Ecosystem Based Management of Coastal Resources: Performance Enhancement at the Science Policy Interface

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Introduction

Ecosystem Based Management (EBM) is a concept that is increasingly advanced by managers and scientists alike, holding great promise in enhancing management performance of coastal resources. Recent reports on ocean policy strongly advocate such a concept and in the U.S., various agencies are adopting ecosystem considerations in management approaches.[2]

It has been clear for some time that existing mechanisms of environmental management in coastal areas, in spite of progress, have been inadequate.[3] The rapid changes in human demography, spatial distribution, and the time horizons involved argue strongly for more comprehensive, integrated approaches to coastal resource management. Coastal areas are being exposed to human-related impacts at unprecedented and often underappreciated rates.

A brief synopsis of current projections indicates the urgency of the management problem. From 1990 to 2000, the U.S. added 33 million people and is growing at over 3 million per year.[4] Coastal states represent 21% of the land mass of the U.S., yet they comprise 80% of the economy and 70% of the population.[5] The top twenty coastal and Great Lakes metro areas are on track to add 32 million people and increase urban footprints by 46% by 2025.[6] Every week, 3,300 new residents enter southern California, 4,800 arrive in Florida, while 1,500 new homes per day are built along U.S. coasts.[7] Over 20,000 acres of coastal habitat disappear each year while every eight months the oil equivalent of the Exxon Valdez spill enters coastal waters from nonpoint source pollution.[8] The recent National Water Quality inventory lists 51% of assessed estuaries as impaired and 78% of Great Lakes shorelines as impaired.[9]

These problems and their magnitude and geographic scale are affecting the integrity of ecological systems. Rapid growth and development indicate if management performance remains constant then problems promise to escalate rapidly, revealing a plethora of near intractable problems confronting coastal environments. Enhanced management performance is a necessity; this is the context within which EBM must be implemented**.**

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[2] NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION, NEW PRIORITIES FOR THE 21ST CENTURY: NOAA'S STRATEGIC PLAN FOR FY 2003-2008 AND BEYOND (U.S. Department of Commerce, National Oceanic and Atmospheric Administration) (2003); and M. Sissenwine and S. Murawski, *Moving beyond "Intelligent Tinkering:"advancing an ecosystem approach to fisheries* 274 MAR. ECOL. PROG. SER. 291-295 (2004).

[3] J.H. Adler, *Legal Obstacles to Private Ordering in Marine Fisheries,* 8 ROGER WILLIAMS UNIVERSITY LAW REVIEW 9-42 (2002); and U.S. COMMISSION ON OCEAN POLICY, AN OCEAN BLUEPRINT FOR THE 21ST CENTURY (2004).

[4] U.S. Census Bureau, United States census January 9, 2000 (2002).

[5] M.K. Orbach, *Socio-economic Assessment of the Southeast Region, Report on Issues, Initiatives and Imperatives,* Coastal Conference 2006 on ecosystem based approaches to management in the southeast region, NORTH CAROLINA SEA GRANT, NORTH CAROLINA STATE UNIVERSITY (NC-SG 2006-08) (2006).

[6] D. McGrath, *Predicting urban sprawl in top US coastal cities*, ILLINOIS-INDIANA SEA GRANT HELM (Fall): 1-6 (2000).

[7] J.K. Bourne, Jr., *Land on the Edge: America's coastlines are in danger of being loved to death*, NATIONAL GEOGRAPHIC, July 2006, 60-87.

[8] PEW OCEANS COMMISSION, AMERICA'S LIVING OCEANS: CHARTING A COURSE FOR SEA CHANGE (Pew Oceans Commission) (2003).

[9] U.S. ENVIRONMENTAL PROTECTION AGENCY, NATIONAL WATER QUALITY INVENTORY: 2000 REPORT (EPA-841-R-02-001) (2002).

EBM in Theory

There is a rich literature emerging on what EBM is by definition and in the principals behind the concept. Numerous recent articles explore the principles of EBM in various contexts.[10] The report of the U.S. Commission on Ocean Policy (USCOP) has an extensive discussion on EBM.[11] The more important elements from these and other reviews from a science and policy perspective include:

a) The idea of sustainability and focus on long-term functioning of ecosystems in acceptable states or condition; i.e., maintenance of the integrity of systems as whole, not single species elements;
b) The importance of regional approaches due to ecosystems that scale local to global across political jurisdictions, including the key concept of place-based solutions to problems;
c) The idea of adaptive management, the notion that we need mechanisms in management policy to rapidly respond to changes in knowledge and to manage conservatively in the face of uncertainty;
d) The concept of managing human behavior, accounting for management performance and insuring adequate societal response to problems;
e) The idea of public and political engagement in the management process and policy formulation;
f) The reorganization of our institutions of governance to specifically support EBM approaches including cross jurisdictional coordination; and,
g) The need for a strong foundation of science and recognition that institutions of governance need to develop effective science-policy interfaces and sufficient capacity to insure management critical science is generated and transferred at relevant scales.

One of the challenges not often discussed but inherent to EBM is that human institutions and social mores must respond rapidly enough to current and expected conditions. They have never had to evolve at this pace or under these circumstances before. Barnes has recognized that many of today's environmental problems may be largely systemic to social systems that evolved under conditions that no longer exist.[12]

EBM Implementation and the Science Policy Interface:Institutional Performance

A successful transition to sustainability will require adequate performance from our institutions of governance such as the collective infrastructure of government, those legal, social, and educational entities that collectively determine a nation's response dynamics to environmental threats including policy and societal response.[13]

The Nation's capacity for adequate institutional performance is determined in large measure by the research and educational institutions that contribute science based information to the policy domain. A critical element in that infrastructure is the rate of knowledge creation and flow of science based information into the policy domain, across the so called science-policy interface. Generating best available science to support EBM

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[10] *See* M. Sissenwine and S. Murawski, *Moving beyond "Intelligent Tinkering:" advancing an ecosystem approach to fisheries*, 274 MAR. ECOL. PROG. SER. 291-295 (2004); and K.K. Arkema, et al., *Marine ecosystem-based management: from characterization to implementation*, 4 FRONT. ECOL. ENVIRON. 10, 525-532 (2006).
[11] *See generally* U.S. Commission on Ocean Policy, An Ocean Blueprint for the 21st Century (2004).
[12] PETER BARNES, CAPITALISM 3.0: A GUIDE TO RECLAIMING THE COMMONS (Berrett-Koehler) (2006).
[13] R.C. Baird, *The Human Dimension in Ecosystem Management: Institutional Performance and The Sea Grant Paradigm, in* SUSTAINING LARGE MARINE ECOSYSTEMS: THE HUMAN DIMENSION **17-26** (T. Hennessey and J. Sutinen, eds., Elsevier) (2004).

relates directly to knowledge creation, translating that knowledge into a format useful to the policy domain, and then actually making that transfer across a two way interface.

Most would agree with the USCOP report that performance is the issue in EBM.[14] A critical challenge to performance is that rates of knowledge creation and translation of that knowledge relative to management needs and the push pull of flow across the science/policy interface must be sufficient to allow institutional response adequate to addressing EBM issues. Given the demand for improved institutional performance in the next decade and beyond, we have equal urgency in better organizing our research institutions and communication channels to accommodate those demands.

Best Available Science

Both the Pew and U.S. Ocean Commissions call for additional resources to enhance the knowledge base.[15] However, while important, resources alone are insufficient to insure adequate EBM performance. Innovative ways of thinking about how institutional constructs in research, education, and communication are organized and performed are in order, a new mindset in thinking about the process. A better understanding is needed of how useful scientific knowledge is to policy decisions. Furthermore, an understanding of what is needed to more effectively use the end products of EBM approaches is necessary.

Much has been written about issues and problems surrounding best available science in the policy domain and will not be expanded upon here.[16] Recognizing, however, that the science agenda for sustained EBM practice must be better tailored to complex multi-dimensional challenges reveals the need for structural and alignment issues at the science policy interface and possible changes from current practice. In fact, that process of rethinking has begun to emerge under the rubric of sustainability science[17]: recognition has emerged that successful practice of EBM requires broad interdisciplinary approaches and integration of that knowledge into management useful formats.[18]

Institutionally we need to think about creating more sub-structure in our university curricula and in the organization of our research institutions including technical societies that better integrate multidisciplinary science with the policy domain. Human dynamics, natural processes and complex systems all intersect in EBM issues.

We are seeing more of this as universities now support research centers that create multidisciplinary environments for focus on societal issues. Likewise NSF and other federal agencies are investing in university based centers. This is a start but more is needed including more effective ways to organize and utilize current research and development assets. Thus, policy makers, university presidents and increasingly non-government organizations must be constantly educated about issues and how emerging

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[14] *See supra* note 11.
[15] *See supra* note 8; and *Id.*
[16] *See* R. Costanza, *Developing Ecological Research That is Relevant for Achieving Sustainability*. 3 ECOLOGICAL APPLICATIONS 579-581 (1993); E.J. Rykiel, Jr., *Scientific Objectivity, Value Systems, and Policymaking.* 51 BIOSCIENCE 433-436 (2001); and P.J. Sullivan, et. al., *Defining and Implementing Best Available Science for Fisheries and Environmental Science, Policy, and Management*, 31 FISHERIES 9, 460-465 (2006).
[17] Robert W. Kates, et al., *Environment and Development: Sustainability Science*, 292 SCIENCE 641-642 (2001).
[18] NATIONAL COUNCIL FOR SCIENCE AND THE ENVIRONMENT. RECOMMENDATIONS FOR ACHIEVING SUSTAINABLE COMMUNITIES, SCIENCE AND SOLUTIONS. REPORT OF THE 2ND NATIONAL CONFERENCE. NATIONAL COUNCIL FOR SCIENCE AND THE ENVIRONMENT (2002); and W.C. Clark and N.M. Dickson, *Sustainability Science: The Emerging Research Program*, 100 PROC. NATL. ACAD. SCI. USA 14, 8059-8061 (2003).

areas of research or new paradigms of institutional organization can contribute to EBM performance. Increasingly universities are recognizing the value of system wide engagement with real problems. For instance, Arizona State University is experimenting with large, problem-focused, interdisciplinary research centers that teach students to communicate with the public and address real problems as central to the educational enterprise.[19]

The Research Enterprise

Ecosystems are highly complex systems and not well understood so basic research programs that advance our knowledge of such systems including the human dimension will enhance EBM performance. Knowledge must also be relevant to the scale of consideration (i.e. place based) for EBM applications. The research enterprise must have sufficient capability to generate both local knowledge and knowledge at larger scales, such as a distributed research capability with assets in multiple states and locales. Otherwise, EBM policy decisions may lack information for adequate solutions when location-specific changes to human behavior are needed in practical applications.

EBM goals involve modifying human behavior so as to preserve ecosystem function within acceptable states, however defined. Determination of acceptable ecosystem states and what baseline conditions are to be used is a politically mediated process yet critical to EBM practice. Likewise, changes to systems over time need to be determined. Both of these involve information from the research enterprise.

That enterprise should be structured to provide the following relevant to EBM application:

- a) Information on ecosystem condition through indicators and proxies;
- b) Observation capability to measure indicators in quasi-real time;
- c) Data management systems to analyze and communicate information to users;
- d) Outreach capability to translate and communicate information useful to policy development;
- e) Programs of technology development to improve assessment and monitoring capability;
- f) Decision support tools that enhance predictability and generate reasonable future scenarios; and,
- g) More efficient, effective methods of ecosystem restoration and mitigation.

Science Policy Interface

Enhancing the effectiveness of the science-policy interface is absolutely critical to successful EBM practice. Good, relevant science alone is insufficient. There is rich literature on the interplay of science and government in setting public policy and the need for major changes in governance and management.[20] Enhancing the science-policy interface means better aligning the science enterprise with policy needs and more effective communication across the interface. Some of the structural or alignment issues include:

- a) reducing time from knowledge creation to practical application;

[19] C. Macilwain, *US higher education: The Arizona experiment*, 446 NATURE 7139, 968-970 (2007).

[20] K.N. Lee, Compass and gyroscope: integrating science and politics for the environment (Island Press) (1993); M.K. Orbach, Beyond freedom of the seas: ocean policy for the 3rd millennium (National Academy of Sciences) (2002); and L.B. Crowder, et al., *Sustainability: Resolving Mismatches in U.S. Ocean Governance*, 313 Science 617-618 (2006).

b) posting data in easily accessible formats;

c) changing the structure of our regulatory agencies to: separate research centers from regulatory operations, increase engagement between agencies and universities, co-locate agency research centers with universities;

d) developing a pedagogy and research paradigm in the social sciences to more effectively get science to policy at various levels of decision making (legal, legislative, public);

e) developing a cadre of outreach specialists and scientists trained in the pedagogy; and

f) improving coordination and communication among multiple jurisdictions, local to international, that collectively determine EBM policy and performance.

Final Thoughts

EBM is an immensely complex undertaking. To do well will require better alignment of our institutions of governance and the nation's research enterprise, focusing on what gets taught, how we are organized, funding priorities, and communication channels. Moving EBM from theory to practice requires an appropriate mindset, one that focuses our attention on what we need to know, what we need to do, and how it gets done in order to maintain acceptable ecosystem functionality.

R.A. Buchanan, in discussing the social prerequisites for the industrial revolution, indicates three conditions are necessary for the successful generation of a new technological innovation.[21] All are critical to EBM application in this century of the environment. The first element is the existence in society of important groups that are prepared to consider EBM seriously and sympathetically. Second, this first factor will depend upon technological innovation that is encouraged to meet societal needs. The third factor, equally indispensable, is appropriate investment in operations and physical assets plus the human resources with the skill sets appropriate to the task.

While all these factors are to various degrees in place today they are not yet optimally aligned to fully support EBM. For the foreseeable future, EBM in practice will remain truly an art form requiring both scientific knowledge and creative know-how in bringing science, policy, and society into responsiveness on many scales. Given the growth scenarios on the horizon, just maintaining current conditions will be a formidable task. Welcome to the world of EBM.

[21] R.A. BUCHANAN, INDUSTRIAL ARCHAEOLOGY IN BRITAIN (1972).