



Duke University/Brown University

The Babeldaob Island Ecosystem- Based Management Initiative

A Case Study of Marine Ecosystem-Based Management

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About the Study

Citing declining health of the world's oceans, policymakers, managers and scientists have called for expanded efforts at ecosystem-based management in marine and coastal systems (MEBM). In many places in North America and around the world, collaborative, adaptive planning and management processes have developed to enable scientists, managers and stakeholders to move beyond management of single species and single user groups to incorporate complexity, consider larger scales and longer timeframes, and incorporate measures of ecosystem integrity.

The David and Lucile Packard Foundation invested in the development of science to support management in a number of initiatives in California, Mexico and the Western Pacific. The Foundation also recognized the need to capture the lessons from the experiences at these initiatives as well as the many other places that are trying to move toward an ecosystem-based management approach. Accordingly, they provided grant support to research teams at the University of Michigan and Brown and Duke Universities to develop rich case studies of MEBM, documenting the approaches and their accomplishments, and analyzing the challenges the efforts faced and the factors that have promoted progress. Ultimately, the projects seek to provide lessons that can inform the practice of MEBM.

This document contains one of the complete case studies. Others can be accessed through the project website: www.snre.umich.edu/ecomgt/mebm.

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Introduction

The Republic of Palau (Palau) is an archipelago comprising more than 340 islands roughly 885 km east of the Philippines in the western Pacific Ocean (Bureau of Budget and Planning 2010). With a total population of approximately 20,000 and land area of 490 km², Palau is one of the smallest countries in the world (Bureau of Budget and Planning 2010). The tropical marine waters surrounding this small island developing state are vast, and Palau's exclusive economic zone extends over 616,029 km² (Bureau of Budget and Planning 2010). These waters are home to the most diverse coral reef fauna in Micronesia and the highest density of tropical marine biota of any comparable geographic region (Golbuu et al. 2005; Goldberg et al. 2008).

On the terrestrial side, Palau's Babeldaob Island is the largest island in the country and the second largest island in Micronesia. The island has been isolated from modern development until recently as the majority of the 10 states in Babeldaob could be reached only by boat until the 1990s (National Action Program to Combat Land Degradation 2004). However, with the completion of an 85 km road circumnavigating the island in 2007, and the relocation of the Government Capital to Melekeok State in Babeldaob in 2006, the population and use of land on Babeldaob are expected to change dramatically (National Action Program to Combat Land Degradation 2004).

In anticipation of rapid development on Babeldaob and associated sedimentation of the surrounding coral reefs, Palau Conservation Society (PCS) and its partners are fostering an ecosystem-based approach to improving "ridge-to-reef management of coastal resources" on the island. In practice, this has largely involved collecting and feeding scientific information into the land use planning and other policy processes, largely at the state level. Overall, this initiative may be characterized as a sustainable development project focused on land use planning with the intention of mitigating upland development threats to coral reefs and associated human communities.

Ecosystem Characteristics and Stressors

Key Characteristics of Babeldaob's Social-Ecological System

The main Palau archipelago stretches about 200 km from Ngaruangel in the north to the Angaur island in the south (Figure 1) (Babeldaob EBM Partnership 2009). The 97,920 km² volcanic island of Babeldaob constitutes 80% of the landmass in Palau and is the second largest island in Micronesia, following Guam (Kitalong 2008; Sakuma 2004a). The island is 37 km long and 15 km at its widest, containing 33 km² of mangroves, and bordering a 500 km² lagoon (Kitalong 2008; Holm et al. 2005). The tropical ocean surrounding Babeldaob contains a barrier reef that stretches from the northern tip of Babeldaob down to a southern lagoon, merging with a fringing reef on the island of Peleliu in the south (Golbuu et al. 2005). The barrier reef is well-

developed to the west of the main island cluster¹, but less developed and discontinuous to the east (Golbuu et al. 2005). There is also barrier reef to the southeast of Babeldaob, and a submerged barrier reef (5-10m below sea level) on the central east coast (Golbuu et al. 2005). During the 1997-1998 El Niño, there was massive coral bleaching and mortality in Palau in which one-third of the country's corals died, with mortality reaching 90% in some places (Golbuu et al. 2005). However, coral reefs in Micronesia are thought to be among the most resilient in the world, so Palau's coral communities recovered rapidly from this bleaching event (Wilkinson 2002). While there are no endemic corals in Palau, the archipelago's coral diversity is comparable to that of the highest diversity areas in Philippines, Indonesia and Australia (Figure 2) (Golbuu et al. 2005).

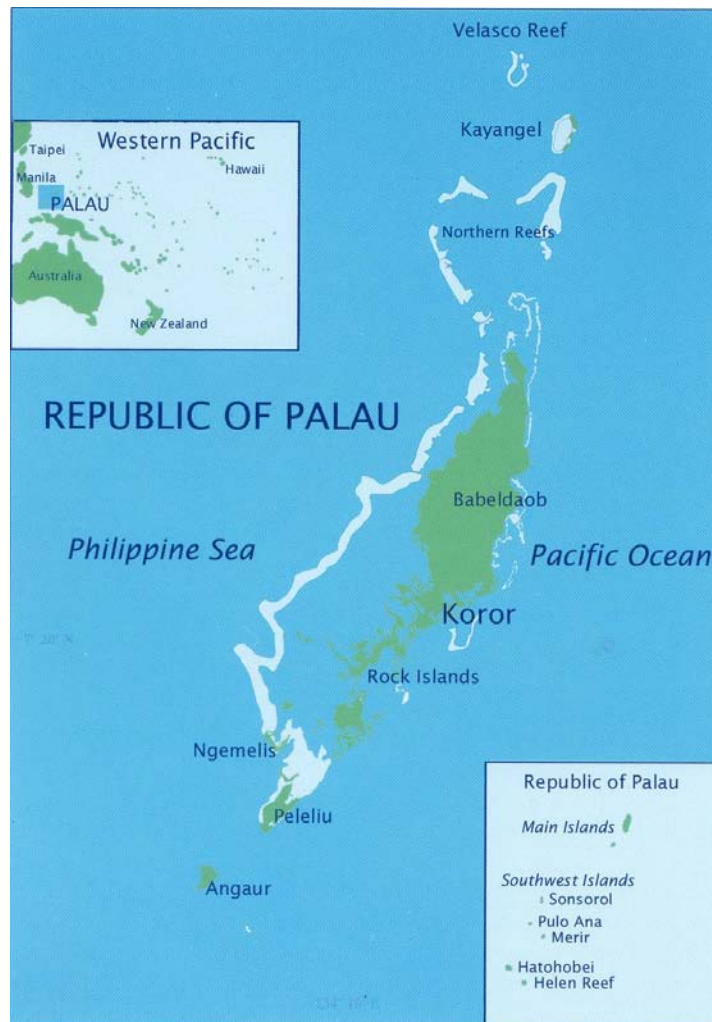


Figure 1. Map of the Republic of Palau showing the island of Babeldaob in green (Palau Conservation Society 2007).

¹ Babeldaob, Koror, Malakal, Arakebesan and Peleliu islands

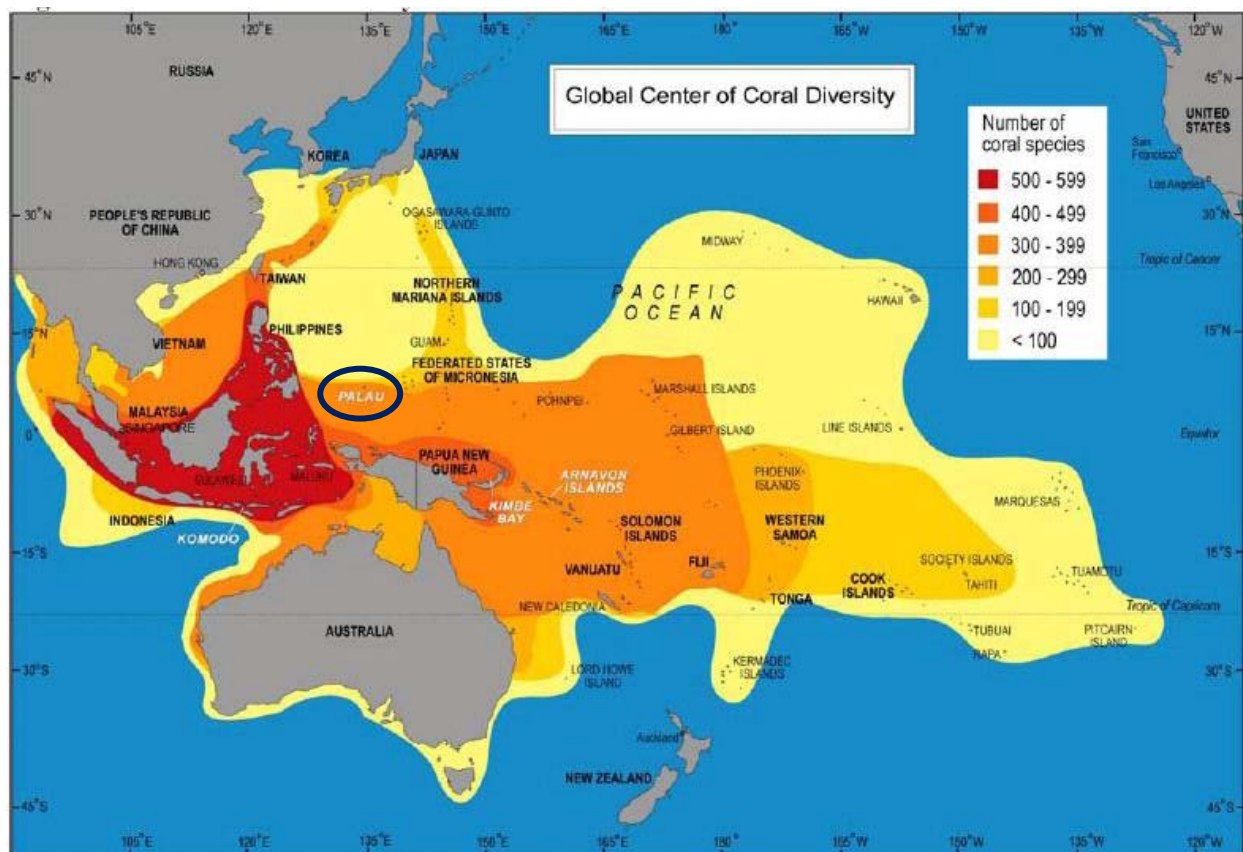


Figure 2. Map of coral species diversity. Palau is circled in black. (Palau Conservation Society 2007).

The population of Palau has a per capita income 50% higher than that of the Philippines and much of Micronesia (CIA 2009). Tourism is the main source of revenue for Palau and there is a serious effort underway to attract higher-income tourists (Marino et al. 2008). In 2006, 82,397 people visited the small archipelago, the vast majority of whom came to dive, snorkel and tour the famous Rock Islands (Marino et al. 2008). The government is the chief employer in Palau, relying heavily on the United States for funding under the Compact of Free Association. Among other things, the Compact of Free Association provided Palau with up to \$700 million in return for military facilities between 1994 and 2009, adding an additional package of \$250 million in January 2010 (CIA 2009).

Having previously been a United Nations trusteeship administered by the United States, Palau gained independence in 1994, and is now a constitutional government in free association with the United States. The small island developing nation is divided into 16 states, 10 of which are on Babeldaob Island. At the most recent estimate, Babeldaob houses just 30% of the country's population, or 5,977 people (Palau Statistics Division 2005). The large majority of Palau's population of approximately 20,000 still resides in the previous national capital in Koror state (Palau Statistics Division 2005). About one-quarter of Babeldaob's population is concentrated in the island's southernmost state of Airai, the connection point between Babeldaob and Koror state (Palau Statistics Division 2005). The rest of Babeldaob's population lives in coastal villages scattered throughout the island, generally leading subsistence or semi-subsistence

lifestyles: “They live in villages along the coast, fishing the reefs and farming taro, tropical fruits and vegetables on small plots of land” (National Action Program to Combat Land Degradation 2004). There is relatively little agricultural production on Babeldaob due to its highly weathered, easily erodible, acidic, volcanic soils (Sakuma 2004a). For the local population, the most important marine resources include reef finfish, pelagic fish, mangrove crab, lobster, trochus, giant clam, beche-de-mer, and other invertebrates (FAO Undated). Most of the fishing takes place in lagoons and the outer reef slopes (FAO Undated). Commercial fishing in Palau is primarily limited to foreign vessels fishing for tuna in the exclusive economic zone for sale and processing outside of Palau (Bank of Hawaii 2000).

Of particular importance to the context within which the EBM project operates is the newly constructed 85 km road circumnavigating Babeldaob, and the relocation of the Government Capital to Melekeok State in Babeldaob in 2006 (National Action Program to Combat Land Degradation 2004). Both developments are expected to change the population and use of land on Babeldaob dramatically. In anticipation of these changes, Palau initiated a National Action Program to Combat Land Degradation in 2004, and obtained a four-year sustainable land management grant from the United Nations Development Program to develop a national framework for land use planning. Development partners such as the Asian Development Bank, among others, have identified land planning and zoning as important steps toward facilitating private growth objectives (Asian Development Bank 2009). As of January 2010, only one state, Koror, had a formal land use plan in place, though several states on Babeldaob had initiated processes for land use planning. Currently, the primary formal mechanisms for regulating land use and development in Palau are a permitting system and environmental impact assessment process administered by national government and semi-government² agencies. Importantly, the land use planning process in Palau is operating within a context of uncertain property rights and an ongoing effort to privatize land ownership (Asian Development Bank 2009).

Finally, the EBM project is just one of several environmental management and conservation efforts in Palau. For example, Palau is a signatory to the Micronesia Challenge, a regional agreement between the Republic of Palau, the Republic of the Marshall Islands, the Federated States of Micronesia, the U.S. Territory of Guam, and the Commonwealth of the Northern Mariana Islands to conserve at least 30% of the near-shore marine and 20% of the terrestrial resources across Micronesia by 2020 (Remengesau et al. 2006). In line with this regional commitment, Palau is implementing national-level legislation to establish a nationwide network of protected areas, both terrestrial and marine. While the EBM project and other recent efforts have terrestrial components, Palau’s formal and traditional environmental management activities have historically been largely marine-focused.

² Matthews (2007) defines several organizations operating in Palau as “semi-government” as “these agencies receive some of their operating funds from the national government, but are led by a Board of Directors and are able to operate somewhat more autonomously than strict government agencies.”

Ecosystem Threats

The Palau EBM partnership is focused on preempting expected threats to a relatively healthy social-ecological system: both phases of the project (I and II) seek to “avoid further degradation of natural watersheds and coral reefs while most development activities are still in the planning stage” (Babeldaob EBM Partnership 2009). In Phase I (2006-2008), EBM partners identified sedimentation due to poorly planned development on land as the major threat to coral reefs and associated human communities in Babeldaob. Partners were concerned that the newly constructed compact road would open Babeldaob to poorly planned development in the context of a lack of comprehensive formal or traditional land use policies and a lack of capacity and technical expertise at the state level for environmental planning. One partner explains that “all of a sudden you have modern technology that makes the interior of your island accessible and you don’t have any cultural thing to fall back on and figure out how to manage this” (Manager).³ The following excerpt reflects the partners’ general thinking on anthropogenic ecosystem threats in Babeldaob:

Construction of the Compact Road was completed in 2007, opening up Babeldaob to development activities and internal population movements. The road has provided easy access to Babeldaob’s remote interior forests, savannas and wetlands. These ecologically sensitive areas are now subject to increasing pressure from human activities. This increased accessibility promises development opportunities such as housing subdivisions, commercial farms, aquaculture projects, hotel and golf course development and other commercial projects. However, these activities can result in land degradation and deforestation leading to loss of terrestrial biodiversity, increasingly polluted runoff, decreased soil water storage, and increased sedimentation, which can adversely impact streams, reefs and nearshore fisheries and local livelihoods. (Babeldaob EBM Partnership 2009)

Partners point to sedimentation that took place during the construction of the road and in areas of Babeldaob such as Airai Bay, where development is the most advanced, as indicators of undesirable impacts from poorly planned development (Sakuma 2004b). For example, a scientist noted that during the construction of the compact road, “we saw areas that literally got covered with mud. And people who used to fish in those areas, when we interview them, they said you can’t even see your hands during heavy rainfall even inches from your face. So the reef literally got covered in mud” (Figure 3). Sedimentation physically smothers corals and prevents coral larval recruitment (Bruckner et al. 2005; Victor 2004).

³ To preserve anonymity, interviewees are described as “scientist, manager, or stakeholder” depending on the role from which they are speaking in the particular quote. In other words, a single interviewee may be referred to as a scientist, a manager, and a stakeholder in this study.



Figure 3. Partners' representation of connections between road development and the health of marine resources. (Palau Conservation Society 2007).

For Phase II of the EBM cycle (2009-2012), partners identified specific conservation targets and threats through two broader, separate processes: the Nature Conservancy's Conservation Action Planning (CAP) process, and a national conceptual modeling exercise in 2008 (Babeldaob EBM Partnership 2009). The CAP process produced a threat assessment that was used to prioritize resource management goals and develop a conceptual model of twelve conservation targets and threats to those targets for all of Palau during the 2008 meeting, which was attended by 75 managers and decision-makers (Babeldaob EBM Partnership 2009). The EBM partnership adopted an "abridged version" of the 2008 conceptual model for Phase II based on priorities assigned during the above exercises and the capacities of the project team (Babeldaob EBM Partnership 2009). EBM partners aligned their activities with this national conceptual model because "adoption of a derivative of the national conceptual model assures that our project is supportive of other national and regional initiatives [. . .] which are guided by the same threat assessment and conceptual model" (Babeldaob EBM Partnership 2009). Conservation targets for the EBM project include forests, freshwaters systems, and coral reefs and lagoons (Babeldaob EBM Partnership 2009). Identified threats to those targets are development, overharvesting, invasive species, and climate change (Babeldaob EBM Partnership 2009).

Despite the multitude of identified ecosystem threats, the EBM project (both Phase I and II) focuses primarily on development threats: "The EBM Core Group agreed that unmitigated impact of land-based stress has a long lasting detrimental impact on coastal marine resources through habitat degradation and alteration and should be the core of this EBM initiative" (Babeldaob EBM Partnership 2009). Another reason that the EBM project "will focus on the highest prioritized threat- loss and degradation of habitat due to urban and commercial development" is that overharvesting, invasive species and climate change "will be addressed more thoroughly by other initiatives, as with other sources of funding" (Babeldaob EBM Partnership 2009). There is a clear recognition among project partners that "you can't do everything at one time. You've got to pick your priorities, and you have to pick where you're most strategic and where your interventions are most strategic" (Manager).

Partners' concerns about sedimentation and development stemming from increased road access are reflected in both grey and academic literature. For example, a 2007 report by the Nature Conservancy identifies the single most important threat to Palau's natural ecosystem as the "compact road" and associated development such as resort hotels, golf courses, casinos, and a new port (Hinchley et al. 2007). Similarly, Ueki (2000) predicts that thousands of people previously residing in Koror will resettle and build houses in Babeldaob.⁴ As of January 2010, the expectation of rapid development and associated impacts had not been realized. One EBM partner reflected that "everybody had a vision that within five years there would be several golf courses, these huge mega-resorts. But I think in reality what's going to happen is it's not going to be quite that rapid because of other reasons - mostly cultural reasons" (Manager). Another partner noted that "development is not happening to the degree that we thought," adding that "it isn't big hotels, it's really the single family homes" (Manager).

EBM Initiative

Project Initiation and Motivation

When EBM partners first applied for a planning grant to develop the regional initiative in 2004, the compact road was still under construction and was not expected to be completed for another two years. The main impetus for the Palau EBM initiative "was the construction of this road, along with the associated development activities and anticipated demographic and land use changes" (Babeldaob EBM Partnership 2009). The Palau Conservation Society and its partners saw "a vital window of opportunity to implement effective resource-use policies and practices before broad-scale development" began (Sakuma 2004b). Within Palau, EBM partners thought that Babeldaob island had "the most potential for damage if [they] don't do something" (Scientist).

At the same time, the partners perceived a "great scarcity" of data to inform basic resource use decisions on Babeldaob (Sakuma 2004b). The EBM project offered partners an opportunity to collect social and ecological data that could be used to balance "sustainable development with the need to prevent the loss of biodiversity from habitat destruction and sedimentation of the surrounding lagoon and coral reefs resulting from land degradation and run-off" (Babeldaob EBM Partnership 2009). Most of the project activities are focused in three states on Babeldaob (Airai, Melekeok and Ngeremlengui) and their associated watersheds (Ngerikiil, Ngerdorch and Ngeremeduu) (Babeldaob EBM Partnership 2009). The results of the work in these areas are intended to "provide information that will lead to the development of guidelines and recommendations for the rest of the island, as well as for Palau as a whole" (Babeldaob EBM Partnership 2009). The case study sites on Babeldaob were chosen because they allow for research in the context of different levels of development - high, medium, and low levels (Manager).

⁴ Census data is provided only up to 2005.

When asked about their motivation to undertake an ecosystem-based approach to managing development threats on Babeldaob, many interviewees explained that Palauans have “always done ecosystem-based management-ish kinds of activities, more on an intuitive level, but not with that name before” (Manager). The EBM project in Palau “came out of a series of discussions between Packard, PCS, the primary stakeholders in the EBM project [. . .] [and] it was Packard that sort of initiated the project as a cohesive, pre-planned, very organized initiative” (Manager). The Foundation saw Babeldaob as an ideal site to “demonstrate EBM” due the multiple and diverse relationships between biological, physical, and human processes; the island’s high biodiversity; the small-scale of the island that allows testing of the EBM approach across a large range of coastal ecosystems; the presence of serious environmental threats and management issues; and anticipated community support grounded in a cultural history of ecological knowledge and management (Sakuma 2004b). Another expectation was that “what is done in Palau could influence activities throughout Micronesia” (Gold et al. 2004).

Goals and Objectives

In short, the EBM project seeks to mitigate upland development threats to the marine environment by promoting science-based land use planning and other policies directed at sustainable development: “I really want Palau to get developed but developed in a way that has the least impact on the environment” (Scientist). Similarly, project documents stress that

Resource management that is guided by EBM principles ensures that development meets people’s needs with minimal impact to the integrity of the natural environment. This proposed project can provide valuable EBM recommendations to guide development so that people and communities can prosper with minimal impact to Babeldaob’s ecosystems. (Babeldaob EBM Partnership 2009)

Project partners stress that implementing EBM is not the goal, but rather a method for achieving the project’s – and Palau’s - sustainable development goals. When asked if EBM is a goal, one project partner emphatically replied no, explaining, “The goal is to be able to be Palauan in the 21st century.”

The goals of Phase I of the EBM cycle (2006-2008) as outlined in project documents were to “foster healthy coastal communities and ecosystems on Babeldaob Island” and “develop a collaborative process to improve natural resource management for Babeldaob Island” (Holm et al. 2005). To achieve these goals, partners identified four objectives:

- (1) Conduct biophysical and social science research in order to answer questions about vulnerable natural resources, their uses and management;
- (2) Jointly analyze research results, and develop a set of environmental and social indicators, conceptual models of ecosystems of Babeldaob Island, and management and policy recommendations;

- (3) Create avenues for sharing and disseminating scientific and other information with key stakeholders; and
- (4) Foster wide participation in order to build a collaborative process for resource management (Holm et al. 2005).

These objectives are based on the logic that “understanding both the biophysical and social aspects of resource health and use, as well as how they are linked, are necessary for sound management” (Holm et al. 2005). For Phase II of the EBM cycle (2009-2012) the overall project vision was refined to “healthy Babeldaob ecosystems that supports culturally and environmentally appropriate low impact development guided by scientific knowledge and strong alliances that benefit the health and well-being of the people of Palau” (Babeldaob EBM Partnership 2009). To move toward this overarching goal, EBM partners identified specific goals for Phase II in relation to each conservation target and the “development threat”:

- Forests: By 2020, Babeldaob’s forests maintain or have higher percent healthy coverage than initial baselines;
- Freshwater Systems: By 2020, critical rivers, streams and lakes are healthy;
- Coral Reefs and Lagoon: By 2020, coral reef health around Babeldaob is maintained at 1992 levels;
- Development Threat: By 2015, all urban and commercial development that occurs in three Babeldaob states (Ngaremlengui, Melekeok and Airai) located in the priority watersheds are in compliance with land use plans and national environmental protection standards (Babeldaob EBM Partnership 2009).

Interviews with project partners suggest that, in practice, Phase I activities were largely focused on research. Phase II activities are expected to focus more on communicating this research to decision-makers. The key objectives for Phase II are thus to continue analysis and synthesis of scientific information, and deliver EBM science and recommendations to decision-makers, conservation and land-use planners and resource managers in a way that is acceptable and useful to them (communications) and continue to build a culture of collaboration among researchers, managers and planners who regularly develop and implement EBM activities and use EBM the deliverables to achieve their conservation and sustainable development goals in an integrated and effective manner (collaboration).

The links between conservation targets, threats, and objectives for Phase II are made explicit in Figure 4.

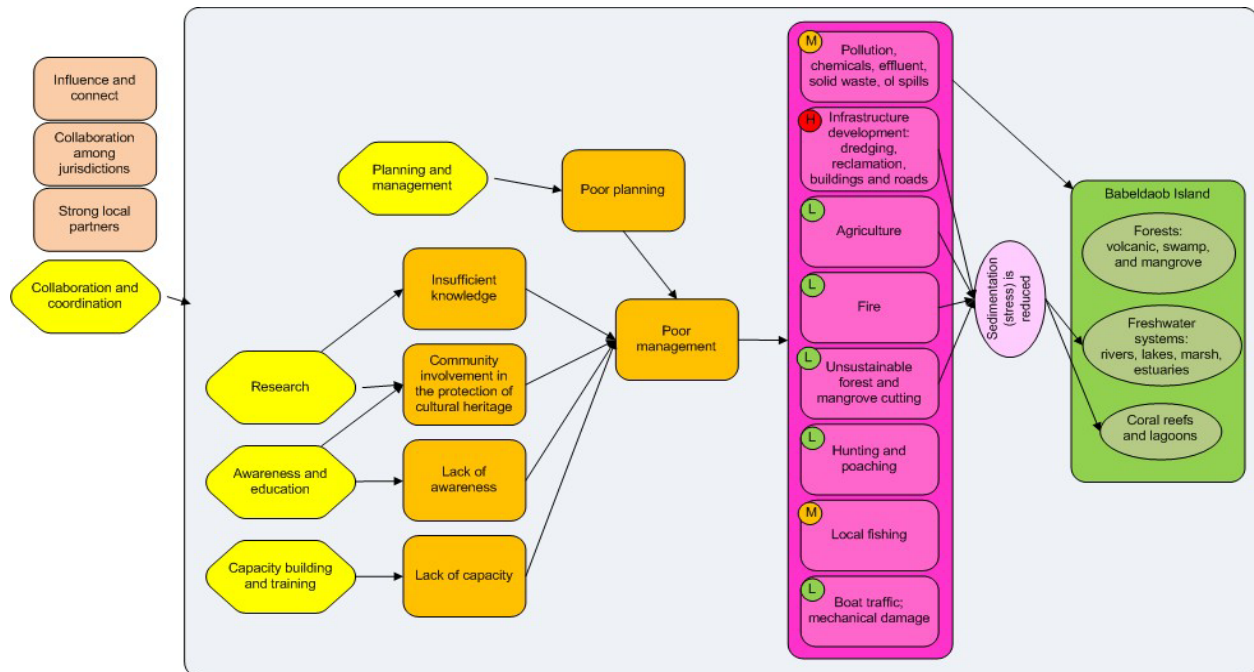


Figure 4. Conceptual model for EBM Project, Phase II (Babeldaob EBM Partnership 2009).

Project Structure

Under the leadership of the Palau Conservation Society (PCS), the Babeldaob EBM initiative is implemented by a multi-disciplinary and multi-sectoral “EBM Partnership” comprising organizations involved in research, resource management, decision-making, communications, and education in Palau. The organizations in this partnership include:

Belau National Museum: A semi-government institution (i.e., organization that receives some of their operating funds from the national government, but are led by a Board of Directors and are able to operate somewhat more autonomously than strict government agencies (Matthews 2007)) that works “for the preservation and promotion of the natural heritage, exhibition of natural, cultural, social and historical values, and the development of arts at all levels” (About the Belau National Museum Webpage). This group provides natural scientific expertise to the EBM initiative.

Palau International Coral Reef Center: A semi-government institution, which “conducts research that enhances knowledge and conservation of coral reef systems and their associated marine environments” (PICRC Our Mission Webpage). This group provides natural scientific expertise to the EBM initiative.

Environmental Quality Protection Board: A semi-government institution and nation regulatory agency responsible for setting drinking water quality standards and establishing water treatment and disinfection requirements (Franz 2001).

Palau Automated Land and Resources Information System (PALARIS): A part of the national government that “has the responsibility to develop the National Geographic Information System (GIS), a centralized land and resource system to inventory and support the management of human, economic and natural resources of the Republic of Palau” (OERC PALARIS Webpage). This agency provides the EBM initiative with expertise in resource management, Geographic Information Systems, and social science.

Bureau of Arts and Culture: A part of the national government that is responsible for protecting and preserving “the tangible and intangible historic and cultural resources of Palau” and ensuring “that the opportunities for education and enjoyment of Palau’s cultural heritage are available to everyone” (Bureau of Arts and Culture Webpage). This agency provides social science expertise to the EBM initiative.

During the first year of the initiative, PCS focused on developing operational procedures and strategies for collaboration and data management (Holm et al. 2005). In June 2006, PCS hired an EBM Coordinator to be based at PCS and tasked with “pulling together the researchers, resource managers and other stakeholders; coordinating the research components; ensuring that research results are accessible and shared; enabling joint analysis of the research; and developing avenues of communication and coordination among the different stakeholder groups in Palau” (Holm et al. 2005). Also, early in Phase I, PCS formed an “EBM Core Group” composed of one or more members of the organizations in the EBM partnership. In Phase I, quarterly meetings of the core group were intended to facilitate cooperation among researchers, resource managers, government agencies, traditional leaders, decision-makers, and other organizations and resource users (Holm et al. 2005). Among other things, the core group was tasked with coordinating data management and analysis, developing conceptual models to track targets and conditions, document EBM rules and approaches, and form the basis for EBM in Palau (Holm et al. 2005).

During Phase II, the EBM Core Group is tasked with developing practical and useful data for resource managers; conducting analyses that integrate biological and social data for decision-making and policy; conceptualizing and developing communications products; and ensuring that relevant recommendations and best management practices are integrated with the various planning processes that are currently in place (Babeldaob EBM Partnership 2009). These duties will be facilitated by a “research and learning coordinator.” While the Environmental Quality Protection Board and the Bureau of Arts and Culture have regulatory authority pertaining to permits for development, neither the core group nor the partnership have been granted formal authority by a governmental body.

Strategies and Tools

Conduct Policy-Relevant Research

The core strategy of the Babeldaob EBM initiative is generating policy-relevant research and feeding that information into land use planning and other policy processes at the state⁵ and national government levels: “[the EBM project will generate scientific information that] will be analyzed, synthesized and communicated to Palau’s leadership to guide decision-making regarding Babeldaob’s development activities in order to achieve sustainability” (Babeldaob EBM Partnership 2009). As one partner explains, “our overarching goal is providing information to communities or the state so that they can make decisions based on good and current scientific information to be able to do resource management or to do infrastructure development” (Scientist).

Collaborate

To facilitate the communication of information, the EBM project seeks to “build and support a culture of effective collaboration” (Babeldaob EBM Partnership 2009). It has done this by bringing representatives from government agencies and NGOs together to participate in its “EBM Core Group”.

Act Opportunistically

In addition to the foregoing strategies, which are formally spelled out in project documents, the presence of a less deliberate, more opportunistic implementation strategy emerged from interviews with partners: “a lot of time it really entails being opportunistic and looking for opportunities that we don’t necessarily have the control over [. . .]. We do what we can in the context of whatever is going on at the moment” (Manager). That is, instead of implementing “top-down EBM,” partners seek to “inject EBM concepts” into complementary projects in Palau, measuring success in terms of “how many of these different frameworks actually take our work and continue it on in their frameworks” (Scientist and Manager).

Tools

As of January 2010, Palau’s EBM initiative had not yet utilized EBM tools such as MARXAN, EcoSim, and EcoPath because they do not operate at a scale appropriate for Palau. EBM partners explain:

When we started the project and we were working with Nature Conservancy. [...] They brought out people from Australia with a MARXAN mapping system - totally off scale for Palau. [...] Nobody ever started using it. [...] There's a

⁵ The terms “state” and “community” are used interchangeably in Palau.

different sort of approach that's needed for a little place like Palau as far as scale goes. You can't treat Palau the same way as you do the Australian barrier reef. [...] Some of those tools don't work very well here, so we have to invent new tools. (Scientist)

[EcoSim and Ecopath] are for really big stuff, so we looked at a lot of those things and [...]the scale is very different. (Manager)

However, as of January 2010, there were plans in the works to use CommunityViz to model and communicate possible development scenarios.

Role of Science

Palau's EBM project generates science with the primary goal of using this information to guide decision-making about development: "The EBM Partnership proposes to provide Palau's leaders at both the state and national level with [information] so they can better understand the short- and long-term economic, ecological, and sociocultural trade-offs inherent to different development options in Babeldaob" (Babeldaob EBM Partnership 2009). As one EBM partner explains, "we thought that the science from EBM could best effect decision making" (Manager). In addition to integrating information into land use planning processes at the state level, the project is collecting science to be used in land use planning processes and development regulations at the national level: "if we had good science that we were able to feed into the land-use planning process [...] and if we could integrate it into the environmental regs for development, which is the EQPB rules and regs, then that would be the best disciplined use of that information" (Manager).

Research questions for the ecosystem-based management initiative were developed during Phase I "over the course of several meetings among researchers, resource managers and other stakeholders in Palau." (Holm et al. 2005). A general consensus emerged from these meetings that "the lack of good baseline data for many habitats and species in Palau was a critical issue" (Holm et al. 2005).

Natural Science

The fundamental objectives of the biophysical science research were to:

- (1) Define and map critical habitat for several key commercially and culturally valuable marine species,
- (2) Characterize watershed discharges and water quality both upstream and downstream in relation to current and predicted future land uses, and
- (3) Test a set of terrestrial and aquatic bioindicators to assess habitat health along the length of the streams (Holm et al. 2005).

Social Science

The fundamental objectives of the social science research were to:

- (1) Map and describe key stakeholders with an interest in resource management of Babeldaob Island,
- (2) Analyze the decision-making process as it relates to natural resource use and management,
- (3) Describe and map historic and present resource uses of Babeldaob Island to be used as a basis for land use planning,
- (4) Assess demographic changes and trends on Babeldaob in order to determine potential resource management needs, and
- (5) Describe and assess traditional and other resource management techniques (Holm et al. 2005).

In practice, the social science data collected during Phase I largely focused on mapping decision-making and was collected with the primary intention of being used by the EBM team to target the communication of biophysical science to decision makers:

There is some social data but very little. So the social data collected as part of the EBM research dealt specially with decision-making because we needed to identify who these decision makers were and what factors contributed to the decisions that they made so that we could know how to bring the science to them. (Manager)

Outcomes

In the first three years of the EBM initiative in Palau, progress has been made in several key areas. In particular, indicators of ecosystem health have been identified, several nature reserves were established, progress was made toward implementing land-use planning, and collaboration was enhanced among agencies that seldom worked together in the past.

Development of Ecosystem Health Indicators

Scientists developed a suite of indicators to facilitate monitoring of ecosystem health from the ridge to the reef along the new road system (Babeldaob EBM Partnership 2009). Indicators for the entire ecosystem include biodiversity, species richness, and abundance (Babeldaob EBM Partnership 2009). For coral reefs, estuaries, and mangroves, sedimentation rates will be monitored (Babeldaob EBM Partnership 2009). Sea grass and other critical fish habitats will be indicators for lagoons, mangroves, and estuaries (Babeldaob EBM Partnership 2009). Water quality parameters such as turbidity, nutrients, and dissolved oxygen will be monitored for

freshwater streams and marine environments (Babeldaob EBM Partnership 2009). Additionally, aquatic microinvertebrates will be monitored for freshwater streams as will indicators of microbiological pollution such as coliform bacteria (Babeldaob EBM Partnership 2009). For the forest floor, ants will serve as indicator species, and birds will do the same for the forest canopy (Babeldaob EBM Partnership 2009). There are also management indicators identified to address the extent to which threats are being mitigated. These are riparian buffer zone regulations and land use plans in place by 2015 in the three priority watersheds.

Informed Decision-Making

Information generated through the EBM project has already impacted environmental policy in Babeldaob. Based on research conducted by scientists at the Belau National Museum, legislative action was taken in the state of Ngaremlengui to create a no-take bird sanctuary and nature reserve (Scientist; Babeldaob EBM Partnership 2009). Data collected by the EBM partners is now being used to guide management decisions within these areas. One partner describes this outcome:

We have scientific publications, but we also have legislative action that was based on our science. [The state of Ngaremlengui] created a bird sanctuary and nature reserve using our data that we gave to them, so they actually are using data to make decisions about how to manage at least the reserve areas. (Scientist)

In addition, through partnership with the Environmental Quality Protection Board, biological indicators developed through the EBM initiative will be transferred over to a freshwater watershed that comprises a portion of Ngaremlengui's water supply to improve monitoring for public health (Scientist). The first cycle of the EBM effort also led to focused land-use planning activities in two of the states identified as being at most at risk for rapid development, Airai and Melekeok (Babeldaob EBM Partnership 2009).

Enhanced Collaboration

The EBM initiative has enhanced collaboration among agencies that have not historically worked directly with one another. EBM partners identified this element of collaboration and coordination among organizations as a very important outcome of the EBM initiative in Palau as participating groups explained that their agencies "are too small and lack the human and financial resources to work in isolation" (Manager). An EBM partner explains:

Before, PCS wasn't really working with the EQPB director, and certainly not very much with the museum. [...] I think that this Packard-funded EBM project has really been a glue for stakeholders over the last 5 years to really, really collaborate. [...] [Without the EBM project] everybody would still be working in their own organizations and agencies and doing their own thing. (Manager)

Challenges

Palau's EBM initiative has been challenged by a number of factors, including the lack of institutional infrastructure for receiving and using scientific information in decision-making; difficulty maintaining political and landowner support for land use planning; trouble synthesizing research results; limited expertise on the island; mismatches between the scale of EBM models and the Palauan context; and difficulty of incorporating novel land management initiatives with established marine management practices.

Insufficient Infrastructure for Using Scientific Findings

Palau currently lacks the institutional infrastructure to receive the scientific information being generated by the EBM effort and apply it to relevant policy-making processes. In the words of an EBM partner:

The problem is that they don't have the structure to receive it. Because Palau is still in the developmental stage, they don't have the institutions to receive the information or the structures – neither the social or regulatory structures – to apply it. They are developing those. [...] We've had to adjust our schedules to how those things develop. (Scientist)

Research Synthesis

Synthesizing the research conducted by the EBM project is an issue that has manifested in a number of ways. First, it has been difficult to translate research findings such that stakeholders are able to understand them. As one scientist explains, "I think our challenge and what we need to do more and better is translating that information, using that information". Another elaborates:

People have difficulty understanding the science or the information you have in reports [...] so what I want to do is to basically synthesize them into a picture like this (points to large painting of environment scene hanging on the wall) that you can bring to people and say, "Here's EBM and here's a scenario that if you do this, this will happen." [...] That has been a challenge for us to pull everything together into a one picture that you can use to engage stakeholders. (Scientist)

Second, the EBM effort in Palau has struggled to decide how much science is enough; that is, at which point the system is well enough understood to act: As one partner explains, "We're still trying to navigate 'How much science is enough?' That's also a big challenge that we have here" (Manager). Also, according to another partner, science does not always give clear cut answers to inform management decisions:

On one hand [the scientists] tell me that we have enough science to inform specific planning actions but they then say it depends on this, this, this and this and that. It seems like sometimes scientists are reluctant to go out on a limb and give me a number.

Lastly, EBM partners have faced difficult decisions relating to the use of research results before they have been published. An EBM partner explains this challenge thus:

Really implementing EBM requires [...] an amount that's outside of certain individuals' and certain agencies' comfort zones of collaboration, sharing, and cooperation. And particularly in the research community, there can be some measure of hesitation in sharing data - having your data used immediately to affect positive management, as opposed to waiting until the data is fully analyzed, interpreted, and published. (Manager)

Community Support

A few partners noted that difficulty maintaining political support from state governments is hindering the progress of EBM in Babeldaob. One partner explained:

In Palau, the states own the resource. [...] To get what we want to be implemented, we really need to work with the direct stakeholders, which are the state government. [...] That has been the challenge, is getting them to understand and to see the need to implement some of the things that we are recommending. (Manager)

Another EBM partner describes the difficulty of regulating land use in the context of Palau's limited land base and complex tenure issues: "But we are encountering some resistance [from landowners] – Babeldaob is small and land tenure is messy. No one wants to deal with it" (Manager). Moreover, generating community support for land management has been more challenging than for marine management as land management is a relatively new activity compared to the country's long history of marine management. The challenges associated with this lack of experience is expressed by one EBM partner as such:

I don't think Palauans have a system for dealing with land management because it was never an issue in the past, it's a new thing. Now that we have development, we have bulldozers, we have big hotels and big roads and all of the sudden we're facing these things and we've never [had to deal with them before]. (Scientist)

Limited Local Expertise

There is limited scientific and technical expertise among the small Palauan population to draw from in order to implement EBM. For example, EQPB had difficulty retaining a researcher to undertake the water quality monitoring activities that it proposed to conduct for the first year of the grant cycle (Holm 2007). Given "the dearth of qualified applicants to draw from," the institution sought the services of a private consulting firm to conduct elements of the survey work (Holm 2007). Here is how one of the EBM partners expressed this challenge of limited local expertise:

We have a really small pool of people to pull from; we lose a researcher and it's difficult to replace them fairly easily. [...] Our remoteness makes it difficult; it's difficult to really inspire people to want to come work in Palau - to live and work in Palau - for long periods of time. (Manager)

This is especially the case in social science:

A great challenge for Palau has been in making the clear links between the socio-economic and ecological aspects of EBM information and approaches. This is mainly because we have such limited expertise in Palau, particularly in the area of economics and the links with biodiversity. It has been really challenging to find someone outside of Palau that has this kind of expertise who has the time and willingness to spend some time working with Palau on this. (Manager)

Mismatches between EBM Models and the Palauan Context

Another challenge to EBM progress in Palau relates to the incongruence between existing models of EBM and the Palauan context, especially as it relates to scale. There are not examples of EBM that Palau can emulate. An EBM partner describes this problem,

So we look to the rest of the world to see who can we look at/model after and it's like ... they're talking about very different landscapes and the scope and the scale that we're looking at is very small. [...] There's a lot of literature out there, [but] it's just not comparable to what we have. (Manager)

Facilitating Factors

Several factors have facilitated the implementation of EBM activities in Palau, including the country's small scale, the co-existence of other initiatives with complementary goals, and the purported presence of a "traditional conservation ethic" or general receptivity to conservation efforts among Palauans.

Small Scale

EBM partners explained that Palau's small size has made it easier demonstrate ecosystem-based management by facilitating the collection of information and partners' access to decision-makers:

Palau is small and compact, so it's easier to demonstrate an ecosystem-based approach in this context because you're not defeated by scale. [...] Here everything is close and tight, and you can see point-source pollution affecting the reef. You know, things like that. (Scientist)

Its Palau, we're small. We're 20,000 people - 400 miles long, 237,000 km² big. [...] I think that if you can get a group of people that are that close in proximity,

and ecosystems that are still relatively intact and close to each other, then it's really easy to systematically do surveys and collect information. (Stakeholder)

I think we're very fortunate that we are a pretty small country, so we have access to, the whole scale of, from the community all the way up to the executive level. It's pretty easy for us to get a meeting with the president if we need to. [...] We have a lot of [...] social capital. Everybody knows whoever it is we need to talk to. [...] The communities are very tight. [...] The states that we're working in, we're also from these states and so it makes it easier to get things moving. (Manager)

Simultaneous Initiatives with Complementary Goals

Conservation institutions and other national and regional initiatives have been developed simultaneously with the EBM project in Palau, and these other efforts have complementary goals such as the engagement of stakeholders in active management of resources in Babeldaob. This has provided opportunities for transferring EBM science, principles, and recommendations to decision-making groups during early phases of their planning and development efforts (Babeldaob EBM Partnership 2009). Such complementary initiatives include the Babeldaob Watershed Alliance (BWA); Palau Protected Areas Network (PAN); Palau Sustainable Land Management Program (SLM); a new Ministry of Natural Resources, Environment and Tourism; a new Ministry of Public Infrastructure, Industries, and Commerce; the Micronesia Challenge, a regional conservation commitment launched by Palau in 2006; ecosystem-based fisheries management discussions; and State Conservation Areas, with 8 newly established areas between 2006 through 2008 (Babeldaob EBM Partnership 2009).

Local Receptivity to Conservation

EBM partners describe Palau as a country with a history of environmental stewardship, home to people who have long considered resources in a holistic manner at an ecosystem-level. They explain that this 'traditional conservation ethic' has helped garner support for EBM implementation because EBM is based on an already widely accepted perspective in Palau:

We have people with a culture of environmental stewardship so we can build on that. (Manager)

EBM's definition isn't a new concept to Palau and Palauan culture. It's actually a relatively ancient idea. Conservation in Palau has been happening for thousands of years and I truly believe it's always been at an ecosystem-based level. (Stakeholder)

We've always had an EBM approach culturally – and I think most island cultures probably do. (Manager)

Key Lessons Learned

Ecosystem-based management practitioners in the tropical Western Pacific find little in common with the experiences of initiatives taking place in other areas of the world, but have particular characteristics in common with one another (Clarke and Jupiter 2010). This section describes lessons learned from the perspective of those implementing EBM, and draws on a report from the Wildlife Conservation Society of the results of a two day workshop held in August 2009 to discuss shared experiences implementing EBM in the tropical Western Pacific (Clarke and Jupiter 2010).

Importance of Partnerships

For EBM to be effective, the full spectrum of stakeholders must be recognized and strategic decisions must be made regarding community involvement in the process of ecosystem management transformation (Clarke and Jupiter 2010). Management success is facilitated by collaborative alliances that bring together institutions with diverse expertise, skill sets, responsibilities, and resources (Clarke and Jupiter 2010). Partnerships that harmonize and integrate management activities enhance efficiency and promote mutually accepted solutions to ecological issues (Clarke and Jupiter 2010).

Importance of Understanding Existing Institutions and Decision-Making Processes

EBM practitioners need to fully understand the context in which they are operating and must identify opportunities to connect their work to co-existing organizations, policies, programs, and management processes (Clarke and Jupiter 2010). In the Western Pacific, customary tenure is a major feature of natural resource management regimes; therefore, effective conservation must recognize and understand existing traditional and legal resource rights and decision-making protocols (Clarke and Jupiter 2010). Engaging local personnel will help gain insights into traditional authority structures and community administrative procedures (Clarke and Jupiter 2010). Socio-cultural research may also inform understanding of formal and informal decision-making processes (Clarke and Jupiter 2010).

Because EBM is inter-sectoral, it may require participation of several existing institutions, the establishment of new organizations, coordination mechanisms between entities, and/or a combination of these approaches (Clarke and Jupiter 2010). In particular, engaging traditional leaders in planning and decision-making processes is a critical component of effective EBM implementation in the Western Pacific context because traditional leaders possess significant influence in rural communities (Clarke and Jupiter 2010).

Effective Use of Science

Science can make a variety of contributions to management planning particularly with regard to identifying management targets, threats, and actions (Clarke and Jupiter 2010). To ensure scientific recommendations are implemented, research needs to address prioritized management questions, including social and economic issues (Clarke and Jupiter 2010). Scientific investigations should have practical application and research results need to be

clearly communicated to decision-makers (Clarke and Jupiter 2010).

Effective Means of Education and Communication

Education and communication are important elements of EBM, especially programs that raise awareness of ecosystem values, threats and causal factors; promote behavioral or policy change; and build capacity to successfully implement management actions (Clarke and Jupiter 2010). In the Western Pacific context, important messages are usually communicated most effectively through casual gatherings, and newsletters and fact sheets in the local language that are focused on essential topics are effective within communities (Clarke and Jupiter 2010). It is important to follow up printed messages with verbal communication and allocate sufficient time and resources to such activities in project proposals and plans (Clarke and Jupiter 2010).

Project Monitoring

A program for ongoing monitoring of key indicators is necessary to measure EBM effectiveness (Clarke and Jupiter 2010). EBM monitoring plans need to be directly linked to management targets and threats and include a variety of biological and socioeconomic indicators across all ecosystem types contained by the management area (Clarke and Jupiter 2010).

Utility of EBM Tools in this Context

Because many EBM tools were developed for application in developed countries, they have limited applicability to the Western Pacific context where technical capacity is lower, data is often scarce, and people are skeptical of computer-generated models, in some instances (Clarke and Jupiter 2010). Biodiversity conservation and resource preservation will be improved if communities and site managers are willing and able to implement emergent management suggestions (Clarke and Jupiter 2010). EBM practitioners should note, however, that there may be legitimate socioeconomic and/or governance limitations that prohibit communities or site managers from carrying out management activities in places that EBM tools prioritize for protection (Clarke and Jupiter 2010). Whether or not outputs fulfill local objectives may ultimately determine if EBM tools are successful in this region (Clarke and Jupiter 2010).

How to Scale up EBM

While EBM is a place-based approach, it is not solely about site-based conservation (Clarke and Jupiter 2010). EBM principles are applicable at larger spatial scales and can be incorporated into national and sub-national policies and programs (Clarke and Jupiter 2010).

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