Synthesis Report for the

ECOSYSTEM-BASED MANAGEMENT FOR SUSTAINABLE COASTAL-MARINE SYSTEMS INITIATIVE

2004-2009

AN INITIATIVE OF

The David and Lucile Packard Foundation

CONTENTS

PREFACE

WHEN I JOINED THE DAVID AND LUCILE PACKARD FOUNDATION IN LATE 2005, the Foundation was one year into a new initiative to strengthen the science of ecosystem-based management and help move it from academic discussions into practice.

At the time, the field of ecosystem-based management (EBM) seemed locked in a debate about definitions and terminology. What does EBM mean? What does EBM include and not include? How do we talk about EBM? There were few, if any, scientists who claimed expertise in marine and coastal EBM, and only a handful of leaders were promoting the approach.

The last four years have been a period of rapid growth and learning during which the field of EBM has moved well beyond definitions. New, young leaders are emerging and shaping the field. For example, two of our grantees, Heather Leslie from Brown University and Karen McLeod from COMPASS, have published a well-received, comprehensive guide to utilizing EBM. Courses on EBM are now being offered at universities in the United States and abroad, including an EBM-focused doctoral track at the University of California, Davis. And at conservation conferences, instead of single sessions on EBM, there now are entire tracks (often with overflowing rooms) dedicated to discussing EBM science and applications.

EBM in the real world is in a stage of growth and exploration, although progress in practical application has been outpaced by theoretical advancement. It's hard to point to an example of fully functional EBM in practice, but many places are testing key elements of the approach. Up and down the west coast of the United States, communities are working at a local level to implement an ecosystem approach that fits their scale and issues. This work has led to a growing appreciation of incremental

success, experimentation with new approaches and learning across sites as well as recognition that progress takes time.

In order to move to the next phase, there must be a focused effort to make the institutional and policy changes that are necessary to support an EBM framework. A key task will be building awareness and demand among political leaders at all levels. The ability to influence such efforts is far beyond the reach of science and requires new people and organizations to advocate for and nurture change. Consequently, the Packard Foundation Science Program made its final grants through the EBM Initiative in 2009.

The EBM Initiative's grantees have contributed to an increased recognition of the need for an ecosystem-based approach to marine management by deepening the field of EBM science, delivering tools to apply in practice, and spearheading approaches for establishing EBM on the ground. The Foundation is proud of this progress.

This report documents the EBM Initiative by describing the design of the Initiative, highlighting key insights that have been gained through grantees' accomplishments, and identifying lessons learned that can help the Foundation, its grantees and the broader EBM community learn from this experience.

The Foundation remains deeply committed to EBM as a marine conservation approach and hopes that this report will provide insights that can be used to continue to advance the field.

— KRISTIN SHERWOOD, *Program Officer 2005-2010, Ecosystem-Based Management for Sustainable Coastal-Marine Systems Initiative, The David and Lucile Packard Foundation*

WHAT IS ECOSYSTEM-BASED MANAGEMENT FOR MARINE AND COASTAL AREAS?

IN 2005, A GROUP OF SCIENTISTS and policy experts, with support from the Packard Foundation, sought to clarify and codify the principles of ecosystem-based management (EBM). The resulting Scientific Consensus Statement on Marine Ecosystem-Based Management released by the Communication Partnership for Science and the Sea (COMPASS) was endorsed by 220 scientists and policy experts from academic institutions across the United States.

The *Consensus Statement* defined and elaborated the EBM concept as follows:

Ecosystem-based management is an integrated approach to management that considers the entire ecosystem, including humans. The goal of EBM is to maintain an ecosystem in a healthy, productive and resilient condition so that it can provide the services humans want and need. Ecosystem-based management differs from current approaches that usually focus on a single species, sector, activity or concern; it considers the cumulative impacts of different sectors.

Specifically, ecosystem-based management:

- emphasizes the protection of ecosystem structure, functioning and key processes;
- is place-based in focusing on a specific ecosystem and the range of activities affecting it;
- explicitly accounts for the interconnectedness within systems, recognizing the importance of interactions between many target species or key services and other non-target species;
- acknowledges interconnectedness among systems, such as among air, land and sea; and
- integrates ecological, social, economic and institutional perspectives, recognizing their strong interdependences.

To read the full consensus statement, please visit
http://www.compassonline.org/pdf_files/EBM_Consensus_Statement_v12.pdf

THE CONTEXT: WHY EBM?

PALAU

Extensive scientific research and work with local initiatives like the Babeldaob Watershed Alliance have identified how EBM policies can help ensure that the island's community has access to the quality and quantity of water they need now and in the future.

PALAU-PCS.ORG/

IN 1999, THE NATIONAL ACADEMY OF SCIENCES issued the report, "Our Common Journey: A Transition Toward Sustainability," which led to a wide-ranging discussion within the Packard Foundation about supporting the birth of the emerging field of sustainability science.[1] At the same time, the Foundation's asset base had declined due to an economic downturn, leading Foundation leaders to refocus discussions around investing in sustainability science to an investigation of issues surrounding the sustainability of ocean and coastal- marine systems.

Foundation staff reviewed over thirty years of literature on conservation initiatives dealing with coastal-marine ecosystems and concluded that these efforts had not worked as effectively as hoped. Around the same time, a number of reports identified inadequate scientific understanding of ecosystems and the failure to effectively link science to decision-making as key impediments to achieving sustainability of coastal-marine ecosystems.[2]

It was becoming clear that there was a growing need for management approaches that focused on the entire ecosystem, including the people and communities that are part of that ecosystem, as opposed to approaches that addressed isolated parts of the system or individual species. The Pew Ocean Commission and the U.S. Commission on Ocean Policy reports specifically called attention to the urgent need to reform existing ocean and coastal management using an ecosystem-based management approach.[3]

The concept of managing the oceans on an ecosystem scale, rather than addressing individual species or

[1] National Research Council. 1999. Our Common Journey: A Transition Toward Sustainability. Washington, DC: National Academy Press.

[2] (NOAA 1996, NRC 1999, NMFS 1999, IUCN 2000, Reykjavik 2001, WWF 2002)

[3] Pew Oceans Commission. 2003. *America's Living Oceans: Charting a Course for Sea Change.* Arlington, VA: Pew Oceans Commission; U.S. Commission on Ocean Policy. 2004. *An Ocean Blueprint for the 21st Century: Final Report of the U.S. Commission on Ocean Policy.* Washington, DC: U.S. Commission on Ocean Policy.

economic sectors, had begun to take hold as a potential solution to these issues, and key marine science and policy leaders were promoting the concept.[4]

Ecosystem management of land-based systems began in the 1950s, but its application in the marine environment was new. Although the term "ecosystem management" has been defined in numerous ways, the general tenets of this still-evolving approach include the following:

- the use of ECOLOGICAL BOUNDARIES FOR MANAGEMENT rather than administrative or political boundaries;
- the maintenance of ECOSYSTEM INTEGRITY AND RESILIENCE as a primary goal in order to sustain the long-term ability of ecosystems to deliver desired goods and services;
- a recognition that PEOPLE ARE PART OF THE ECOSYSTEM and that achieving management objectives often requires altering human uses and activities; and
- a FLEXIBLE MANAGEMENT APPROACH that senses and reacts to the responses of ecological and human systems to interventions and other changes.

In 2003, consistent with its commitment to supporting the role of science in conservation efforts, the David and Lucile Packard Foundation assessed the opportunities and challenges related to advancing EBM in a marine setting. One promising sign was that ecosystem approaches were starting to emerge in key pieces of ocean-related public policy such as the National Marine Sanctuaries Act[5], the Magnuson-Stevens Fishery Conservation and Management Act[6], the Presidential Executive Order on Marine Protected Areas[7] and a commitment by the World Summit on Sustainable Development[8] to comprehensive, holistic approaches for marine management.

Experiences with land and watershed systems were already demonstrating that the transition to ecosystem approaches posed significant challenges in aligning policies, institutions and communities to change how people use and manage natural resources. However, it also was clear that while policy directives might support an ecosystem

[4] Millennium Ecosystem Assessment; Pew Oceans Commission; U.S. Commission on Ocean Policy; "Sustaining Marine Fisheries." 1999. National Research Council.

[5] National Marine Sanctuaries Act 2000 (NOAA) s 1431, http://sanctuaries.noaa.gov/library/national/nmsa.pdf (15 March 2010)

[6] Magnuson-Stevens Fishery Conservation and Management Act 1996, http://www.nmfs.noaa.gov/sfa/magact/ (15 March 2010)

[7] Marine Protected Areas 2000 (Presidential Order 13158), http://ceq.hss.doe.gov/nepa/regs/eos/eo13158.html (15 March 2010)

[8] World Summit on Sustainable Development 2002, http://www.worldsummit2002.org/ (15 March 2010)

approach, significant resources would be necessary to produce the science needed to implement EBM in marine and coastal environments.

The Foundation concluded that attempts to initiate EBM were significantly undermined by gaps in scientific understanding about how to manage coastal-marine systems, by insufficient incorporation of scientific knowledge into decision-making and by inadequate inclusion of stakeholders in the process of building the scientific basis for EBM.

The Ecosystem-Based Management for Sustainable Coastal-Marine Systems Initiative (EBM Initiative) was launched to assist in overcoming these science-related barriers to EBM implementation. The Foundation hoped to create new capabilities that would match the scale and scope of emerging and potential future management responsibilities and thereby spur broader adoption and implementation of EBM.

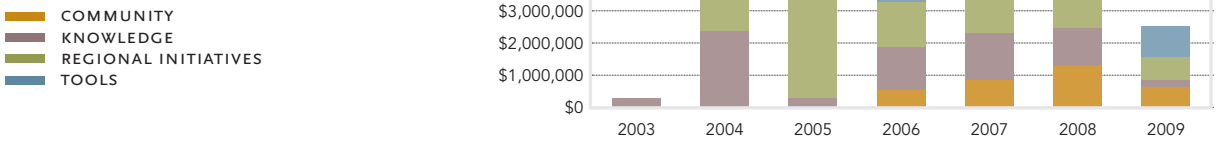
Through this strategy, the Foundation hoped to create new knowledge and ensure its application to protect and restore coastal-marine ecosystems. A deliberate decision was made to support research and synthesis activities that advanced understanding of EBM, and place-based activities that provided an opportunity to demonstrate EBM in specific places. In implementing this strategy the foundation decided to link its science activities with the key priorities of its ocean and coasts conservation programs in the western Pacific, the Gulf of California, and the central California coast.

The primary purpose of this report is to document the EBM Initiative in ways that will help the Foundation and its grantees learn from this experience.

Figure 1 EBM INITIATIVE INVESTMENTS

The EBM Initiative invested in three strategies: knowledge, tools and regional initiatives. In 2006, Initiative staff added a communications and community-building strategy.

Distribution of Investments:



DESIGNING THE EBM INITIATIVE

WHEN THE FOUNDATION LAUNCHED the Ecosystem-Based Management for Sustainable Coastal-Marine Systems Initiative in 2004, the Millennium Ecosystem Assessment had yet to be published and EBM was a nascent approach with uncertain promise for marine management. Although a group of leading experts was encouraged by the promise of the approach, a field of marine and coastal EBM did not exist, and only scant efforts existed to implement EBM on the ground.

This lack of definition and structure posed challenges. In response, EBM Initiative staff defined an entry point, outlined a strategy, set expectations and made a sustained commitment in the face of significant uncertainty. EBM was a high-risk proposition and the EBM Initiative was designed to address the uncertainties.

Over the next five years, the Foundation invested more than $32 million in grants designed to test the promise of this approach and to help lay the scientific foundation for widespread EBM adoption. *(See Fig. 1.)*

THE INITIAL DESIGN

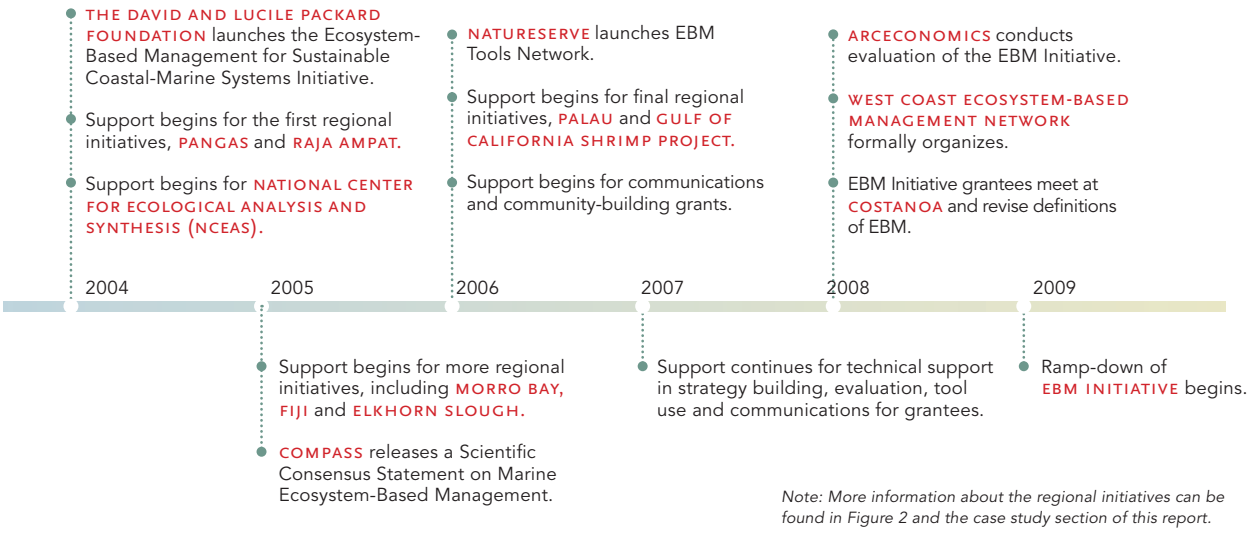
The EBM Initiative's overarching long-term goal was to *create, and ensure the use of, the knowledge, tools and skills needed to sustainably manage coastal-marine systems.* During the first five years, the Initiative focused on defining and testing the scientific framework for EBM through three strategies:

initiative strategies

- The KNOWLEDGE strategy focused on filling critical information gaps and strengthening the science underlying EBM by building knowledge about the ecological, social and economic processes affecting EBM.
- The TOOLS strategy facilitated the development and dissemination of tools that would help stakeholders and decision-makers use existing scientific information to make choices about ecosystem use and management. Such tools include computer software to model ecosystems, visualize the effects of different management actions or involve stakeholders in ecosystem-planning activities.
- The REGIONAL INITIATIVE strategy invested in site-based efforts to implement EBM in areas of established interest to the Foundation—the western Pacific, the Gulf of California and the central California coast. These regional initiatives were designed to build a baseline scientific understanding of each ecosystem and reveal broader lessons about the frameworks, processes and institutional arrangements necessary to implement EBM. A brief description of each regional initiative can be found in *Figure 2.*
- In 2006, Initiative staff added a fourth strategy focused on COMMUNICATIONS AND COMMUNITY BUILDING to help speed learning and innovation within

the field, to build communities of practice around EBM and to support grantee efforts to help policymakers and resource managers understand and use EBM science. *Figure 1* highlights the distribution and timeline of grants for the Initiative.

Figure 1.1 TIMELINE OF INVESTMENTS



Note: More information about the regional initiatives can be found in Figure 2 and the case study section of this report.

EBM INITIATIVE GRANTEES

A list of EBM Initiative grantees for each strategy can be found in the appendix of this report. (p. 32)

The chief anticipated outcomes of the Initiative's strategies were a scientifically credible framework, a set of practical tools and new capacities for achieving EBM. The Foundation also expected to foster an improved understanding of what scientific gaps needed to be filled. Finally, the Foundation hoped that the practical demonstration of EBM and its sustainability benefits in real places would inspire broader adoption of this emerging approach across the public, private and not-for-profit sectors.

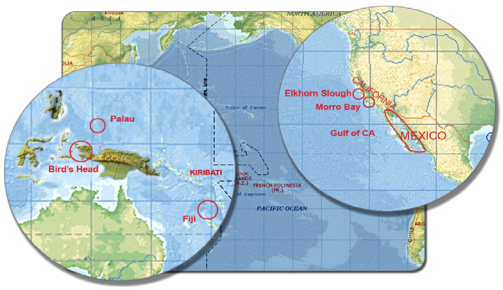
FUNDING

The Foundation made more than $32 million in grants to 66 organizations and committed almost half of the Initiative's total budget to projects initiated in 2004. These early commitments enabled the grantees and the Foundation to explore different approaches to EBM over a longer time period, but limited the Initiative's ability make significant investments in new areas.

The Initiative's investments were also highly leveraged. According to grantees, 57 percent of the funding for grantee projects came from sources other than the Foundation.[9]

[9] *Getting Closer to EBM: Evaluation of the David and Lucile Packard Foundation's EBM Initiative*, ARCeconomics, January 2009. Internal report produced for the Packard Foundation.

Figure 2 EBM INITIATIVE REGIONAL INITIATIVES



To select the regional initiatives, Initiative staff looked for projects that combined science and action to demonstrate EBM in the Foundation's priority conservation areas (the central California coast, Gulf of California, and Western Pacific). Initiative staff looked for projects that would:

- make important contributions to the science of EBM for coastal-marine systems;
- guide the process of EBM through development of appropriate management frameworks at different scales;
- assess the economic and social impacts of EBM on local communities; and/or
- foster EBM of key economic sectors such as fisheries or coastal land-use activities.

Central California Coast

ELKHORN SLOUGH, CALIFORNIA, USA

http://www.elkhornslough.org/index.html

Human interventions including the relocation of the mouth of the estuary to build a harbor, river diversions and agricultural runoff are causing widespread dieback of salt marsh, erosion of habitat and depletion of oxygen in the water. The Tidal Wetland Project has used an EBM approach to identify and implement strategies to protect and restore habitat while both enabling human activities and minimizing the risk of unintended impacts on the ecosystem. Activities include convening meetings of decision-makers, scientists and members of the public to drive a consensus-based decision process, evaluating the ecological and socio-economic implications of management alternatives and initiating the implementation of a major restoration project.

MORRO BAY, CALIFORNIA, USA

http://www.slosea.org

The San Luis Obispo Science and Ecosystem Alliance was designed to address the currently fragmented science and management efforts in Morro Bay. To get started, resource managers, stakeholders and scientists worked together to develop a conceptual model of the watershed, estuary and nearshore environments and used this model to identify critical interrelationships that require targeted research. Project activities include establishing commercial and recreational baselines for economic uses of Morro Bay, setting up a water-monitoring system to track elements such as tide height and water quality and completing the bathymetric mapping of navigable waters within the Morro Bay estuary.

Gulf of California

PANGAS, GULF OF CALIFORNIA, MEXICO

http://pangas.arizona.edu/en/resources/EBM

Pesca Artesanal del Norte del Golfo de California — Ambiente y Sociedad (PANGAS) is working to create and implement species- and region-specific management plans for a more sustainable small-scale fishery in the northern part of the Gulf of California in Mexico. The project's approach couples interdisciplinary science with traditional fishing knowledge. The first phase resulted in the characterization of the fishery, scientific findings at the species and ecosystem level and a greatly improved understanding of the physical oceanography of this region. This work has created a platform for developing new management schemes by presenting a compelling scientific case and cultivating support from the government and affected communities.

GULF SHRIMP, GULF OF CALIFORNIA, MEXICO

http://www.pescasustentable.org

This project is working to create better scientific approaches for understanding shrimp fisheries in the Gulf of California and to help government fisheries management agencies test and apply improved management models. The complex social and environmental factors that influence changes to shrimp fishery policies and the historically difficult relationships among stakeholders make it a challenging project. Activities include leading negotiations with federal authorities, advancing the development and integration of various fishery management models and minimizing operation costs and bycatch volumes.

Western Pacific

RAJA AMPAT, INDONESIA

http://www.wwf.or.id/
http://www.tnc.org
http://www.conservation.org

This team is working to protect the Bird's Head Seascape from destructive overfishing and unsustainable use of marine resources by developing a network of marine protected areas (MPAs). Seven new MPAs have been designated since the project began. A key focus has been understanding and demonstrating the connectivity of geographies, ecosystems and people through studies of turtle migration, fish spawning aggregations, genetics of coral reef species, patterns of resource use and valuation of ecosystem services for the area.

FIJI

http://www.wcs.org/saving-wild-places/ocean/kubulau-seascape-fiji.aspx

This project is undertaking seascape-scale marine management for the Vatu-i-Ra and Cakau Levu reefs and better management of coral reefs and the adjacent watersheds. The success of this work depends on the support and buy-in of government and local communities, which have significant control over the access to and use of traditional fishing grounds, known as qoliqoli. Activities include establishing new networks of marine protected areas (MPAs) at Kubulau and Macuata qoliqolis; linking the MPA networks to management of adjacent estuarine, freshwater and terrestrial areas; developing Fiji's first holistic ridge-to-reef EBM plan for Kubulau; and securing support for management efforts from local, provincial and national government departments.

PALAU

http://www.palau-pcs.org/

This team is working to ensure that development decisions on Babeldaob resulting from a new road that circles the island consider the impacts on the water, land, fish and people of Babeldaob. Extensive scientific research and work with local initiatives like the Babeldaob Watershed Alliance have identified how EBM policies can help ensure that the island's community has access to the quality and quantity of water they need now and in the future. Activities include creating a Babledaob watershed map, implementing a strategy that addresses the key land-based threats to coral reefs and developing communication products for the project.

GRANT-MAKING APPROACH

Because this was such a new field, the program staff for the EBM Initiative employed a highly consultative grant-making approach. Foundation staff interacted with core grantees on a regular basis in order to stay abreast of the changes and emerging needs within the EBM field and adjusted its grant-making strategies where possible and appropriate in response to insights from the field. This approach required flexibility and transparency from both sides. For example, Initiative staff learned through consultation that many scientists and technical expert grantees would benefit from training and expanded capacity in communication, strategy building and stakeholder facilitation. Initiative staff collaborated internally with Packard's Organizational Effectiveness Program to help fill these needs.

GRANTEE EXPERIENCE ON THE GROUND

OVER THE PAST FIVE YEARS, Initiative grantees have explored EBM as a concept and in practice in a period of growth, experimentation and learning. In this section, Initiative staff share some lessons that emerged through the work of grantees in order to help the Foundation, its grantees and the broader EBM community learn from this experience.

LESSON 1

EBM looks different in different places.

Common principles guide EBM, but EBM, as practiced by the regional initiatives, looks different in different places. Each project followed the same general principles but took its own particular approach to initiating EBM as determined by the place's specific human and natural history and its social, institutional and policy context.

One of the key principles of EBM is identifying who makes or influences decisions that affect the ecosystem, finding ways to bring these sometimes piecemeal decisions into a broader context and developing shared ecosystem goals. In contrast to conventional "stakeholder engagement," EBM calls for meaningfully engaging all relevant individuals and entities, not just the ones that are highly visible members of particular sectors or that have established political clout. This process of working with diverse parties who have different and potentially conflicting priorities is crucial for building shared goals for the ecosystem.

The regional initiatives identified and engaged decision-makers and stakeholders in various ways. For example, Morro Bay and Elkhorn Slough started by establishing standing committees and formal structured processes for developing a shared vision and goals for the ecosystem, organizing scientific activities around accomplishing these goals and enabling shared learning by resource managers and stakeholders. Leaders of the Morro Bay regional initiative have advanced the concept of an "integrated ecosystem group," consisting of a leadership team, a science team and an advisory committee

composed of stakeholders, scientists and representatives of all organizations with authority relevant to the ecosystem.[10]

Engagement of stakeholders and decision-makers in the international regional initiatives, in contrast, was generally less formal. In Fiji and Raja Ampat, local communities have either legally recognized (Fiji) or *de facto* (Raja Ampat) resource management rights. EBM efforts therefore started informally at the community level and were led by teams from international NGOs whose credibility was generally high in these communities. Government agencies and other stakeholders joined the EBM projects only after the local understanding and engagement were secured. In contrast, the two regional initiatives in the Gulf of California invested early on in developing collaborative ties with government agencies because of the stronger role of state and, particularly, federal government in Mexico.

A BRIDGING ROLE

Rather than directly involving stakeholders and state decision-makers, the Palau Conservation Society (PCS — the organizational lead for the regional initiative) played a bridging role between community interests and government agencies.

In Palau, rather than directly involving stakeholders and state decision-makers, the Palau Conservation Society (PCS—the organizational lead for the regional initiative) played a bridging role between community interests and government agencies. PCS could speak credibly to, and sometimes for, both of these interests because it had good relationships at staff and leadership levels and an established track record.

Many regional initiatives found it challenging to interact with, much less integrate, the interests and needs of the relevant industry and resource users, beyond the fishing groups that have a clear vested interest in the condition and management of ocean ecosystems. For instance, Raja Ampat faced challenges with the growing strip mining industry, Elkhorn Slough with surrounding agriculture industry and Palau with rapidly expanding coastal development. Including such diverse entities can be time consuming because it requires making a case for and motivating their engagement. It also can complicate and slow consensus building. However, failure to do so has the potential to seriously undermine EBM.

No single proven approach for successful EBM implementation emerged through the regional initiatives. This may prove to be a fundamental aspect of EBM, or it may simply reflect the early stage of EBM's development as a management approach. Over the near term, funders and leaders should encourage continued experimentation and innovation with a broad range of approaches in practice—ranging from science-led to stakeholder-led. The key will be to carefully evaluate each project and compare the relative costs and benefits of different strategies and starting points in order to identify, replicate and potentially scale-up good practices.

[10] Wendt, D. E., L. Pendleton, and D. Maruska. 2009. "Chapter 11: Morro Bay, California, USA." Pp. 183-200 in K. McLeod and H. Leslie, eds. *Ecosystem-based Management for the Oceans.* Washington, DC: Island Press.

LESSON 2

The initial scale and scope of an EBM project is less important than a commitment to fully understand and sustain the ecosystem.

Virtually all of the regional initiatives experienced an expansion and diversification of their geographic, social and/or governance scales of interest as the EBM project progressed. Many started with a small, localized scope based on what seemed realistic and tractable. As the work matured, they began to consider how they might scale up the strategies and tactics to address issues at a larger, regional level.

For example, after three years of operation at the bay level in Morro Bay, the team there decided to extend their boundaries to include the larger-scale ecological processes that affected the bay and began investigating potential replication of their model on a regional scale. At Raja Ampat, the initial interest in marine protected areas (MPAs) has expanded to include coastal development and road construction, because these affect MPA condition through runoff and sedimentation. Further, through studies of population connectivity, participants have come to understand that coral reef biodiversity and endangered species such as turtles need to be managed at much larger scales than their initial archipelago-wide approach. And at Elkhorn Slough, although the primary focus has been on restoring the system's hydrology, the team has gained an improved understanding of how the Slough's health is affected by upstream pollution.

For some regional initiatives, viewing EBM as a logical and incremental improvement over traditional management approaches, rather than a paradigm shift, made it easier to adopt the approach and move forward. In Fiji, for example, the project team learned that it needed to ease community concerns by demonstrating how EBM would add value to the existing integrated coastal zone management that had taken decades to put in place. Similarly, in Raja Ampat, the team is using EBM principles, such as taking into account species connectivity within the archipelago ecosystem, to inform and improve a network of MPAs that were initially designated through a political process rather than a scientific one.

Making decisions about scale and ecosystem boundaries is one of the chief challenges in initiating an EBM project. Mismatches are common among the operational scales of stakeholder interests, policy frameworks and ecological processes. Tackling all of the factors that affect an ecosystem can seem too daunting at the start. Moreover, different people have very different perceptions about what the right scale is. The regional initiative experiences did not reveal any "best" scale for initiating EBM. Instead they suggest that the pragmatic approach is to roll up your sleeves and get started where you can, but expect the scope and scale of EBM projects to evolve and expand over time as knowledge and experience deepen.

LESSON 3

Early investments in natural science can improve decision-making in EBM, but understanding and addressing the social dynamics of the ecosystem is equally important.

The regional initiatives began by building a robust scientific understanding of their ecosystems. Each project's investment in science varied, but generally focused on establishing a baseline understanding of physical and biological aspects of the ecosystem, drivers of ecosystem condition and relevant indicators of ecosystem status and change. This work built understanding about how the system should best be managed and laid the foundation for some projects for establishing common goals across stakeholder groups.

For example, Elkhorn Slough documented the slough's hydrology, how it has been altered historically and what these changes mean for birds, invertebrates and fish that live in and around the slough. This information contributed to the development of a hydrodynamic model. Improved understanding from these efforts has helped guide the development and evaluation of restoration strategies for the slough.

Work in the northern Gulf of California comprehensively documented the scale of fishing activities and how critical ecosystem elements are affected by people. Other work in this area included the development of fish population and connectivity models. Information resulting from these efforts is contributing to the development of national fishery management plans. Modeling of the shrimp fishery in the Gulf of California assisted in understanding ecosystem processes and managing the area as two regions—the Upper Gulf and Sinaloa—and has contributed to the development of a shrimp management plan.

In general, most regional initiatives invested far less in understanding the social and governance structures, processes and frameworks that combine to generate decisions about ecosystem management and use. For some, the initial pursuit of highly resolved knowledge about physical and biological aspects of the ecosystem may have delayed progress towards institutional change. A more efficient approach might have been to start by building community support and a collaborative process and only then identifying targeted science to answer questions and support planning processes.

Experience in Palau demonstrates the challenge of integrating the ecological and social dimensions of EBM. Scientific investments made by that project were relatively evenly balanced between efforts to understand the ecological and social processes affecting the island of Babeldaob. However, the social science effort focused primarily

on a historical review of natural resource use rather than on documenting ongoing population expansion and predicting its potential effects on coastal development pressure and ecosystem condition. The latter could have contributed meaningfully to land-use p lanning activities that are currently underway.

Regardless of whether a project's starting point is science or community building or advocacy, it's clear that enlisting the assistance of skilled facilitators, process managers and institutional and policy analysts helps to jump-start the movement of science into action. But more work and new capacities will be necessary at all of the sites, to build the understanding, interest and demand from decision-makers in institutionalizing an EBM approach.

LESSON 4

Practical applications should drive the development and focus of EBM-related science.

A key challenge for knowledge grantees was focusing their work on real-world EBM applications and delivering products that were useful to practitioners. The lack of working models for EBM made it difficult for scientists to anticipate needs that could arise from EBM implementation. Also, adopting this "use-inspired" approach to scientific inquiry required new ways of doing business for some academic scientists and programs.

For example, the Foundation initially asked the National Center for Ecological Analysis and Synthesis (NCEAS), a knowledge grantee known for its academic working groups and data management capabilities, to play a key role in identifying science gaps and disseminating information to the broader EBM community. Success in communicating with the broader EBM field was somewhat mixed, in part because of a mismatch between these initial expectations and NCEAS's established strengths in academic research. At the same time, NCEAS has supported numerous working groups that have been highly productive from a more academic perspective, producing numerous books, scholarly publications and white papers. The organization also ran a distributed graduate seminar in which faculty and students from numerous universities collaboratively assessed the successes and failures of past EBM efforts and the reasons for these outcomes. The lessons derived from this analysis formed the basis for a particularly important paper in the EBM literature.[11]

The NCEAS approach to EBM has evolved over the course of the Initiative, and more recently supported working groups are anticipated to be more tightly linked to real-world application. Examples of promising new NCEAS-funded projects include several that are assisting the Indo-Pacific Coral Triangle Initiative in developing feasible EBM governance frameworks and in demonstrating the links between land-use management decisions and marine biodiversity in the region.

[11] Arkema, K. K., S. C. Abramson, and B. M. Dewsbury. 2006. "Marine Ecosystem-based Management: From Characterization to Implementation." *Frontiers in Ecology and the Environment* 10:525-532.

LESSON 5

EBM is likely to benefit from the practical adaptation of scientific concepts from other areas of environmental management and conservation.

Scientists funded under the EBM Initiative's knowledge strategy adapted and reinforced several general concepts for marine and coastal contexts.[12] All promise to be highly relevant to many EBM applications; the next step will be to expand, test and verify a set of practical tools and applications for real-world deployment. These concepts include the following:

1. THE CONDITION OF AN ECOSYSTEM AFFECTS ITS ABILITY TO DELIVER THE SERVICES THAT PEOPLE RELY UPON FOR THEIR LIVES AND LIVELIHOODS. EBM aims to secure the long-term delivery of diverse *ecosystem services* that support human well-being by sustaining critical ecosystem structures, functions and processes. The concept of ecosystem services allows the articulation of management goals in terms of desired societal outcomes, often builds on traditional ecological knowledge and can help reveal differing perspectives about these goals.[13]

2. THE IMPACTS OF HUMAN ACTIVITIES ON COASTAL AND MARINE ECOSYSTEMS ARE CUMULATIVE. Examining cumulative impacts makes it possible to assess the aggregate effects of disparate actions and choices on the condition of an ecosystem and its ability to sustain delivery of desired services. Although the concept of cumulative impacts is not new, its application to coastal and marine ecosystems provides a clear rationale for management-planning approaches that include multiple sectors and stakeholders.[14]

3. SELECTING GOALS FOR EBM INVOLVES TRADE-OFFS. In most cases, it will not be possible to maximize delivery of all desired services from an ecosystem. Instead, choices will need to be made that may assign higher priority to some services, and managing for these services sometimes may be detrimental to others. Explicit analysis of these *trade-offs* can help ensure that management plans realistically and transparently address and balance the full range of societal goals for an ecosystem.[15]

[12] Lester, S.E., et al. 2010. "Science in Support of Ecosystem-based Management for the U.S. West Coast and Beyond. *Biological Conservation.* Accessed online at doi:10.1016/i.biocon.2009.11.021.

[13] Millennium Ecosystem Assessment. 2005. *Ecosystems and Human Well-being: Current State and Trends.* Washington, DC: Island Press.

[14] Halpern, B. S., K. L. McLeod, A. A. Rosenberg, and L. B. Crowder. 2008. "Managing for Cumulative Impacts in Ecosystem-based Management through Ocean Zoning." *Ocean and Coastal Management* 51:203-211.

[15] Wainger, L. and J. Boyd. 2009. "Valuing Ecosystem Services." Pp. 92-111 in K. L. McLeod and H. M. Leslie, eds. *Ecosystem-Based Management for the Oceans.* Washington, DC: Island Press; Nelson, E., G. Mendoza, J. Regetz, S. Polasky, H. Tallis, D. Cameron, K. M. Chan, G. C. Daily, J. Goldstein, P. M. Kareiva, E. Lonsdorf, R. Naidoo, T. H. Ricketts, and M. Shaw. 2009. "Modeling Multiple Ecosystem Services, Biodiversity Conservation, Commodity Production, and Tradeoffs at Landscape Scales." *Frontiers in Ecology and the Environment* 7:4-11.

4. Finally, with ecosystem-based management in other environments, EBM FOR MARINE AND COASTAL AREAS INVOLVES UNCERTAINTY BECAUSE SCIENTIFIC KNOWLEDGE ABOUT ANY GIVEN ECOSYSTEM WILL ALWAYS BE INCOMPLETE. However, "adaptive management" and consideration of the factors that create ecological and social resilience can enable action in the face of uncertainty and change. By articulating assumptions about how an ecosystem functions and then monitoring appropriate indicators, managers can assess progress towards EBM goals, build knowledge about the ecosystem and adapt management approaches. Considerable interest now centers on identifying meaningful *indicators of ecosystem health and human well-being* for these purposes.[16]

These examples suggest that a more systematic assessment of the ways that science has informed the development of approaches to ecosystem-based management in land and watershed-based systems might reveal additional concepts that are potentially applicable to EBM.

LESSON 6

Experimentation with tools over the past five years has catalyzed broad interest and generated promising examples of how tools that match user needs can yield benefits in practice.

The Initiative's investments in tool development assumed that EBM would require new techniques to capture and display the complex ecological and social dynamics of ecosystems in ways that would assist and simplify decision-making. Although various existing models—for understanding the behavior of multi-species systems, exploring scenarios or setting conservation priorities, for example—looked promising, they would need to be adapted to EBM contexts and tested for utility. And previously unanticipated needs might arise through EBM applications that would require novel tools.

The Initiative funded more than 20 tool projects that addressed problems ranging from generic needs likely to arise in many EBM projects to very specific data assembly tasks that might contribute to EBM, but are not EBM-specific problems. The most successful tools focused on clearly defined problems with established user groups. This focus on practical problem solving ensured that the tools and their outputs were relevant and usable.

For example, marine protected areas (MPAs) are likely to be critical to EBM in many situations because of their potential role in ecosystem restoration and in the delivery of cultural and economic services. Efforts to establish MPAs also are far

[16] See, for example, the NCEAS working group on ecological indicators of ecosystem health at http://www.nceas.ucsb.edu/ebmthree; Walker, B. and D. Salt. 2006. *Resilience Thinking.* Washington, DC: Island Press; Walters, C. 1997. "Challenges in Adaptive Management of Riparian and Coastal Ecosystems." *Conservation Ecology 1,* http://www.consecol.org/vol1/iss2/art1; Leslie, H. M. and A. P. Kinzig. 2009. "Resilience Science." Pp. 55-73 in K. L. McLeod and H. M. Leslie, eds. *Ecosystem-Based Management for the Oceans.* Washington, DC: Island Press.

ahead of EBM in many locales. Thus, many of the tool projects focused on MPA planning and implementation, some with significant success. "MarineMap," for example, has played an integral role in California's groundbreaking designation of a statewide network of MPAs. "Open OceanMap," developed by EcoTrust, has also contributed to this effort by collecting spatial data on the use and value of commercial and recreational fishing grounds. More recently, the Palau Automated Land and Resource Information System, a government GIS program, has begun exploring software tools to develop soil maps on the island of Babeldaob. The maps highlight those areas that are best and worst for land uses like development and agriculture in terms of impacts on sedimentation and pollution of downstream coastal ecosystems.

In some instances, efforts to apply sophisticated modeling tools in the real-world contexts of the regional initiatives went beyond the kinds of analyses that could helpfully advance conservation. At Raja Ampat, for example, the development of Ecopath and Ecosim models did not effectively address the questions that were being raised by the field practitioners. The problem was a mismatch between the capabilities of these modeling tools—which have proven useful in other contexts—and practical needs.

Understanding has grown significantly over the past five years about the kinds of tools that might be adaptable for EBM and their potential value for understanding complex systems, engaging stakeholders and making informed decisions, due in large part to the efforts of the Packard-supported EBM Tools Network (see following section). Some members of the EBM community now believe that successfully advancing EBM, especially on large spatial scales and in complex policy situations, will depend on having effective and easily adapted tools. Considerable enthusiasm exists across the technical community for filling this need. The key will be for the tools to genuinely address user needs and for them to be informed by such real-world considerations as scale, data availability and feasible management options.

LESSON 7

Creating "communities of practice" can help speed progress in EBM.

As the EBM Initiative progressed, the question of who would advance this new approach came to loom as large as the "how to do EBM" question that had informed and shaped the original design. There were only a few people who deeply understood and could champion EBM concepts or who were deeply committed to advancing EBM science or implementation. Those people were dispersed institutionally and isolated geographically. To speed progress on EBM, Initiative staff sought to support strategies for convening people to share knowledge and build communities of practice.

For example, the early development of the EBM Consensus Statement, spearheaded by COMPASS, not only solidified the starting framework for EBM but also, by inviting voluntary signatories, made the initial step in establishing a community of academic experts interested in advancing EBM and communicating its principles to policy-makers. Follow-up EBM conferences convened by COMPASS starting in 2005 helped make this community manifest by bringing together many of the original Statement signers along with other scientists, managers and policymakers.

Spurred by the interests of people directly engaged in place-based EBM projects, two "practitioner networks" have recently developed with support from the Initiative. One, on the West Coast of the United States, started in 2008 by bringing together people from six different EBM projects, including Morro Bay, Elkhorn Slough, and four others not funded by the Initiative. Participants report that the information sharing and relationships facilitated by this network have significantly sped progress at their respective EBM projects. This network is also connected to the activities implemented under the West Coast Governors Agreement.[17] The Coastal Services Center of the National Oceanic and Atmospheric Administration, which hosts the West Coast network, sees it as testing a concept that may prove replicable in other geographies. The other more recently established network is a grassroots effort of the three regional initiatives in the Western Pacific—Fiji, Palau, and Raja Ampat. One lesson learned about the establishment of these types of practitioner networks is that they are only useful if the practitioners have a lot in common. For example, early in the Initiative a combined California-Mexico-Western Pacific network was explored but did not gain traction.

A different kind of networking activity led by the University of California at Santa Cruz and COMPASS, and collaboratively supported by the Packard Foundation and Gordon and Betty Moore Foundation, called The California Current EBM Initiative (CCEBM), sought to bring together and advance the interdisciplinary work of natural and social scientists working on EBM in the California Current marine ecosystem. Organized around a 2008 conference attended by more than 90 scientists, managers and policymakers, the CCEBM Initiative also included significant pre- and post-conference work to develop science-based tools and concepts related to examining trade-offs and considering ecosystem services. Numerous scientific collaborations catalyzed by the conference continue today.

Perhaps the most transformative and innovative tools grant supported by the EBM Initiative was the "EBM Tools Network" coordinated by NatureServe, which uses Internet technologies to start building a global community of EBM practitioners and experts.[18] Although initially focused on building an online searchable library of software tools, the EBM Tools Network evolved into an important and highly credible

[17] http://westcoastoceans.gov/

[18] http://www.ebmtools.org/

EBM TOOLS NETWORK

More than 1,900 people from 100 countries have signed on thus far to receive updates on new tools and resources for EBM and to participate in Network activities.

WWW.EBMTOOLS.ORG

teaching and information-sharing hub. Periodic webinars hosted by the Network and presented by experts provide demonstrations of relevant tools—such as InVEST, which models and maps ecosystem services, and Connie, a tool for exploring connectivity—to audiences that typically number 60-100 or more.[19] The Network's listserv provides an important extension function by relaying practitioner questions to a community of technical experts and other practitioners. More than 1,900 people from 100 countries have signed on thus far to receive updates on new tools and resources for EBM and to participate in Network activities.

By investing in these multi-pronged EBM efforts—place-based projects, knowledge and tool development and networking and community building—the Foundation sought to jump-start the new field of EBM. The Initiative's 2008 evaluation concluded that the field of EBM advanced significantly between 2003 and 2008, due in large part to the work of the Initiative. The real driver of this change, however, has been the considerable collective energy, intelligence and imagination of the Initiative's grantees.

TAKING STOCK OF THE EBM INITIATIVE

THE CONCLUSION OF THE EBM INITIATIVE provides an opportunity to step back and consider what has been accomplished and learned over the past five years. This section presents findings from an external evaluation and the challenges of funding an emerging field.

EVALUATION

In 2008, the David and Lucile Packard Foundation commissioned an evaluation of the EBM Initiative by ARCeconomics that examined the design and accomplishments of the Initiative as well as whether it will have a lasting impact on marine conservation and management.

The evaluation assessed the EBM Initiative by looking at how it moved toward the long-term goal that was stated in the original strategy document: "... [creating] and [ensuring] the use of the knowledge, tools, and skills needed to manage coastal-marine systems sustainably." The evaluation process included close collaboration with Foundation staff; examination of program materials; interviews with Initiative developers, program officers, and grantees; web surveys of grant project leaders and of the broader field of EBM; a literature review; and a gathering of grantees to discuss the evaluation results.

[19] For more on InVest see http://www.naturalcapitalproject.org/InVEST.html and for more on Connie see http://www.per.marine.csiro.au/aus-connie/quickGuide.html.

Figure 3 EBM AS AN ACCEPTED APPROACH

In the judgment of the EMB field and Packard grantees (the orange and green triangles, respectively, in the figure at right), EBM has moved much closer to being an accepted approach to coastal marine resource management since 2003, and the contributions of the Initiative have played a significant role in bringing about that change.

CHANGE IN EBM AS AN ACCEPTED APPROACH, 2003-2008

Source: Survey of EBM field, Getting Closer to EBM: Evaluation of the David and Lucile Packard Foundation's EBM Initiative, ARCeconomics, January 2009. Internal report produced for the Packard Foundation.

The evaluation found that Initiative grantees made significant strides. According to members of the EBM community, since 2003 the concept of EBM has moved closer to broad acceptance, although it still falls short of full recognition and understanding, particularly outside of the United States *(Figure 3)*.

The most important gaps today are the absence of full demonstrations of EBM in practice and limited progress in changing existing resource management approaches. Practical real-world demonstrations of EBM in diverse contexts are sorely needed. Some might usefully build upon existing "not-quite-EBM" approaches (such as MPA designation processes or the work of the National Estuary Program) to help advance them towards more complete integration of EBM principles and practices.

The evaluation concluded that future efforts to advance EBM will need to adapt the current science-based, science-led approach so that it includes far greater and earlier attention to stakeholder issues and resource management structures. Success will be contingent on addressing socially complex issues. This, in turn, will require expanded competencies in social context assessment, policy analysis, facilitation and other areas.[20]

THE CHALLENGES OF INVESTING IN A NASCENT FIELD

One of the challenges was the fact that the EBM Initiative was operating in a nascent field, which provided little opportunity for setting benchmarks and later evaluating outcomes. However, this new field did provide an opportunity for learning and experimentation for both donors and grantees.

[20] *Getting Closer to EBM: Evaluation of the David and Lucile Packard Foundation's EBM Initiative,* ARCeconomics, January 2009. Internal report produced for the Packard Foundation.

For donors working to fund strategies which seek to advance a new field, program staff point to the need for flexibility in developing and adapting a strategy, and in allocating and sequencing funds. Significant uncertainties will always surround how best to advance a new field, and, consequently, initial strategy choices will almost always have some gaps or flaws. Within the EBM Initiative, options for adjusting strategies or investment portfolios were limited by the size of commitments made at the start.

Setting benchmarks for progress in a new field also requires a different approach from those used in better-established fields. Appropriate indicators might include, for example, the emergence of new leaders and influential ideas, or the adoption and diffusion of core concepts.

To inform a flexible approach to funding, it is important to integrate mechanisms to continuously monitor changes in the field. Real-time and deliberative assessment can enable donors to respond appropriately to changes on the ground by redirecting funding, assisting with strategy development and capacity building, or by other means. Initiative staff relied on close partnerships with key players in the field in order to learn about and support new and emerging opportunities as they unfolded.

THE FUTURE OF EBM

APPROACHES TO OCEAN MANAGEMENT have begun to shift from managing single species and sectors towards managing ocean ecosystems as an integrated whole. The emergence of EBM as a potential guiding paradigm and the Foundation's investments in EBM have both reflected and contributed to this change.

Towards the end of the EBM Initiative, grantees convened at Costanoa, a rural California retreat, to reflect on the Initiative, learn about the ongoing evaluation and share knowledge and experiences across the grantee community. One important result of that meeting was the development of a conceptual framework of an experience-based approach to EBM. This framework built on the "what is EBM" foundation laid by the initial EBM Consensus Statement by explaining "how to do" key aspects of EBM. *(See Figure 4)*

Many elements of the Costanoa Framework embody good management practices more generally. But EBM is more than just good management, and the framework reflects unique elements that are needed to focus on ecosystems. These include a need to understand the entire ecosystem and to engage the full set of interests who affect and are affected by ecosystem condition. The framework implies that science plays a supporting role in EBM, such as in understanding the ecosystem or in monitoring for adaptive management, but that EBM is not a science-led endeavor.

Figure 4 EXPERIENCE-BASED FRAMEWORK OF EBM DEVELOPED BY EBM INITIATIVE GRANTEES

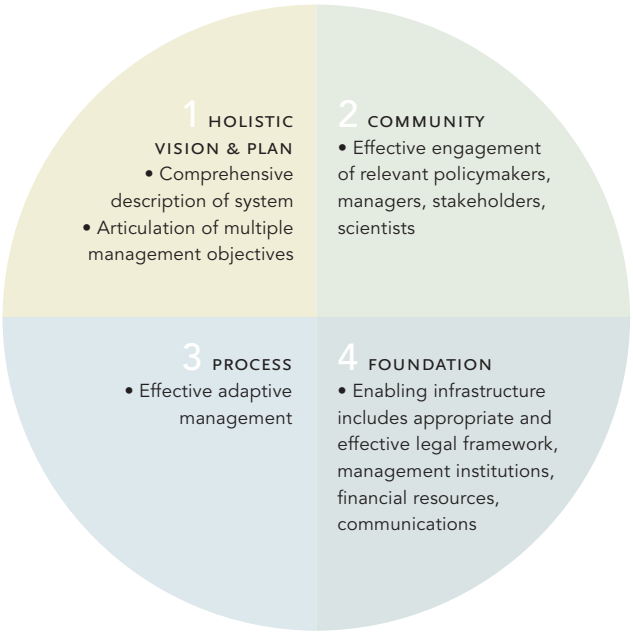
The Costanoa Framework identifies four critical elements for implementing EBM:

1. EBM must be based on a **COMPREHENSIVE UNDERSTANDING** of the ecosystem and articulation of the full set of societal objectives to be met.

2. EBM must **INTEGRATE THE PEOPLE** who make decisions about, can inform or have a stake in how an ecosystem is managed, including relevant policymakers, managers, stakeholders and scientists.

3. EBM must use a **PROCESS OF ADAPTIVE MANAGEMENT** that makes it possible to learn from and continuously improve management actions.

4. EBM needs a **FOUNDATION THAT INCLUDES A LEGAL FRAMEWORK** that supports multi-sectoral management; management structures that facilitate collaboration; financial resources that sustain implementation; and effective communications that promote integrated approaches.



The Costanoa Framework is about how to implement EBM per se. But the potential legacy of EBM is somewhat broader. At its core, rather than being just a methodology, EBM is really about changing the ways in which we conceptualize and manage marine and coastal ecosystems as a whole. It is at this broader level that many of the principles and practices pioneered under EBM may yield additional benefits.

For example, marine spatial planning (MSP) is emerging as a unifying tool for allocating various uses to different areas of the coasts and oceans. The scientific concepts andtools developed through EBM efforts could help ensure MSP results in sustainable ocean ecosystems and uses. They could also help speed the transition towards ecosystem approaches to fisheries management encouraged in the 2006 revision to the Magnuson-Stevens Fishery Conservation and Management Act and under development in Mexico and other nations.

In the United States, the Obama Administration's Ocean Policy Task Force recently proposed adopting EBM as a foundational principle of national ocean policy.[21] The European Commission has embraced the concept of EBM, and the Coral Triangle Initiative, a public-private partnership working to manage the marine resources of Melanesia and Southeast Asia, promises to advance ecosystem conservation over a vast geographical area.

[21] http://www.whitehouse.gov/administration/eop/ceq/initiatives/oceans

The tone and tenor of U.S. and international discussions about how best to manage coastal and marine resources have shifted significantly in the five years since the EBM Initiative was launched. The vocabulary and concepts of ecosystem management have begun to infiltrate applications ranging from community-based local efforts to large-scale fisheries management and international efforts. EBM is likely to play an important role in furthering this transition as attention now shifts towards developing and strengthening the policy and governance structures essential for enabling and supporting EBM.

REGIONAL INITIATIVE CASE STUDIES

THE FOLLOWING CASE STUDIES provide highlights from a regional initiative in each of the three geographic regions of established interest to the Foundation. The information for these case studies was gathered through grantee reports and other Foundation documents as well as interviews with regional initiative staff.

CASE STUDY 1

Morro Bay

A STRUCTURED APPROACH TO EBM AT MORRO BAY

Nestled along the coast of central California, Morro Bay remains one of the most untouched and best functioning estuaries in the state. It is home to a rich and productive coastal ecosystem as well as active tourism and fisheries industries. Yet the health of the estuary is vulnerable to a growing number of threats, ranging from pollution, invasive species and climate change to unintended overuse by the very industries that contribute to the vibrancy of the local coastal economy. In addition, the various institutions and agencies that manage, regulate or develop scientific information about the ecosystem historically have operated in isolation from one another. In short, Morro Bay provides an excellent opportunity for testing EBM.

This test began in 2006 with establishment of the San Luis Obispo Science and Ecosystem Alliance (SLOSEA). SLOSEA aims to bring together the fragmented science, regulatory and management efforts in the Morro Bay Estuary by engaging "scientific experts, resource managers, county officials, staff at state regulatory agencies and community leaders in applying innovative science to gain real-life solutions to the biggest issues facing the Central Coast and many other coastal communities." Support for SLOSEA has come from the EBM Initiative, the California

Coastal Conservancy, the Campbell Foundation, California Sea Grant and the Resources Legacy Fund. Perhaps the most important changes from the project are a better conceptualization of the Morro Bay ecosystem—its ecological boundaries and interacting components—and how decisions made within and outside the ecosystem affect its condition.

The structure of SLOSEA includes two key features intended to advance an EBM approach. First, the program's Advisory Committee brings together representatives of public agencies and resource managers who have jurisdictional authority or management responsibilities related to the watershed, estuary and nearshore resources, stakeholders who live and work in the ecosystem and science representatives. Periodic meetings of this committee provide a forum for developing a collective vision for the Morro Bay ecosystem and for considering how the various managers' decisions, interests and actions dovetail with one another. The committee also identifies priorities for the kinds of scientific information and investigations that would most usefully inform decision-making. Second, a team of faculty and researchers from California Polytechnic University at nearby San Luis Obispo are actively engaged in SLOSEA, creating a cadre of scientists interested in and fully responsive to the scientific needs of the Advisory Committee's resource managers.

A COLLECTIVE VISION

SLOSEA has synthesized existing knowledge and filled important gaps to establish a scientific foundation for understanding and adaptively managing the Morro Bay estuary ecosystem.

In the three years since its establishment, SLOSEA has synthesized existing knowledge and filled important gaps to establish a scientific foundation for understanding and adaptively managing the estuary ecosystem. A conceptual model now exists that identifies key elements of the ecosystem and has proven important for identifying meaningful indicators and for targeting research to reveal critical links among these elements and threats that can be affected by management interventions. Economic data are being gathered to reveal, for example, the relationship between ecosystem health and the local economy. To inform water quality regulations, SLOSEA has established a network of water quality monitors in Morro Bay that transmit real-time continuous data on key pollutants and has developed an initial hydrodynamic model to illustrate and explore the movement of land-based pollution through the bay.

SLOSEA also has pioneered approaches for participatory fisheries monitoring through which teams of fishermen and scientists collect statistically valid data about the health of fish populations. The resulting information potentially will aid in evaluating the effects of marine protected areas on fish populations, in federal fisheries stock assessments, and in demonstrating the utility of models that have lower data requirements for setting fish catch limits. SLOSEA's initial effort has evolved into the California Collaborative Fisheries Research Program, a collaboration of scientists,

fisheries managers, and fishing communities from Port San Luis to Humboldt Bay, whose goal is to move fisheries management toward a more regional, ecosystem-based system that reflects the population ecology of most nearshore species.

Several issues requiring management or policy action by other entities have risen to the top of the agenda through the SLOSEA process. These include

- SUPPORTING SUSTAINABLE FISHERIES AND FISHING COMMUNITIES by "right sizing" fisheries management plans to a regional scale that better matches the underlying population biology and ecology of fished species;
- BUILDING A ROBUST WATERFRONT ECONOMY by integrating information about economic impacts and trade-offs into decisions about pollution, fisheries management and other factors;
- PROTECTING COASTAL WATER QUALITY by developing regulations and voluntary approaches based on an understanding of the sources, sinks and previously unexamined impacts of land-based pollutants in the bay;
- CONSERVING FRAGILE COASTAL HABITAT by developing best management practices that will optimize access, yet ensure sustainability, of intertidal ecosystems in local state parks; and
- CONTROLLING INVASIVE SPECIES that threaten the Morro Bay's submerged plant and animal communities by developing early detection and eradication programs that eliminate new invaders before they spread and cause extensive harm.

Many of the policies that directly affect the above issues and the Morro Bay ecosystem fall under the authority of the state or federal government. Perhaps not surprisingly, given its local scale and early stage of development, SLOSEA has struggled in its early years to find ways to penetrate and influence these policies. Participants are confident, however, that the cooperative local management and scientific approach they have built now positions SLOSEA well to have a credible and effective voice in these larger matters. Efforts are already underway to develop novel partnerships with state and federal agencies that will advance SLOSEA's conservation goals related to water quality, coastal access and fisheries management. Another promising sign is the recent invitation from the Pacific Fisheries Management Council for SLOSEA to participate in a newly formed Ecosystem Advisory Subpanel that will advise its deliberations on West Coast fisheries management.

CASE STUDY 2
Palau

COMMUNICATIONS HAS BEEN KEY IN PALAU

Until recently, Babeldaob, the largest island in Palau, remained largely inaccessible and undeveloped. Completion of the Compact Road that circles the island has changed this situation. Many Palauans now are moving into previously remote areas where local communities are considering economic development options, such as small-scale forestry and ecotourism. Pressure is building to build resorts, golf courses, tourist destinations and other amenities. New development now underway is already having environmental impacts through increased sedimentation and dredging.

The Palau EBM Initiative was launched to help ensure that the people who make and influence development decisions—including traditional leaders, state officials and the national government—understand how their choices will affect the water, land, fish and people of Babeldaob. Its goals are to foster healthy coastal communities and ecosystems and to develop a collaborative process to improve natural resource management.

The Initiative started by conducting research to investigate the potential effects of development on water quality and downstream ecosystems, and participants documented vulnerable ecosystems and how changes in land use could increase sediment in streams, mangroves and reefs. The next task was to make this information available and useful to local communities and decision-makers who influence land-use decisions on Babeldaob.

This communication and integration of scientific information into decision-making has been challenging for several reasons. Importantly, local traditional leaders, state governors and national policymakers all play a role. These groups operate at different levels of government and vary significantly in their specific information needs and their requirements for translating scientific findings into non-technical terms. With the global economic downturn, Palau's budget deficit and uncertainty about future levels of financial assistance from the U.S., Palauan decision-makers have been less focused on environmental issues in recent years. In addition, the use of written communication tools is complicated by fact that Palau's traditional language, used in most routine transactions, was originally an oral, not a written, language.

At the same time, these various audiences are also very open to information about ecosystems. Concern for nature is ingrained in Palauan culture, as is a way of life

that includes farming and fishing. Palauans routinely engage in activities that are consistent with EBM principles, such as observing land-based species for insights into the status of marine species, and many Palauan legends include environmental elements. Moreover, the economy of Palau depends on tourism, which is directly impacted by the quality of the marine resources that draw divers and other visitors.

The approach of the Palau EBM Initiative has been to communicate information about ecosystem problems and solutions in ways that are relevant and actionable. For example, the Initiative helped the state legislature in Ngaremlengui to understand that designating a sanctuary in a swamp forest that was particularly rich in native and migratory birds would increase revenues from ecotourism. When it became clear that the public agency that regulated new home construction in Airai had no jurisdiction over landscape management, the EBM team worked with a local community group to develop the Green Lawn Project which plants lawns for homeowners to prevent erosion and runoff. The EBM Initiative also has developed close partnerships with several other initiatives that have deep ties to local communities and public agencies to advance shared objectives.

RELEVANT AND ACTIONABLE SOLUTIONS

The Initiative helped the state legislature in Ngaremlengui to understand that designating a sanctuary in a swamp forest that was particularly rich in native and migratory birds would increase revenues from ecotourism.

The emphasis on communications in Palau has paid off in numerous ways. Some involve tangible choices about land management, like those described above. But others have to do with how people think and who they are talking to. For example, greater understanding now exists among state decision-makers about the linkages among different elements of Palau's ecosystem—an improvement that derives specifically from the EBM approach. They consequently are more willing to balance development and resource conservation and undertake land-use planning. The EBM team is now a member of the task force advancing a national initiative on sustainable land management and plays a role in strategic discussions about forestry. Through these and other avenues, the EBM team believes that an understanding of ecosystem principles will play a greater role in determining the future of Babeldaob.

CASE STUDY 3
Upper Gulf of California Mexico

CHANGING THE MANAGEMENT OF SMALL-SCALE FISHERIES IN THE UPPER GULF OF CALIFORNIA, MEXICO

The upper Gulf of California (UGC) is a highly productive ecosystem and is recognized worldwide for its biological significance. It is also a place where conservation interests and fisheries management sometimes collide. In recent years, rapidly growing coastal populations and a growing demand for seafood have caused a dramatic surge in small-scale fishing fleets. The result has been a steady downward trend in the population of most of the more than 70 species targeted by small-scale fishers. Management approaches that do not address the structure, interactions and connectivity of marine fish populations—that is, how the ecosystem operates—are partly to blame for this situation.

PANGAS (Pesca Artesanal del Norte del Golfo de California—Ambiente y Sociedad) was formed in 2005 to help develop remedies to reverse the declining small fisheries. Founded by scientists from three academic institutions and representatives of two conservation organizations, PANGAS initially focused on developing critical information about the ecosystem and how it affects and is affected by people. Scientific investigations combined intensive field observations conducted by professors, graduate students, local nonprofits and fisher partners with cutting-edge modeling and laboratory approaches. PANGAS also tapped key stakeholders and decision-makers to advise the project and set the stage for implementing its findings. In addition, training was provided to Mexican and U.S. students and local fishers to build their understanding and skills for research, management and conservation.

This first phase of PANGAS yielded important information and tools and also built local capacities. Improved understanding of connectivity within and among populations of targeted species was achieved through coupled biological-oceanographic models, field experiments and "fingerprinting" studies that identify where fish live at different times of their lives through chemical signatures. A comprehensive geographic information system (GIS) database—which includes more than 3,000 layers of spatial information about the distribution of 52 fished species, locally derived information about fish reproductive grounds and nurseries and areas of historically exceptional catches—now exists for research and management uses. Data developed through a new voluntary regional fishers' logbook program is part

of this system. More than 20 students have received training in research and monitoring approaches relevant to conservation and fisheries management. Extensive surveys of local communities, fishing camps and boat captains have revealed how social processes and market forces shape fishery uses and yielded insights into potential management options. A regional monitoring program has been established for tracking the biota of sub-tidal rocky reefs. Results of all of these efforts have been communicated to relevant communities and government entities.

These early investments in knowledge and capacity development are being used to try to improve fishery management policies by fostering a better scientific understanding of the ecosystem. PANGAS is working with INAPESCA (Instituto Nacional de Pesca or National Fisheries Institute) to develop management plans for small-scale fisheries. The project also is assisting in ensuring that scientifically based management plans and monitoring protocols are established for the San Pedro Martir Island Biosphere Reserve. The Mexican federal government recently invited PANGAS, as part of a regional coalition of conservation interests, to help develop guidelines for non-governmental fishery management plans that will augment government resources in this area.

APPENDIX A: EBM INITIATIVE GRANTEES BY STRATEGY

COMMUNITY

Coastal Conservancy Association
Commonweal
Consortium for Oceanographic
Research and Education, Inc.
Duke University
Ecotrust
Foundations of Success, Inc.
Island Press—Center for Resource Economics
Marine Conservation Biology Institute
Point Reyes Bird Observatory
Resources Legacy Fund
Resources Legacy Fund Foundation
SeaWeb
Spitfire Strategies, LLC
Tides Center
University of Arizona

KNOWLEDGE

ARCeconomics, Inc.
Brown University
California Ocean Science Trust
Environmental Law Institute
Lazar Foundation
Marine Conservation Biology Institute
Monterey Bay Aquarium Foundation
Nature Conservancy, Inc.
Oregon State University
Regents of the University of Michigan
Resources Legacy Fund
San Diego Society of Natural History Balboa Park
SeaWeb
Regents of the University of California
Trustees of Princeton University
United Nations Educational,
Scientific and Cultural Organization
University of California, Davis
University of California, San Diego
University of California, Santa Barbara
University of New Hampshire
University of the South Pacific
University of Washington
University of Washington Foundation
World Resources Institute

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Kabang Kalikasan ng Pilipinas
NAFIN, S.N.C.,
Fideicomiso Fondo para la Biodiversidad
Nature Conservancy, Inc.
Palau Conservation Society
Palau International Coral Reef Center
Tides Canada Foundation
University of Arizona
Wildlife Conservation Society
World Wide Fund For Nature
World Wildlife Fund, Inc.

TOOLS

Civic Results
Duke University
Ecotrust
Foundations of Success, Inc.
Marine Environment and Resources Foundation, Inc.
National Oceanic and Atmospheric Administration
Nature Conservancy, Inc.
NatureServe
Orton Family Foundation
Palau Conservation Society
PlaceMatters, Inc.
Regents of the University of Michigan
Sage Foundation
University of Maryland at College Park
University of Maryland Center for Environmental
Science
University of Queensland
University of Texas at Austin
University of the South Pacific
Wildlife Conservation Society

APPENDIX B: OTHER EBM ONLINE RESOURCES

Advancing Ecosystem-Based Management:
A Decision Support Toolkit for Marine Managers
www.marineebm.org/

California Current Ecosystem-Based Management Initiative
ims.ucsc.edu/CCEBM/public_detailspage.html

Communications Partnership for Science and the Sea (COMPASS)
www.compassonline.org/marinescience/solutions_ecosystem.asp

Duke University's Nicholas School of the Environment and Earth Science:
Marine Geospatial Ecology Lab
mgel.env.duke.edu/proj/mebm/

Ecosystem-Based Management Tools Network
www.ebmtools.org/

Environmental Law Institute's Ocean Program
www.eli.org/Program_Areas/ocean_ebm.cfm

Marine Ecosystems and Management (MEAM)
depts.washington.edu/meam/index.html

National Center for Ecological Analysis and Synthesis:
EBM of Coastal Marine Systems
www.nceas.ucsb.edu/ebm

National Center for Ecological Analysis and Synthesis:
EBM Project Registry
ebm.nceas.ucsb.edu/registry

National Oceanic Atmospheric Administration (NOAA)
celebrating200years.noaa.gov/magazine/chesapeake_fish_mgmt/side1.html

NatureServe: Tools for EBM of Coastal and Marine Environments
www.natureserve.org/prodServices/ebm/index_OLD.jsp

SeaWeb: EBM Management Resources
www.seaweb.org/resources/ebm.php

University of Maryland's Environmental Science Center:
Integration and Application Network
ian.umces.edu/

West Coast Ecosystem-Based Management Network
www.westcoastebm.org/Network_Home.html

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