecosystem dynamics (discussed below) is critical if hoping to determine the ability of current legal systems to support EBM approaches.

Panarchy, Resilience, and Thresholds

Highly adaptable and dynamic ecosystems can be conceptualized through a panarchy, or "nested set of adaptive cycles" (Fig. 2; Gunderson and Holling 2002, p. 74; Garmestani and Benson 2013, p. 2). These adaptive cycles are influenced by exploitation, conservation, and reorganization and are seen in ecosystems that exhibit fluctuations as a result of stabilizing and destabilizing forces. In contrast to a hierarchy, top-down and bottom-up responses can result from pressures on the system, with adaptive cycles interconnected and influencing each other on varying spatial and temporal scales (Gunderson and Holling 2002). Certain thresholds (or tipping points that, when surpassed, cause a system to restructure) separate adaptive cycles operating at different scales. Predicting, determining, and understanding these thresholds requires continued cross-disciplinary research effort and knowledge generation by scientists (another key EBM principle) and is vital if managing for resilience (or a system's ability to tolerate disturbance without surpassing such thresholds; Selkoe et al. 2015). All relevant human impacts must be considered in management approaches, as the probability of surpassing a threshold increases when humans reduce system resilience (Folk et al. 2004). Returning an ecological system to a previous state is difficult and often requires management actions of magnitude greater than originally required to cause the shift (see "hysteresis"; Selkoe et al. 2015). For this reason, it is important that management schemes account for a lack of predictability and take a precautionary

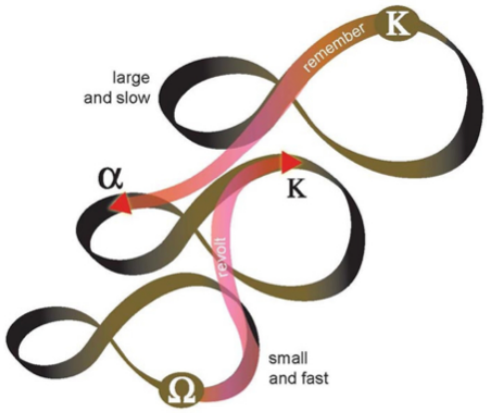

Fig. 2: A nested set of adaptive cycles (panarchy), highlighting both the interconnectedness of ecosystem components and complex feedback loops. The revolt connection signifies changes in one cycle that can cascade into another while the remember connection represents renewal that results from potential stored in slower cycles. Figure from Gunderson and Holling 2002, p. 75.

approach to management, especially if stakeholders value ecosystems in a specific state. Panarchies exhibit complex, non-linear responses to external pressures; unpredictable transformations characteristic of these nested adaptive cycles are largely responsible for challenges in ecosystem management and must be accounted for in legal frameworks.

Current Governance Issues

Two key EBM principles (Fig. 1) involve accounting for the dynamic nature of marine systems and acknowledging uncertainty, making EBM well suited to address the complexities of nested adaptive cycles; however, these ideas are not well reflected through traditional management schemes, as current legal frameworks are subjugated to established hierarchies and legacies of unfavorable legislation, exhibiting levels of rigidity largely incompatible with the trialing and adaptability necessary for EBM (Garmestani et al. 2008; Garmestani and Benson 2013). While a command and control approach to management may have worked in the past (perhaps for more straight-forward issues such as waste management or point-source pollution), contemporary environmental issues like climate change will require frequent modification and flexibility in the legal system (Garmestani et al. 2008).

Current law calls for certainty in legal proceedings, and attempts to solidify "fixes" in response to environmental changes (Karkkainen 2006). A rule-based, prohibitory legal approach confronts environmental issues individually, with little room to consider interactions between multiple stressors contributing to complex ecological issues. Attempting to lock solutions in place simply does not align with the knowledge we have gained concerning highly adaptable, evolving systems. And while it seems tempting to sequentially search for single interventions to environmental issues, the important problems we face are interconnected and will exceed our lifespans. These multidimensional issues call for trans-disciplinary action and major modifications

to current paradigms within the institutional context.

A lack of management flexibility can specifically be seen in the United States, with authors criticizing the ability of current legal institutions to adapt under uncertain future conditions (see "Mitigation vs. Adaptation as a Legal Problem" in Craig 2010). Current restoration paradigms in this region advocate returning ecosystems to a previous, "natural" state, which may never be fully understood (see "shifting baseline syndrome"; Pauly 1995); conversely, the preservation paradigm expects that keeping systems in a single state is both possible and desirable under changing environmental and social circumstances (Craig 2010). Management strategies that reflect restoration and preservation paradigms are ill-suited to complex, dynamic systems and support an inflexible legal framework that accentuates single-fix action plans; even if EBM strategies are better suited to panarchies, the ability of current institutions to accommodate such strategies seems limited. Changes are visibly necessary as US government policies have failed to adequately protect ocean assets in the past (USCOP 2004) and will presumably fail to do so in the future without substantial modifications. Creating adaptable legal systems may be more challenging and time consuming than single-fix mitigation strategies, but making these changes sooner rather than later could ease the transition, be more cost-effective over time, and help foster proactive environmental management.

In addition to a lack of flexibility in current environmental law, system boundaries also come into question, which can be natural (e.g. where land meets sea) or political (a border separating two distinct countries), with management schemes potentially mismatched to corresponding ecosystems. In the United States there are over sixty committees in Congress supervising ocean related issues (Guerry 2005); it is no surprise that jurisdictional boundaries often overlap, resulting in fragmented regulations and incoherent policies that impede resource management at a fundamental level (JOCI 2006), making implementation of holistic ecosystem

management strategies implausible. Realizing EBM will require effective collaboration among various parties and necessitate cooperation beyond traditional political boundaries. This will certainly be the case for highly mobile resources, as protection measures taken in one region could be thwarted by unsustainable practices in another (e.g. tuna catches in the West and East; Crowder et al. 2006), or when resources converge at jurisdictional borders (for example, international water usage of the Great Lakes; Karkkainen 2006). And while necessary first steps are being made to co-manage at the ecosystem level (e.g. the International Joint Commission between Canada and USA), efforts are fraught with these scale mismatches. For example, relevant ecosystem issues might only directly affect a portion of the country (perhaps a few states in the US and a province in Canada), leading issues to be regarded as state matters even though the ecosystem in question lies at an international border and requires continual cooperation between different nations (Karkkainen 2006). If a hypothetical system were approaching an ecological threshold and management actions were required, current legal frameworks would mandate laws to first be passed at the national level and then the state level before management could be implemented (this does not even consider any prerequisite international legal negotiations), a slow and perhaps unsuccessful process. And even though stakeholders might view the status of local ecosystems as highly important to their livelihoods (Karkkainen 2006), relevant issues may not gather adequate legal support at the congressional level. EBM implementation seems problematic with geographical and political mismatches under current conditions.

Spatial mismatches can occur in a more ecological sense as well, as poor political structuring can result in management at inappropriate scales that do not reflect the level at which ecological dynamics and responses transpire. For example, many pressures exerted on coastal systems (sedimentation, pollution, etc.) originate further inland, yet traditional management

approaches might localize estuarine management by focusing on a specific subset of species or issues within a bay. Many authors (e.g. Guerry 2005; Boesch 2006), emphasize the connection between land and sea and argue for management at the watershed level, as nonpoint source pollution, development, and other anthropogenic undertakings which severely impact coastal systems take place over larger geographic scales than are currently considered. Environmental policies need to address ecological issues at relevant spatial scales, difficult under highly fragmented legal frameworks.

It seems that many current social and political systems are not well suited for management at the ecosystem scale, with fixed-rule, command style regulations taking precedence (Leslie & McLeod 2007; Garmestani & Benson 2013). As EBM plans typically develop from preexisting government frameworks, quantitative gap analysis (Cárcamo et al. 2013) can be used to determine "institutional fit" for implementation of EBM under specific legal systems. Institutions that are still in the process of evaluating pressure-state-response relationships in systems and evaluating the worth of resulting ecosystem services under different conditions may not be successful in their applications of EBM (Cárcamo et al. 2013). While identifying current systems of governance that can or cannot support ecosystem-based management is certainly useful, it may perhaps be more advantageous to consider how institutions can change to better reflect the holistic management plans necessary for the future. A fundamental shift in legal objectives and approaches (from a singular, command style to that which aims to manage for resilience and adaptive capacity) is needed to better account for the complex, dynamic nature of nested adaptive cycles and to better reflect current EBM principles.

Institutions to Support EBM

Institutions supporting EBM can address the aforementioned governance issues through the decentralization of power and creation of discussion spaces for competing values to be heard. By determining what services are valued and what tradeoffs we are willing to accept, we can begin to create strategies that will better reflect the environment we wish to create for future generations. What is needed is a shift towards place-based, context dependent, joint management systems that combine the knowledge and skillsets of all parties involved; this should significantly alter traditional hierarchical structures (Karkkainen 2006) and lead to a lack of distinction between centralized governing bodies and those who are governed, as scientists, politicians, NGOs, and local citizens come together to make meaningful contributions towards the collective co-management of complex systems. The integration of user groups into decision-making increases the possibility of arrangements being viewed as "fair", and gives legitimacy to resource management institutions, therefore resulting in higher levels of compliance for policies that stakeholders decide to willingly self-impose (Grafton 2005).

There are many institutional arrangements that could potentially support EBM, one of which would include joining collections of highly fragmented knowledge existing among currently separate and distinct entities (Karkkainen 2006; Craig 2010). As a result of current knowledge fragmentation, only pieces of relevant information reach decision makers, leading to policy gaps and discrepancies. Integrating information from government and nongovernment agencies, scientists, and local citizens who all exhibit a wealth of diverse knowledge would aid in a more comprehensive understanding of ecosystems necessary for EBM. Cross-coordination between agencies and affected individuals at the local level can result in valuable information pooling, typically through establishment of discussion spaces (Karkkainen 2006) which should be used regularly to aid in ongoing conversations about management actions relevant to the specific system.

The benefits of knowledge exchange among diverse groups are well documented in social science literature (Berkes et al. 2000; Drew 2005; De la Cruz-González et al. 2018) and should be recognized and incorporated into the political process. Additionally, there is a need to build interdisciplinary capacity between academics in the social and natural sciences with greater communication of knowledge to the public; boundary organizations (those that specialize in both science and policy) can aid in this process and facilitate conflict resolution among stakeholders (Leslie and McLeod 2007).

Policies should result in monitoring programs (Karkkainen 2006; Craig 2010) with integrated, accessible databases to support ongoing learning. Such databases are pertinent to translate science into policy and should be publically accessible to aid in overall transparency of goals and progress. Managing complex, nonlinear systems will necessitate improved funding for basic research efforts to promote understanding of these systems and their potential tipping points. Knowledge generated from consistent monitoring should be used to inform and make adjustments to management efforts, avoiding simple "fixes" for environmental issues.

A central body (not necessarily the government) is needed to coordinate research and management efforts, capable of adapting goals and objectives as new information is obtained; in this way, reflexive governance (Craig 2010; Garmestani and Benson 2013) is incorporated into institutions. While playing a significant role, the central organization does not mandate rules but rather facilitates and coordinates ongoing learning and discussion and is therefore still compatible with non-hierarchical institutional arrangements. Such changes would likely shift central roles away from traditional governing bodies with examples including the Helsinki Commission for the Baltic Sea (Ehlers 1994) or California's Bay-Delta Authority, comprised not only of state and national representatives, but local citizens as well (Innes et al. 2007). A relevant number of committees with

specific support roles and functions are also required for success, notably in community outreach and education to make plans known and to maintain accountability to the public. The number of committees necessary would be context-dependent, but would likely consolidate fragmented congressional committees and include voices external to the political system as well.

Interactions of complex ecological systems operate on varying spatial scales, well suited to governance systems with nested levels of power and authority. Clam ordinances in Maine provide an example, with citizens given the task of enhancing local shellfisheries; stakeholders replace state functions and manage as they see fit in their specific subdivisions (Hanna 1998). In this case, management decisions can be reviewed and revised much more quickly than could be accomplished with a government-centralized hierarchical framework, because local people are ultimately responsible for making management decisions. Institutions of environmental management that function under similar nested scales of authority have been proven successful in other cases as well (Leslie and McLeod 2007; Dietz et al. 2008). In addition, natural resources to be managed—and the social context within which management schemes are implemented—likely exhibit spatial heterogeneity. While some ecosystem issues might be better addressed with whole-system analysis, significant differences at smaller spatial scales could be more easily explored at smaller scales of governance, making a nested system important for EBM implementation.

Finally, institutions need to support and embrace uncertainty, as it is unlikely that science will ever be able to fully explain the inner workings of ecological systems. Science should be treated as provisional (Grumbine 1994), with management schemes flexible to quickly change and incorporate new procedures as information is continually gained. Scientific monitoring and development of improved models to support management will be an ongoing process that may require frequent adjustments to management actions; this process of continual evaluation will better

reflect inevitable change in dynamic systems. And while the dynamic nature of systems has been acknowledged, laws have not evolved to reflect this recognition, with paradigms of preservation and restoration—rather than adaptive capacity—entrenched in environmental policy (Craig 2010). Shifting to more adaptable forms of law will increase the adaptive capacity of both political and ecological systems to deal with the unexpected. Admittedly, ecological resilience can be increased through some traditional policies, targeting specific anthropogenic impacts known to increase pressure on systems, but important changes need to be made to account for uncertainty. Changes should include altering regulatory standards such as "maximum sustainable yields" to broader-scale evaluations of ecosystems sustaining fish populations under unknown future environmental conditions (Craig 2010). Institutionalizing the precautionary principle and shifting the burden of proof of sustainability to those wishing to extract for economic gain will also be key under future governance systems. There is likely to be much resistance to these proposed changes, as they almost certainly represent upfront economic losses for those with vested financial interests (although perhaps ironically, these are the very groups that should be invested in ensuring the long-term sustainability of ocean resources; Craig 2010). If neoliberal ideologies go unaltered, formal institutions could perhaps start incentivizing adaptive behaviors in the economic sphere.

Conclusion

Successful EBM implementation involves taking context-specific issues, values, and concerns into account while managing for a collective suite of stressors that influence ecosystem health and functioning in a specific time and space. This task is unquestionably challenging and requires fundamental changes to governance systems and much of environmental policy, as simple command-style rules cannot adequately support the management of highly adaptive ecological systems. Current legal institutions stifle the creativity and flexibility needed to manage entire

ecosystems; a framework that allows stakeholders to consider trade-offs between ecological states and resulting services is greatly needed so that we can determine how to best manage for desired conditions. Management action will require coordination by a central body that unifies otherwise disparate groups under cohesive goals and objectives. Consistent monitoring data will inform frequent management adjustments that serve to maintain resilience and adaptive capacity of the system. As EBM plans are largely context-specific, there are no perfect model systems to reference; however, frameworks are being developed to assist in the design and implementation process (e.g. Levin et al. 2009).

A shift towards decentralization and reduction of state sovereignty to collaborative co-management among knowledgeable players and affected stakeholders is increasingly recognized as needed to implement ecosystem-based management schemes (Karkkainen 2006). The time and cost associated with altering institutions do not outweigh the consequences associated with stagnation, as degradation of ecosystems will likely continue in the future under current management regimes. As EBM initiatives become more prevalent in the future, it is hoped that emerging real world successes serve to influence and support other EBM plans under an adaptable legal framework which acknowledges the complex, dynamic nature of socio-ecological systems.

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