PRINCIPLES AND PRACTICE OF ECOSYSTEM-BASED MANAGEMENT

A GUIDE FOR CONSERVATION PRACTITIONERS IN THE TROPICAL WESTERN PACIFIC

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Organisations represented at the workshop included: the Wildlife Conservation Society, Wetlands International-Oceania, The Nature Conservancy, WWF, Conservation International, University of the South Pacific, and the Palau Conservation Society.

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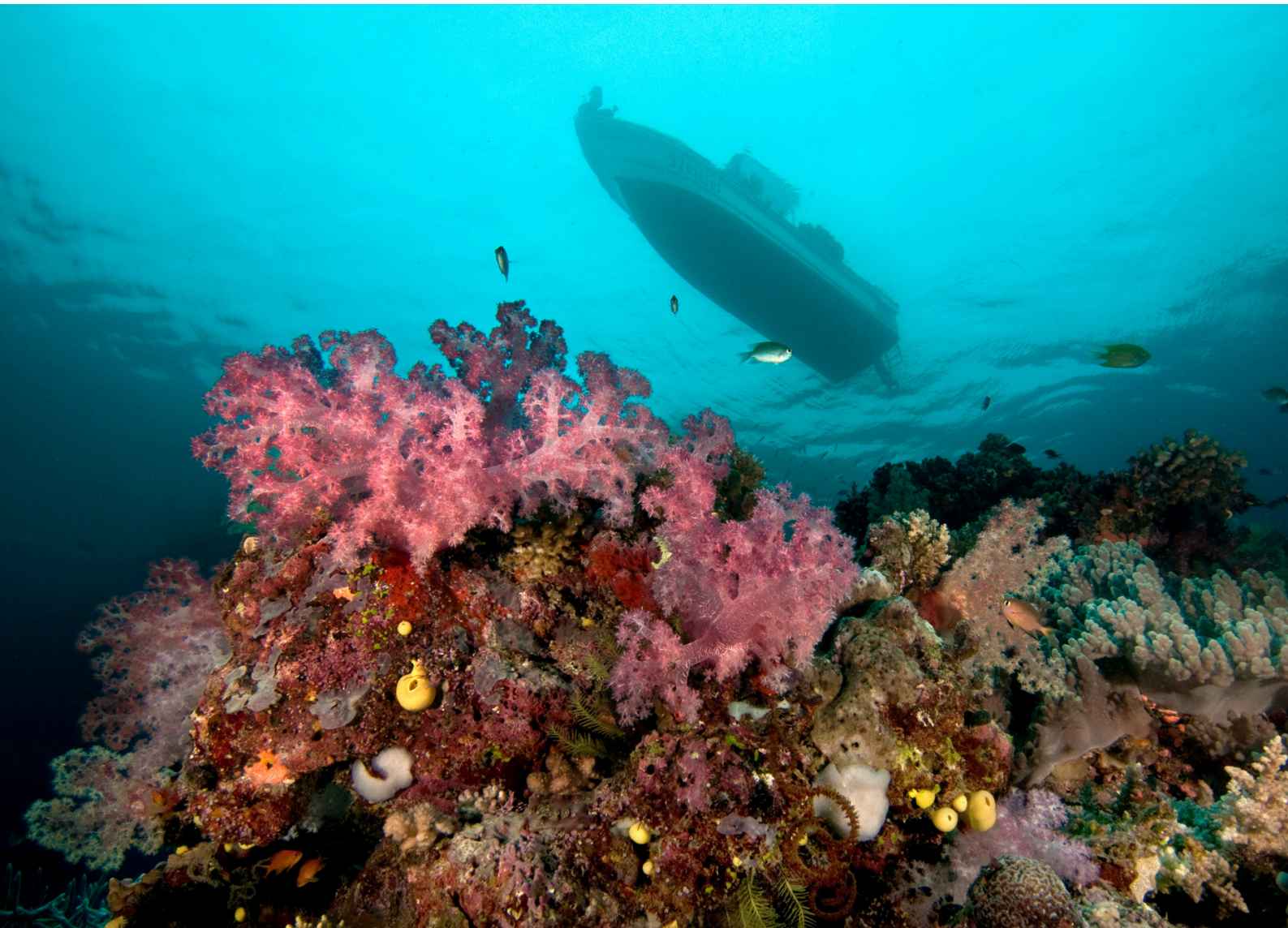
Photo Credit: Lill Haugen



EXECUTIVE SUMMARY

Ecosystem-based management (EBM) is an integrated approach that considers interactions between humans and the environment. The goal of EBM is to sustainably manage natural resources and biodiversity by maintaining ecosystem processes, functions and services.

This guide seeks to inform and influence conservation practice in the tropical Western Pacific and to share lessons from the region with conservation practitioners around the world, particularly in developing nations where EBM approaches used in industrialised countries may not be feasible or appropriate. EBM can be applied at a range of scales and context at any stage in the planning process for site-based projects to national policies and programmes.

Chapters 1-2 provide an introduction to the key principles of EBM and outline the distinctive features of the Western Pacific. EBM is an approach that emphasises: connectivity between biological and social systems; consequences of human actions within ecosystems; protection and restoration of ecosystem structure, function and key processes; and integration of biological, socioeconomic and governance perspectives. Its application in the tropical Western Pacific must be tailored to meet the needs and characteristics of its peoples and ecosystems, which include: high biodiversity and endemism; strong links between terrestrial, freshwater and marine system through small water catchments; heavy reliance on marine resources; high population growth and increasing market access; moderate to high levels of poverty; limited government capacity for effective resource management; traditional tenure and management systems; strong role and rapid growth of community-based management; and strong vulnerability to ecosystem degradation. EBM approaches provide a cost effective strategy for reducing vulnerability to climate change impacts and increasing resilience, while maintaining ecosystem services and sustainable livelihoods in the face of climate change

Chapter 3 presents brief case studies from EBM practitioners in the tropical Western Pacific. It draws, in particular, on lessons learnt from the following field sites:

- Kubulau District, Fiji Islands
- Macuata Province, Fiji Islands
- Kadavu Province, Fiji Islands
- Babeldaob Island, Palau
- Bird's Head Seascape, Indonesia

Chapter 4 discusses the application of the following EBM principles, defined by research and management experience from around the world, but tailored to the requirements for implementation in the tropical Western Pacific:

1. Adopt an integrated approach to ecosystem management
2. Maintain healthy, productive and resilience ecosystems
3. Maintain and restore connectivity within and between social and ecological systems
4. Incorporate economic, social and cultural values
5. Involve stakeholders through participatory governance
6. Recognise uncertainty and plan for adaptive management
7. Use all relevant forms of scientific, traditional and local knowledge.

Chapter 5 examines the application of EBM principles to site-based conservation practice in the tropical Western Pacific. Drawing on examples from field sites in the region, the chapter outlines the following key steps in the management planning process:

- *Identify and involve stakeholders:* Effective EBM requires identification of the full range of stakeholders and strategic decisions about engaging stakeholders in the process of change. Collaborative partnerships greatly enhance management effectiveness, by bringing together organisations with diverse expertise, roles and resources.

- *Identify ecosystem values:* Implementation of EBM calls for an understanding of the interactions between the biological and social systems in the management area. Biological and socioeconomic assessments can provide key indicators of ecosystem functions and the management needs of the people. Integrating local knowledge with existing and emerging scientific knowledge may improve management effectiveness by increasing community participation.

- *Understand the management context:* Because resource tenure is a fundamental issue for conservation and natural resource management initiatives in the tropical Western Pacific, it is important to gain a clear understanding of the legal and *de facto* status of tenure claims in the management area. Gaining a clear understanding of customary and government decision-making processes can greatly enhance the effectiveness of EBM initiatives.

- *Identify key management institutions:* Due to its cross-sectoral nature, EBM may require the involvement of a number of existing institutions, or the establishment of new institutions or coordination mechanisms. In each case, it is necessary to consider the source of the institution's authority or influence, and its interactions with other management institutions. In the Western Pacific, interactions between traditional institutions and government are particularly important, especially in many rural communities where traditional leaders exercise greater influence than government agencies

- *Identify goals, targets and threats:* Clearly defined goals and targets provide a basis for identifying threats and prioritising management responses. Engaging resource owners and users, experts and management agencies in collaborative planning processes provides opportunities for identifying goals and targets that integrate stakeholder concerns and priorities with scientific and traditional ecological knowledge. Scientific research is most useful in the tropical Western Pacific when: studies are based on sound principles and are well-designed; the results reflect a consensus of expert opinions; research outcomes can be easily interpreted and turned into targets that can be monitored; and management strategies based on the findings can be applied generally, taking into account local context.

- *Establish management strategies:* Management plans ordinarily include two operative components: management rules and management actions. Effective EBM requires careful attention to implementation of management rules and actions. Responsibilities and timeframes for implementation should be clearly identified, with mechanisms for periodically reviewing progress on implementation.

- *Develop compliance mechanisms:* Management rules are unlikely to be effective without active efforts to promote compliance, including awareness raising, monitoring, surveillance and enforcement. Punishments for infringement of management rules must be powerful enough to deter offences yet fall within the framework of national legislation.

- *Deliver education and outreach programs:* A range of communication media and techniques have been identified that work well in the Western Pacific, including: key messages delivered through informal settings; logos and slogans; newsletters and fact sheets printed in local languages; and verbal communication to reinforce printed material. Effective communication is often undermined by a failure to allocate adequate time and money allocated to communication activities in project proposals and work plans

- *Identify monitoring and research priorities:* EBM monitoring programs should be explicitly linked to management targets and threats and cover a range of biological and socioeconomic indicators across all ecosystem types within the management area. Monitoring programs should be designed so that their scope and nature is consistent with available resources and technical capacity. In the Western Pacific context, community-based monitoring may play a useful role to tailor adaptive management to local needs.

- *Establish review and adaptation processes:* To implement an adaptive management approach, it is necessary to examine the key values and threats in the management area, develop a set of assumptions about what is occurring and what actions might be used to maintain and restore these values. Failure of management actions to achieve desired results may be because: assumptions were wrong; the management actions were poorly executed; the conditions in the management area have changed; the monitoring was faulty; or a combination of these problems. The management actions should then be modified to reflect information obtained through monitoring, based on agreed process for amending rules and actions.

Chapter 6 introduces the types of EBM tools available and considers their relevance and usefulness in the largely developing nations of the tropical Western Pacific. Because many EBM tools were designed for use in developed countries, their applications in the Western Pacific may be limited by lack of technical capacity, data deficiencies and, in some cases, mistrust of computer-generated models. The successful use of EBM tools in the Western Pacific may ultimately rely on how well the outputs complement local objectives. Where communities or site managers are willing and able to implement the resulting management recommendations, biodiversity conservation and protection of natural resources will be enhanced.

Chapter 7 describes opportunities for scaling up EBM initiatives and integrating EBM concepts in national policies and programmes. By clearly and actively communicating the results of EBM practice to government, conservation practitioners can demonstrate the benefits of an integrated approach to environmental and natural resource management that is aligned with national and regional priorities.

Chapter 8 summarises key lessons learnt about the application of EBM principles and practices in the tropical Western Pacific for community-based management, adaptive management, climate change adaptation, integrating local and traditional knowledge, management implementation, protected area design, communication, and scaling up EBM. Throughout all EBM initiatives in the tropical Western Pacific, management success is highly dependent on a participatory planning process that considers the needs and the traditions of the local communities. In a rapidly changing and globalized world, implementation of EBM is urgently required to preserve the ecosystem services that people depend on for human health and livelihoods.

1. INTRODUCTION

In recent years, extensive scientific research has demonstrated the value of an integrated 'ecosystem-based' approach to management of the coastal and marine environment, yet there are relatively few examples of its successful implementation on the ground,[1] and those that do exist typically focus on temperate systems in the developed world.[2-3]

Thus, recommendations for implementation of ecosystem-based management (EBM) principles have often been made in the context of governance and management structures that are appropriate in developed countries but may not be as applicable in developing states, including the island and archipelagic states of the tropical Western Pacific.

The tropical Western Pacific is characterised by high levels of reliance on coastal marine resources, limited government management capacity and strong traditions of community-based natural resource management. Degradation of coastal ecosystems directly threatens the livelihoods of local communities in the region and increases their vulnerability to natural disasters and climate change.[4]

Recent rapid growth in community-based fisheries management initiatives in the region demonstrates the great potential for effective community-based management of natural resources in the Western Pacific.[5] However, these initiatives have tended to focus primarily on fisheries, with limited emphasis on integrated management of marine, coastal, freshwater and terrestrial ecosystems.

Conservation practitioners working at five EBM sites in the tropical Western Pacific have noted that their experience of EBM practice has shared certain common features, and that these experiences differ from EBM practice in other regions of the world. This publication seeks to document their experience and share lessons learnt for effective EBM practice in the tropical Western Pacific.

The guide is intended for conservationists, government officers and academics involved in natural resource management, nature conservation and environmental protection in the Western Pacific and beyond.

Photo Credit: Stacy Jupiter

1 Arkema KK, Abramson SC, Dewsbury BM (2006) Marine ecosystem-based management: from characterization to implementation. Frontiers in Ecology and the Environment 4: 525-532.
2 McLeod K, Leslie H (2009) Ecosystem-Based Management for the Oceans. Island Press: Washington DC, 368 pp.
3 Ruckleshaus M, Klinger T, Knowlton N, DeMaster DP (2008) Marine ecosystem-based management in practice: scientific and governance challenges. BioScience 58: 53-63.
4 Mcintyre M (2005) Pacific Environment Outlook. UNEP / SPREP, <www.unep.org/GEO/pdfs/Pacific_EO.pdf>, accessed 1 September 2009.

5 Govan H, Tawake A, Tabunakawai K, Jenkins A, et al (2009) Community conserved areas: a review of the status and needs in Melanesia and Polynesia. ICCA regional review of CENESTA / TILCEPA / TGER / IUCN / GEF-SGP, 66 pp.

2. WHAT IS ECOSYSTEM-BASED MANAGEMENT?

Ecosystem-based management (EBM) differs from a single species or single sector approach to management by considering complex interactions between humans and the living and non-living environment over multiples scales in space and time.

The goal of EBM is to sustainably manage both target and non-target species by preserving or restoring habitat quality to maintain ecosystem services.[6]

In particular, EBM:

- emphasises connectivity within and between systems, such as between land and sea (**Figure 2.1**);
- focuses on the consequences of human actions within a specific ecosystem (or linked, adjacent ecosystems);[7]
- emphasises the protection and restoration of ecosystem structure, function and key processes; and
- integrates biological, socioeconomic and governance perspectives.

Use of land and resources by humans may result in significant alteration of ecosystems, disrupting connectivity within and between habitats (**Figure 2.2**).

Modification of ecosystems may reduce their health, productivity and resilience, and must be managed to ensure ongoing availability of ecosystem services. It is important to note that EBM is focused on management of human activities within ecosystems and not the ecosystems themselves.[8]

WHAT IS AN ECOSYSTEM?

An ecosystem includes all of the plants, animals, microbes, soil, air and water within a physical space and the interactions between them. Humans are an integral part of marine, freshwater and terrestrial ecosystems.

The linkages within and between ecosystems arise from biological interactions (for example, seabirds hunting for marine fish to feed their offspring) and physical processes (for example, sediments transported downstream by river networks).[9]

EBM is a framework that can be applied to site-based projects throughout any stage in their development by ensuring that management goals and targets:

- focus on protecting or restoring the natural structure of ecosystems to maintain ecosystem services;
- incorporate social dimensions of resource use and ecosystem values into management;
- recognise the high level of uncertainty and variability in dynamic ecosystems;
- reflect a common vision among stakeholders; and
- are informed and adapted from learning based on science and local knowledge.[10]

6 Rosenberg AA, McLeod K (2005) Implementing ecosystem-based approaches to management for the conservation of ecosystem services. Marine Ecology Progress Series 300: 241-296.
7 Ecosystems vary in scale and may not have clearly defined boundaries. In practice, management boundaries may be defined by a range of ecological, social and cultural factors.
8 McLeod KL, Leslie HM (2009) Why ecosystem-based management? In: McLeod KL, Leslie HM (eds) Ecosystem-Based Management for the Oceans. Island Press: Washington DC, pp 3-12.

9 McLeod KL, Leslie HM (2009) supra n.8.
10 Grieve C, Short K (2007) Implementation of ecosystem-based management in marine capture fisheries: Case studies. <http://assets.panda.org/downloads/wwf_ebm_toolkit_2007.pdf>, accessed 1 August 2009.

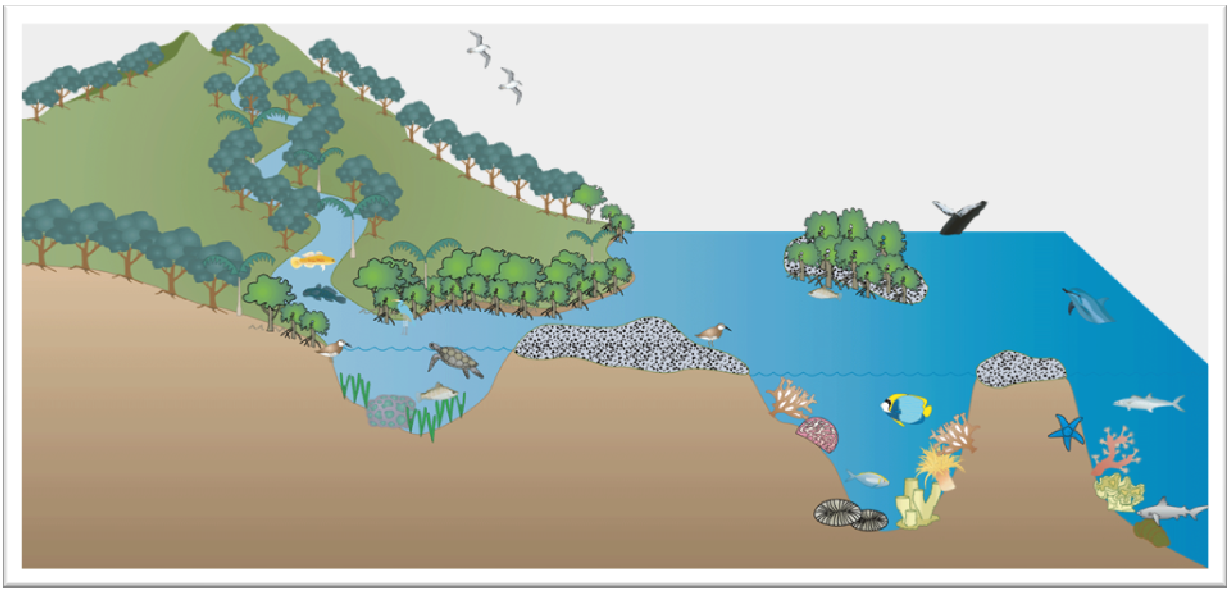


Figure 2.1. | Schematic diagram of healthy connectivity between adjacent ecosystems.[11]

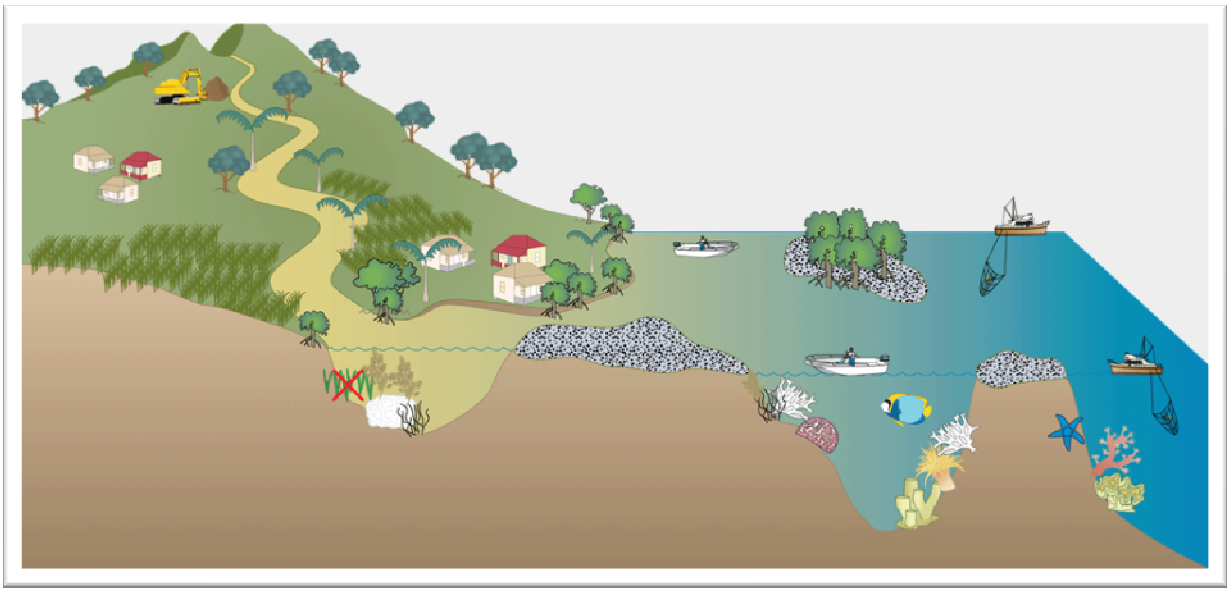


Figure 2.2. | Schematic diagram depicting interruption to ecosystem connectivity due to human activity.

11 Symbols courtesy of the Integration and Application Network (http://ian.umces.edu/symbols).

3. ECOSYSTEM-BASED MANAGEMENT IN THE WESTERN PACIFIC

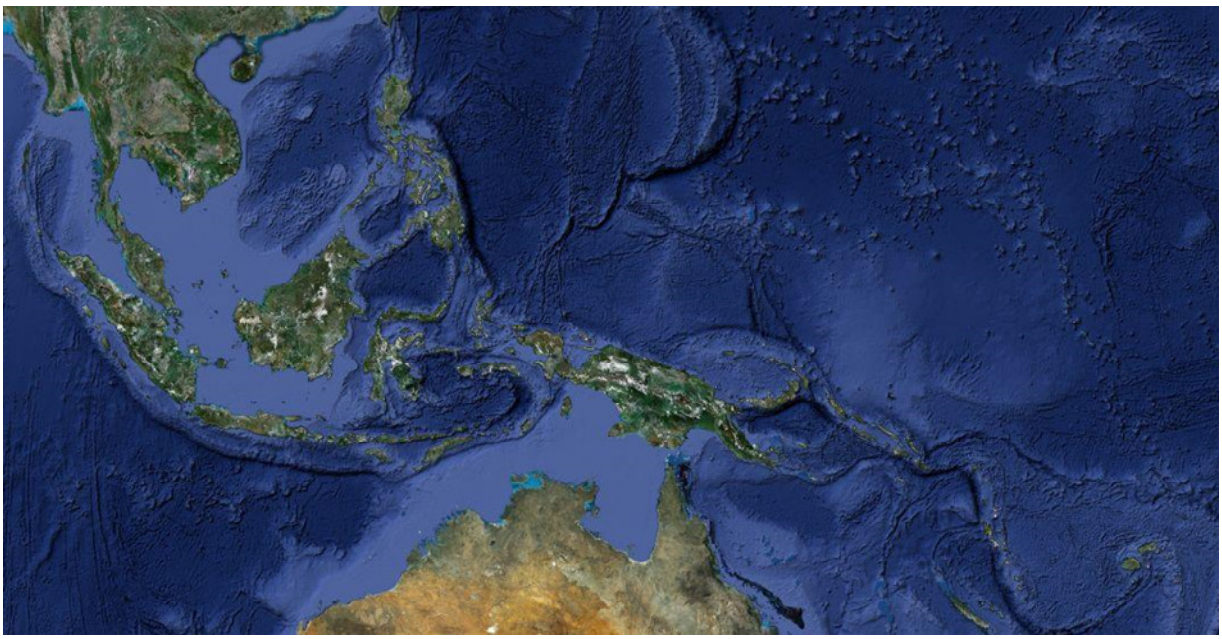


Figure 3.1: The tropical Western Pacific.

This guide seeks to inform conservation practice in the tropical Western Pacific, including the island states of Melanesia, Micronesia and Polynesia, as well as Indonesia, the Philippines and East Timor.

The countries and communities of this region, despite their great diversity, share certain distinctive features relevant to the practice of EBM. The island and archipelagic states of the tropical Western Pacific are largely characterised by:

- very high biodiversity, including many endemic and endangered species;
- vulnerability to ecosystem degradation, natural disasters and climate change;
- strong reliance on marine resources, especially in poor rural communities;
- high population growth and increasing exploitation of natural resources for domestic and international markets;
- developing country economies, with moderate to high levels of poverty;
- limited government capacity for effective natural resource management;
- traditional tenure and management systems for land and marine resources;
- the central role of local communities in managing natural resources; and
- recent rapid growth in community-based conservation initiatives.

The diverse ecosystems of the region play a vital role in meeting basic human needs, supporting sustainable livelihoods and contributing to national development.

For centuries, traditional systems have regulated individual and communal resource use.[12] However, rapid population growth and economic development have placed considerable pressure on natural ecosystems.

12 Johannes RE (2002) The renaissance of community-based marine resource management in Oceania. Annual Review of Ecology and Systematics 33: 317-340.

Key environmental issues in the region include:

Land and forest degradation: Clearing for subsistence and commercial agriculture, poorly managed logging and mining operations and widespread occurrence of fires all contribute to loss of forest cover and land degradation.[13] Subsequent soil erosion slows recovery of forest ecosystems, reduces downstream water quality and can negatively affect coral reefs and coastal fisheries.

Threats to freshwater resources: Watershed degradation, together with contamination of water resources, has led to a significant decline in freshwater biodiversity in many areas.[14] These impacts are likely to be exacerbated by rapid population growth, poorly planned economic development, and changes in rainfall regimes due to climate change.

Degradation of coastal and marine environments: Inshore and offshore fisheries represent the primary opportunity for substantial economic development for many countries in this region.[15] However, important fisheries habitat, such as coral reefs and mangroves, have been affected by land clearing, sedimentation, poorly planned coastal development, destructive fishing practices and over-exploitation (as a result of population growth and expanded market access).

Invasive species: Introduced plant and animal species pose serious threats to the diversity and productivity of island ecosystems in the Western Pacific. Terrestrial, freshwater and marine ecosystems have all been affected to varying degrees by invasive species.[16]

Climate change and sea level rise: The predicted effects of climate change in the region are varied and severe.[17] Changes in temperature, rainfall pattern, ocean currents and pH and other physical systems are expected to affect ecosystems and communities throughout the region, while sea level rise presents a dire threat to low-lying island countries and coastal communities in coming decades.

Waste and pollution: Waste management is a major issue for many countries in the region as growing industrialisation, changes in consumption patterns, urbanisation and increased imports of non-biodegradable materials and chemicals have led to problems with littering, waste disposal, reuse and recycling and hazardous substances.

Natural disasters: Degradation of coastal ecosystems, particularly mangroves and coral reefs, has increased vulnerability to natural disasters such as cyclones and tsunamis.[18]

CASE STUDIES

This guide is informed by the experience of EBM practitioners in the tropical Western Pacific region and draws, in particular, on lessons learnt from the following field sites:

- Kubulau District, Fiji Islands
- Macuata Province, Fiji Islands
- Kadavu Province, Fiji Islands
- Babeldaob Island, Palau
- Bird's Head Seascape, Indonesia

Each of these field sites is described below and referred to throughout the text.

13 Foley JA, DeFries RS, Asner GP, Barford C, et al. (2005) Global consequences of land use. Science 309: 570-574.
14 Jenkins AP, Jupiter SD, Qauqau I, Atherton J (2009) The importance of ecosystem-based management for conserving aquatic migratory pathways on tropical high islands: A case study from Fiji. Aquatic Conservation: Marine and Freshwater Ecosystems. doi: 10.1002/aqc.1086.
15 Gillet R (2009) The contribution of fisheries to the economies of Pacific Island countries and territories. Asian Development Bank. 373 pp.
16 South Pacific Regional Environment Programme (2000) Invasive species in the Pacific: A regional strategy. SPREP. Apia, Samoa.
17 IPCC (2007) Climate Change 2007 – The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the IPCC. Cambridge University Press: Cambridge, UK.
18 Mcintyre M (2005) Pacific Environment Outlook. UNEP / SPREP,<www.unep.org/GEO/pdfs/Pacific_EO.pdf>, accessed 1 September 2009.

CASE STUDY 1 | KUBULAU DISTRICT, FIJI ISLANDS

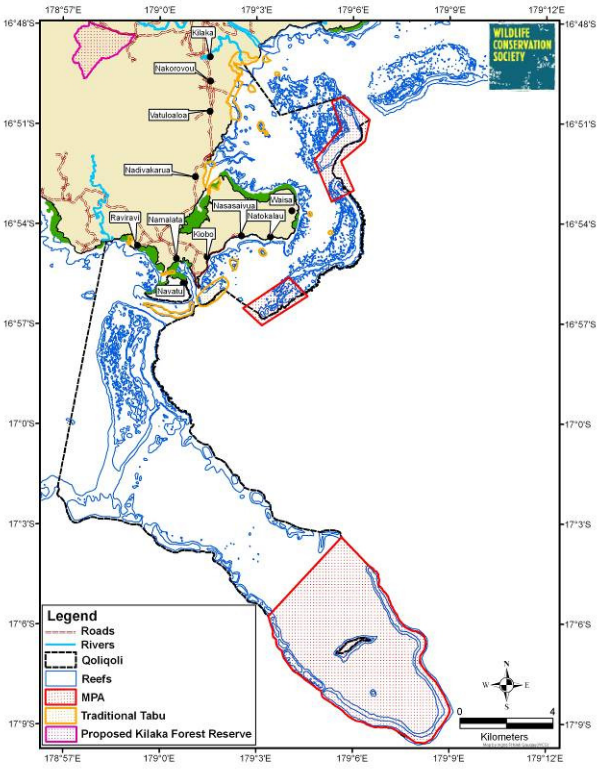


Figure 3.2 | Kubulau District and Fishing Ground

Kubulau District is located in Bua Province, on Fiji's second largest island, Vanua Levu. The large majority (92%) of land in Kubulau is owned by 57 indigenous landowning clans. The management area also includes the clans' customary fishing ground, which extends to the outer edge of the fringing coral reefs (**Figure 3.2**). The fishing ground covers a diverse array of habitats, and supports a high diversity and abundance of fish species.

Households in Kubulau are highly dependent on fishing and farming to meet their subsistence needs, and rely heavily on fishing, farming and copra harvesting to generate cash income. In response to community concerns about declining resource abundance and ecosystem health, the traditional leaders of Kubulau formed a district resource management committee, made up of a chairman and representatives from each of the ten villages, to lead district-wide management of all natural resources: terrestrial, freshwater, coastal and marine.

Socioeconomic surveys and biological surveys were conducted with the assistance of EBM partner organisations. Participatory planning methods, informed by scientific research and traditional and local knowledge, have led to the establishment of marine protected area network and the adoption of an integrated 'ridge-to-reef' ecosystem-based management plan to maintain ecosystem functions and allow recovery of exploited habitats.

Communities in Kubulau have declared 20 marine protected areas, including 3 district marine reserves and 17 village *tabu* areas, covering >30% of the customary fishing grounds. This network includes a mix of larger offshore reserves and smaller inshore reserves, and protects a variety of habitats.

This initiative demonstrates the value of integrating EBM principles and science into community-based management processes, and produced a model ecosystem-based management plan that may be utilised in other field sites in the region.

SNAPSHOT | KUBULAU DISTRICT

Location: Bua Province, Fiji Islands
Population: 1,000
Land Area: 98.5 km^2
Sea Area: 261.6 km^2

EBM Goal: Preservation of the functional integrity of Kubulau's ecosystems, from the ridge to the reef, through community-based management.

Protected Areas: 3 district marine reserves (73km^2), 18 village *tabu* areas (5.7km^2) and one forest conservation lease (40ha).

Management Institution: Kubulau Resource Management Committee (KRMC)

EBM Lead: Wildlife Conservation Society

EBM Partners: WWF, Wetlands International-Oceania, Coral Reef Alliance

CASE STUDY 2 | MACUATA PROVINCE, FIJI ISLANDS

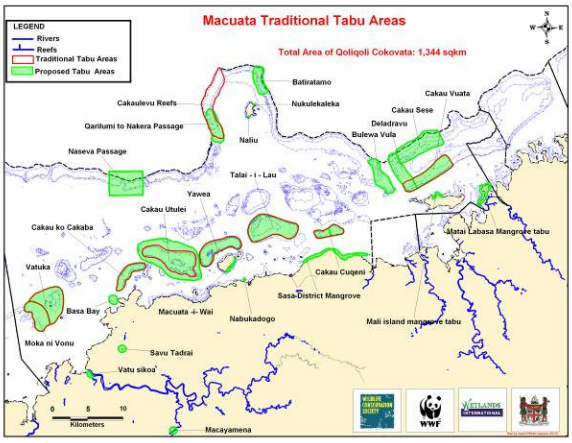


Figure 3.3 | Macuata Province and Fishing Ground

Macuata Province, a rural province of Vanua Levu, is fringed by the Great Sea Reef, an internationally significant reef system. The population of the province is predominantly indigenous, with numerous landowning clans spread across 37 villages (**Figure 3.3**).

At the invitation of the paramount chief of the province, EBM partner organisations have been working with community members and the provincial administration since 2005 to promote sustainable management of marine and terrestrial resources in the province.

Community-based management planning processes have led to the adoption of a range of management measures, including fishing gear restrictions, restrictions on fishing methods, protection of species and the establishment of a network of marine and terrestrial protected areas.

The network of protected areas was originally identified based on local ecological knowledge. In 2008, WWF facilitated a community-based management planning process that resulted in a significant expansion and reconfiguration of the protected area network, based on the findings of ecological and socioeconomic research undertaken by the EBM partners.

Taking into account information and advice provided by the EBM partner organisations, local communities resolved to expand the protected area network to include 25 marine and coastal reserves and 2 forest reserves. The protected area system covers a range of ecosystem types and ecological features (eg. spawning aggregation sites, turtle nesting beaches, mangroves, riparian corridors), over a total area of more than 175km^2.

Ecological field surveys are currently being undertaken to monitor the effect of management measures in the period since initial baseline surveys were completed. Local fishermen have reported significant positive changes since the establishment of the marine reserves. For example, endangered humphead wrasse (*Chelinus undulatus*) are returning to areas where they have not been seen for some years, and larger fish of other species are being observed closer to shore.

The participatory EBM planning process in Macuata demonstrates the potential for integrating local knowledge and scientific research to support community-based adaptive management across a range of ecosystem types.

SNAPSHOT | MACUATA PROVINCE

Location: Vanua Levu, Fiji Islands
Population: 10,000
Land Area: 2,004 km^2
Sea Area: 1,349km^2

EBM Goal: Preservation of the functional integrity of Macuata's ecosystems, from the ridge to the reef, through community-based management.

Protected Areas: 25 community declared marine reserve (175km^2), 2 forest reserves (1.7km^2).

Management Institution: Qoliqoli Cokovata Management Committee

EBM Lead: WWF South Pacific Programme

EBM Partners: Wildlife Conservation Society, Wetlands International, FLMMA, RARE

CASE STUDY 3 | KADAVU PROVINCE, FIJI ISLANDS

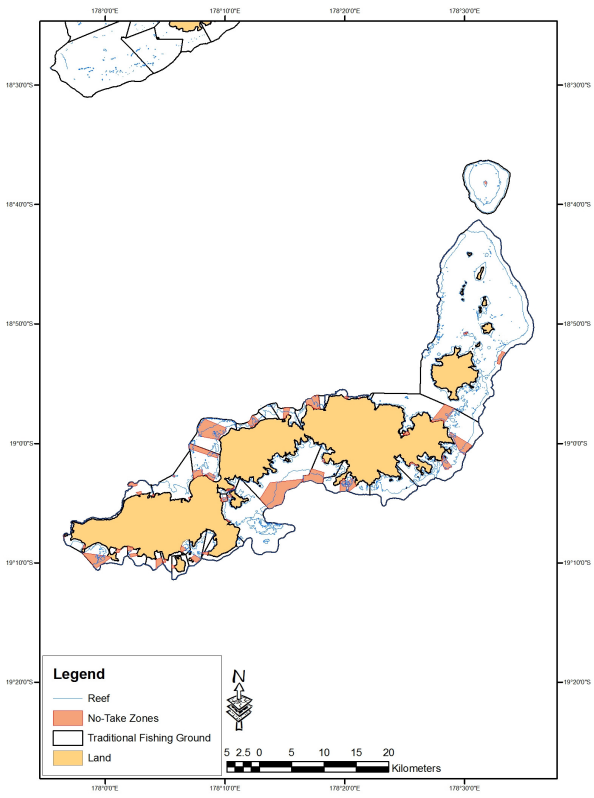


Figure 3.4 | Kadavu Province, Fiji Islands

Kadavu Province was a pioneer of the locally managed marine area (LMMA) concept. The island group that makes up Kadavu Province lies 60 km south of Fiji's main island, Viti Levu. The predominantly (98%) indigenous Fijian population of Kadavu live in 38 villages.

The coastal marine waters of the island group are divided into 30 traditional fishing grounds (*qoliqoli*)(**Figure 3.4**). Between 2001 and 2007, resource owners adopted management measures for each *qoliqoli*, including declaration of no take areas (*tabu*). There are now 43 *tabu* areas in Kadavu, covering a total area of 62.7 km^2.

To support this work, the Kadavu Provincial Council established the Yaubula Management Support Team (YMST). *Yaubula* is a Fijian word that means 'living wealth'. The YMST is hosted at the Kadavu Provincial Office.

In 2007, the YMST convened a province-wide meeting to develop a vision for Kadavu's network of marine managed areas. The outcome of this groundbreaking visioning exercise was a shared commitment to 'an interconnected, ecologically representative, resilient, island-wide protected area network'.

The University of the South Pacific is currently examining how existing *tabu* areas contribute to the provincial network of protected areas. Using gap analysis techniques and reserve design principles, the university aims to inform the development of a functioning and inter-connected network of protected areas.

Stakeholders have emphasised the need to develop a protected area network that appropriately reflects social and cultural considerations, recognising that this may not result in ecologically optimal network design. For example, resource owners have indicated that inshore *tabu* areas are easier to enforce, while large offshore protected areas, despite their ecological benefits, are likely to be hard to enforce within existing resources, and are at risk of becoming ineffective 'paper parks'.

SNAPSHOT | KADAVU PROVINCE

Location: Fiji Islands
Population: 10,160
Land Area: 411 km^2
Sea Area: 408 km^2

Protected Areas: 43 *tabu* areas (62.7 km^2)

Management Institution: Kadavu Yaubula Management Support Team

EBM Lead: Institute for Applied Sciences, University of the South Pacific

EBM Partners: Department of Fisheries, Kadavu Provincial Council

CASE STUDY 4 | BABELDAOB ISLAND, PALAU

Figure 3.5 | Babeldaob Island, Republic of Palau

Babeldaob is the largest island in the Republic of Palau (**Figure 3.5**). Its area, 331 km², makes up over 70% of the land area of the country. Unlike most of the islands of Palau, Babeldaob is mountainous, with rivers and streams flowing from forested catchments to the sea.

The recent completion of an 85 km road around Babeldaob is expected to result in a rapid increase in residential and infrastructure development across the island, as people return to Babeldaob from the overcrowded capital, Koror. Land clearing and construction is already contributing to loss of forest cover and degradation of freshwater and coastal marine ecosystems, due to soil erosion, water pollution and sedimentation.

The Palau Conservation Society is leading a collaborative effort to promote improved ecosystem management in Babeldaob through research, communication and advocacy. The Babeldaob EBM initiative has fostered close collaboration between scientists, government and community leaders and other stakeholders.

The EBM partners have undertaken significant biophysical research, including sediment modeling and monitoring, coral surveys, sediment core analyses, fish habitat mapping, water quality testing and forest bioindicator surveys (birds, macroinvertebrates). Research has also been completed in relation to decision-making processes, stakeholders, demographic change and land-use change.

This research has formed the basis of policy recommendations on issues such as land use planning, environmental impact assessment and establishment of terrestrial and marine protected areas. The initiative has acted as a catalyst for the formation of the Babeldaob Watershed Alliance, a platform for collaborative efforts to improve catchment management and environmental protection across the island.

SNAPSHOT | BABELDAOB ISLAND

Location: Republic of Palau
Population: 3,000
Land Area: 331 km^2
Lagoon Area: 500 km^2

Goals: (1) Foster healthy coastal communities and ecosystems on Babeldaob Island. (2) Develop a collaborative process to improve natural resource management for Babeldaob Island.

Management Institutions: State Governments

EBM Lead: Palau Conservation Society

EBM Partners: The Nature Conservancy, Palau International Coral Reef Center, Bureau of Agriculture, Environmental Quality Protection Board

CASE STUDY 5 | BIRD'S HEAD SEASCAPE, INDONESIA

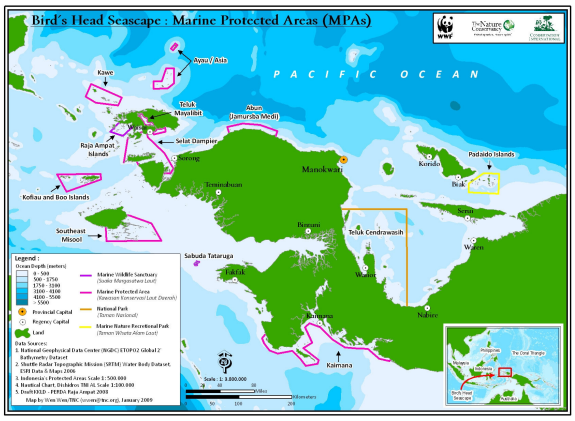


Figure 3.6 | Bird's Head Seascape

The marine and coastal ecosystems of the Bird's Head Seascape (BHS) are among the richest and most diverse on the planet. BHS is located in the north west of Papua Province, Indonesia (**Figure 3.6**) and sits firmly at the epicenter of the 'Coral Triangle', the world's richest concentration of marine biodiversity. Scientific expeditions in BHS have recorded over 1300 species of coral reef fishes and over 600 species of scleractinian corals – the highest coral reef biodiversity ever recorded for an area of this size in the world.

It is also an area rich in natural resources, including fisheries, forestry and minerals. The area's remarkable marine biodiversity and rich natural resources make it both a global priority for marine conservation and a target for resource extraction and development.

Local governments are now facing vital decisions on how to balance sustainable economic development of their rich natural resources with conservation of globally important marine biodiversity. To support this work, The Nature Conservancy (TNC), Conservation International (CI) and WWF have undertaken more than twenty studies encompassing ecological, social, economic and governance issues.

Issues addressed by the research program include: mapping fish spawning aggregations; identifying turtle nesting sites, feeding habitat and migration corridors; marine resource utilisation surveys (including aerial surveys); economic valuation of ecosystem services; analysis of genetic connectivity across the seascape; sea temperature studies to identify reefs resilient to climate change; research into community and stakeholder knowledge, attitudes and practices; and, mapping of traditional tenure systems.

By communicating the findings of their research and engaging actively with local communities and government policy makers, the EBM partners have secured important conservation wins in the seascape. One of the most significant results of the EBM program has been the establishment of a network of 10 legally gazetted marine protected areas, covering more than 9,000 km^2. The MPA network protects marine biodiversity, supports sustainable fisheries and generates income for local communities through visitor entrance fees.

SNAPSHOT | BIRD'S HEAD SEASCAPE

Location:	West Papua Province, Indonesia
Population:	652,000
Land Area:	115,364 km^2
Sea Area:	>180,000 km^2

EBM Goal: To develop an ecosystem-based approach to managing the incredibly rich marine natural resources of the Bird's Head Seascape, and to strike a balance between sustainable economic development and conservation of the area's globally significant marine biodiversity.

Protected Areas: 10 marine reserves (>9,000 km^2), legally gazetted by local governments.

Management Institutions: local governments (Sorong, Sorong Selatan, Raja Ampat, Manokwari, Teluk Wondama, Biak Numfor, Yapen, Supiori, Nabire, Waropen, Teluk, Bintuni, Fakfak, Kaimana).

EBM Lead: The Nature Conservancy (TNC)

EBM Partners: Conservation International (CI), WWF-Indonesia, University of Papua.

IN FOCUS | LOCALLY MANAGED MARINE AREAS

Locally managed marine areas (LMMAs) are one of the great conservation success stories of the Western Pacific. Over the last decade, hundreds of communities in Fiji, Vanuatu, the Solomon Islands, Papua New Guinea, Palau, the Federated States of Micronesia, Indonesia and the Philippines have committed to the sustainable management of near shore marine resources through the establishment, management and monitoring of LMMAs.

WHAT IS A LOCALLY MANAGED MARINE AREA?

A locally managed marine area (LMMA) is 'an area of nearshore waters actively being managed by local communities or resource-owning groups, or being collaboratively managed by resident communities with local government and/or partner organizations'.[19]

In managing their LMMAs, many communities are reviving methods that have been used traditionally as part of their culture for many generations – in particular, periodic fishing closures (known by various names, inluding *tabu* and *ra'ui*).[20] Other communities are using more modern concepts introduced from outside. Many use a combination of both.[21]

It is difficult to reliably assess the benefits of LMMAs based on existing data.[22] However, reported benefits include increased fish populations, reproduction and biomass, improved habitat quality, enhanced local capacity to manage resources, increased environmental stewardship and community cohesion, and increased income from marine resources.[23, 24, 25]

National and regional networking, peer-to-peer learning, and financial and technical assistance by governments, non-government organisations and academic institutions have played a central role in the rapid growth in the number of LMMA sites.

In 2009, a review of the status and potential of LMMAs in the South Pacific described this remarkable proliferation as a 'unique global achievement', and found that 'the extent of this shift towards community-based resource management in Melanesia and Polynesia is unprecedented on a global scale'.[26] However, the review also found that 'marine protected areas alone will be fragile, costly and unlikely to achieve long-term community or national benefits' and recommended an integrated approach to island ecosystems:

'The adaptive management processes central to LMMAs should be built on to include ecosystem-wide (particularly terrestrial) and sustainable development issues and incorporate climate change adaptation and community and ecosystem resilience.'[27]

Ecosystem-based management responds to this challenge, by building on lessons learnt about community-based adaptive management of fisheries resources, and applying them in an integrated, science-based approach to management of terrestrial, freshwater and marine ecosystems. The Kubulau, Macuata and Kadavu field sites presented in this guide are members of the Fiji LMMA Network, and contribute to network learning processes.

19 LMMA Network, <www.lmmanetwork.org>, 30 July 2009.
20 Veitayaki J (1997) Traditional marine resource management practices used in the Pacific Islands: an agenda for change. Ocean & Coastal Management 37:123-136
21 McClanahan TR, Marnane MJ, Cinner JE, Kiene WE (2006) A comparison of marine protected areas and alternate approaches to coral reef management. Current Biology 16: 1408-1413.
22 Seidel H 2009. Evaluating the role of science in Community Based Adaptive Management of coastal resources in Fiji. MSc. Thesis, University of Bremen, Germany. <www.sprep.org/att/irc/ecopies/countries/fiji/88.pdf>, accessed 30 September 2009.
23 Govan H, Tawake A, Tabunakawai K, Jenkins A, et al. (2009) Status and potential of locally-managed marine areas in the South Pacific. SPREP/ WWF/ CRISP/ Worldfish.
24 Alcala AC, Russ GR (2006) No-take marine reserves and reef fisheries management in the Philippines: A new people power revolution. Ambio 35: 245-254.
25 Leisher C, van Beukering P, Scherl LM (2009) Nature's investment bank: How marine protected areas contribute to poverty reduction. TNC, 52 pp.
26 Govan, H. et al. supra n.23.
27 Ibid.

4. EBM PRINCIPLES IN THE WESTERN PACIFIC CONTEXT

Research and management experience from around the world has demonstrated the importance of EBM and has informed the development of core EBM principles.[28]

These principles have been expressed differently in different contexts,[29,30,31] and their implementation must be tailored to each specific site or region. In this guide, we consider the application of the following key EBM principles in the Western Pacific:

1. Adopt an integrated approach to ecosystem management.
2. Maintain healthy, productive and resilient ecosystems.
3. Maintain and restore connectivity between social and ecological systems.
4. Incorporate economic, social and cultural values.
5. Involve stakeholders through participatory governance.
6. Recognise uncertainty and plan for adaptive management.
7. Use all relevant forms of scientific, traditional and local knowledge.

28 Leslie HM, McLeod KL (2007) Confronting the challenges of implementing marine ecosystem-based management. Frontiers in Ecology and the Environment 5: 540-548.
29 McLeod KL, Lubchenco J, Palumbi SR, Rosenberg AA (2005) Scientific Consensus Statement on Marine Ecosystem-Based Management, <www.compassonline.org>, accessed 30 September 2009.
30 Pirot J-Y, Meynell J, Elder D (2000). Ecosystem Management: Lessons from Around the World. A Guide for Development and Conservation Practitioners. <http://data.iucn.org/dbtw-wpd/edocs/2000-051.pdf>, accessed 30 Sept 2009.
31 Preston G (2009) The Ecosystem Approach to Coastal Fisheries and Aquaculture in the Pacific Island Countries and Territories, <http://conserveonline.org/workspaces/pacific.island.countries.publications/Coastal Marine>, accessed 30 Sept 2009.

PRINCIPLE 1 | ADOPT AN INTEGRATED APPROACH TO ECOSYSTEM MANAGEMENT

EBM is an integrated approach that considers interactions between humans and the environment.

Traditional belief systems in the Western Pacific emphasise the strong relationship between people, land and sea. In Fiji, for example, the word *vanua* refers to an area of land and sea, seen as an integrated whole with its inhabitants.[32]

This integrated vision stands in stark contrast with the sectoral approach to resource management adopted by government agencies in both developed and developing countries. In the Pacific, the effectiveness of government interventions in natural resource management issues is often undermined by fragmentation of responsibilities and jurisdiction between government agencies.[33]

EBM overcomes the shortfalls of sectoral management by adopting a comprehensive approach to managing people's impacts on ecosystems within a specific geographic area. EBM seeks to integrate management activities across sectoral boundaries and promote synergies between government agencies, partner organisations and communities.

In Babeldaob (Palau), for example, the importance of cross-sectoral management has been explicitly recognised in the management planning process. The EBM partners work across marine, freshwater and terrestrial ecosystems, and engage actively with government agencies, civil society organisations and the private sector irrespective of sectoral boundaries.

32 Berkes F, Kislalioglu M, Folke C, Gadgil M (1998) Exploring the basic ecological unit: Ecosystem-like concepts in traditional societies, Ecosystems 1: 409–415
33 Wright A, Stacey N, Holland P (2006) The cooperative framework for ocean and coastal management in the Pacific Islands: Effectiveness, constraints and future direction, Ocean and Coastal Management 49: 739-763.

Ecosystem-based management seeks to maintain ecosystem structure, function and key processes to maintain resilience and productivity over time.

Rural communities in the Western Pacific are highly dependent on natural resources for their livelihoods and well-being, making them highly vulnerable to the impacts of ecosystem degradation and natural resource depletion.

EBM recognises the vital role of ecosystems in meeting basic human needs and supporting sustainable livelihoods, and calls for a long-term management approach that makes protecting and restoring ecosystems and all their services the primary focus, above short-term economic or social goals.

Only intact, healthy ecosystems can provide the full range of benefits that humans want and need over long periods of time. The functioning and resilience of ecosystems depends on dynamic relationships within species, among species and between species and their abiotic environment, as well as the physical and chemical interactions within the environment.

For example, in tropical coral reef ecosystems, parrotfish play a crucial functional role by grazing on algae. In the Solomon Islands, establishment of a marine reserve was found to increase the abundance and size of parrotfish within the reserve. The resulting increase in grazing activity reduced macroalgae overgrowth and enhanced coral reef growth, thus enhancing the health and productivity of the reef.[34]

WHAT IS RESILIENCE?

In the context of this guide, the term resilience refers to how well a system, either ecological or social, can maintain its critical functions and processes in response to disturbance. The two main components of resilience are: (1) the ability to resist changing in the face of disturbance; and (2) the ability to quickly recover from it.

The likelihood of an ecosystem shifting to an unfavourable state is increased through human actions which reduce resilience, such as removing entire functional groups or trophic levels, creating increased stress from pollutants, and altering the magnitude and frequency of disturbances.[35]

Photo Credit: Lill Haugen

34 Aswani S, Albert S, Sabetian A, Furusawa T (2007) Customary management as preventive and adaptive management for protecting coral reefs in Oceania. Coral Reefs 26: 1009-1021.

35 Folke C, Carpenter S, Walker B, Sheffer M, et al. (2004) Regime shifts, resilience, and biodiversity in ecosystem management. Annual Review of Ecology, Evolution and Systematics 35: 557-581.

IN FOCUS | UNDERSTANDING AND VALUING ECOSYSTEM SERVICES

People obtain many benefits from natural ecosystems. These benefits are referred to as 'ecosystem services'.[36]

The *Millennium Ecosystem Assessment* sets outs four categories of ecosystem services:

- **Provisioning services** are the products obtained from ecosystems, such as food, fibre, energy, medicines and fresh water.
- **Regulating services** are the regulating benefits obtained from ecosystem processes such as regulation of floods, drought, erosion, pests, disease and natural hazards.
- **Cultural services** are the non-material benefits people obtain from ecosystems through spiritual enrichment, reflection, recreation and aesthetic experience.
- **Supporting services** are ecosystem services that are necessary for the production of all other ecosystem services. Examples include nutrient cycling, water cycling, and provision of habitat.[37]

In the Western Pacific, rural communities are highly dependent on locally harvested fish, crops, livestock and timber. Fresh water is usually obtained from local sources, with the availability of water closely linked to local catchment health. Mangrove and coral reef ecosystems play a vital shoreline protection role, regulating coastal erosion and reducing the impacts of cyclones, storm surges and tsunami. Natural ecosystems are central to traditional belief systems, with links to land and sea playing a vital role in defining cultural identity and social relationships.[38]

Unsustainable use of ecosystems tends to occur when people favor certain kinds of ecosystem production—such as food and fibre production—at the expense of other types of ecosystem services, such as water purification or natural pest control. Poor people, particularly those in rural areas in developing countries, are more directly dependent on ecosystem services and more vulnerable when those services are degraded or lost.[39]

Healthy ecosystems provide benefits to humans that are rarely accounted for in decision-making processes. In 1997, a global valuation of ecosystem services found the following values per hectare, by habitat type: estuaries (US$22,382), swamps/floodplains (US$19,580), seagrass/algae beds (US$19,004), tidal mangroves (US$9,990), coral reefs (US$6,075) and tropical forest (US$2007).[40]

Ecosystem degradation has very real human and financial costs. In 1997-1998, the burning of 10 million hectares of Indonesia's forests affected some 20 million people and led to additional health care costs of US$9.3 billion.[41] In the Cook Islands, a 2006 economic study estimated the cost of watershed pollution on Raratonga at NZ$7.4 million per year, including health care costs from increased illness.[42] The total cost of the 2009 floods in the sugar belt of western Viti Levu, Fiji, has been estimated at F$24 million. Economic analysis found that these costs could have been significantly reduced by improved management of water catchments.[43]

36 Daily GC, Alexander S, Ehrlich PR, Goulder L, et al. (1997) Ecosystem services: Benefits supplied to human societies by natural ecosystems. Issues in Ecology 2:2.
37 Hassan R (2005) Ecosystems and human well-being: current state and trends. Millenium Ecosystem Assessment. <www.millenniumassessment.org>, accessed 1 August 2009.
38 Wong PP, Marone E, Lana P, Fortes M (2005) Island Systems, In: Hassan R (ed) Ecosystems and human well-being: current state and trends. Millenium Ecosystem Assessment. <www.millenniumassessment.org>, accessed 1 August 2009.
39 Prager D, Thompson V (2005) Findings of the Millennium Ecosystem Assessment: How do the poor fare? World Resources 2005, World Resources Institute.
40 Costanza R, d'Arge R, de Groot R, Farber S, et al. (1997) The value of the world's ecosystem services and natural capital. Nature 387: 253-260.
41 Prager D, Thompson V (2005) *supra*. n 38..
42 Hajkowicz S, Okotai P (2006) An economic valuation of watershed pollution in Rarotonga, Cook Islands. IWP Technical Report, SPREP.
43 Lal PN, Rita R, Khatri N (2009) Economic Costs of the 2009 Floods in the Fiji Sugar Belt and Policy Implications. IUCN, Gland, Switzerland, xi + 52 pp.

Ecosystem-based management seeks to maintain and restore connectivity within and between social and ecological systems.

Connectivity is a fundamental feature of natural ecosystems and human societies. If part of an ecosystem is disturbed it can directly or indirectly affect many other aspects of the ecosystem. These linkages between ecosystem components, such as food web structure, predator-prey relationships, habitat associations, and other biotic and abiotic interactions, should be incorporated into management decisions.

There are many types of social and ecological connectivity, varying over spatial scales ranging across habitats, catchments, islands, national borders and regional areas.

Types of connectivity that are particularly significant in the Western Pacific include:

- **abiotic connectivity:** e.g. flows of water and sediment from coastal catchments into coastal marine areas.
- **biotic connectivity:** e.g. dispersal of fish and coral larvae; adult and juvenile migration; spillover of fish from marine protected areas into fishing grounds.
- **socioeconomic connectivity:** e.g. kinship and cultural ties; resource sharing arrangements; overlapping resource claims; and, trade relationships.[44]

Connectivity between ecosystems makes each biome susceptible to degradation from factors arising in adjacent areas. For example, the health and resilience of coral reef ecosystems may be affected by clearing, burning and development in coastal catchments. Raising awareness of connectivity between land and sea is a central element of the EBM initiatives described in this guide.

Because many organisms move between habitats during different phases of their life cycle, protection of their migratory pathways is essential to maintain health populations. In Fiji, >98% of fish species found in freshwater make contact with salt water during their lives. This high degree of connectivity is currently being disrupted by sedimentation from catchment land clearing and non-native fishes, and there is a strong need for communities to take restorative action.[45]

Understanding patterns of connectivity in marine ecosystems is critical to the effective design of marine reserve networks. In the Bird's Head Seascape (Indonesia), an extensive genetic analysis of marine larvae (including coral, clams, fish and crustaceans) demonstrated a high degree of biotic connectivity between reef ecosystems, illustrating the need for an integrated approach to management of coral reef ecosystems and fisheries in the area.

In the Western Pacific, effective EBM often requires an understanding of social and cultural connectivity. Kinship ties, historical relationships and cultural obligations play an important role in decisions about use and management of natural resources in the region, and may present opportunities for integrated management of ecosystems.

In Macuata (Fiji), for example, kinship ties and cultural obligations prompted chiefs from upland villages to commit to catchment protection and restoration measures for the benefit of the coastal villages of the province.

Photo Credit: Aaron Jenkins

44 Report on the 2009 Pacific Ecosystem-Based Management (EBM) Workshop, 10-11 August 2009, Suva, Fiji.

45 Jenkins AP, Jupiter SD, Qauqau I, Atherton J (2009) The importance of ecosystem-based management for conserving aquatic migratory pathways on tropical high islands: A case study from Fiji. Aquatic Conservation: Marine and Freshwater Ecosystems. doi: 10.1002/aqc.1086.

IN FOCUS | RIDGE-TO-REEF MANAGEMENT

Historically, terrestrial, freshwater and marine ecosystems have been studied separately because they have very different physical conditions, productivities and food webs. However, these systems are all open to dispersing individuals and movement of materials and energy, all of which are influenced to varying degrees by disturbance, and may be strongly linked through space and time.[46]

These linkages are particularly tight between coastal water catchments and their adjacent marine systems. Forest cover, particularly along riparian corridors, is critically important as habitat for wildlife and sources of organic detritus for downstream secondary production.[47-48] Riparian vegetation additionally provides downstream water quality benefits through bank stabilization, sediment trapping and nutrient cycling.[49]

Secondary production from riparian forests forms the base of downstream food webs for invertebrates and fishes. In tropical, high islands of the Pacific, many of these organisms are diadromous, meaning that they move across several habitats during their life cycle to reproduce or forage.[50] The habitat range of some species includes the headwaters of streams to the open ocean. This considerable level of migration increases the probability of encountering degraded environmental conditions,[51] therefore protection of these species (and the hydrological linkages between ecosystems) requires integrated ecosystem management.

There are several classes of disturbance which can disrupt ridge-to-reef hydrological connectivity, of which the most critical are: dams and water diversions; introduced species; and downstream consequences of land clearing, discussed in detail below. Many freshwater, estuarine and marine organisms are particularly vulnerable to the effects of sedimentation and associated pollutants in river runoff. Terrestrial sediment in streams can smother food and nesting areas, while increased turbidity makes it more difficult for visual predators to locate prey.[52] Excessive downstream sedimentation can cover mangrove breathing roots, causing tree death,[53] while sediment may kill seagrass directly by burial or indirectly by reducing light availability.[54-55] In the presence of highly elevated nutrient concentrations, sediment particles will aggregate into marine snow and settle on small, benthic coral reef organisms such as coral recruits, which are highly susceptible to smothering and consequent death. Concentrated and persistent exposure to these sticky aggregates can prevent coral recovery following disturbance and may lead to phase shifts from coral to algal dominance on a reef.[56]

46 Jupiter SD (2006) From cane to coral reefs: ecosystem connectivity and downstream responses to land use intensification. PhD thesis. University of California, Santa Cruz, 300 pp.
47 Catteral CP (1993) The importance of riparian zones to terrestrial wildlife. In: Bunn SE, Pusey BJ, Price P (eds) Ecology and management of riparian zones in Australia. Land and Water Resources Research and Development Corporation Occasional Paper Series No: 05/93, Canberra, Australia, pp. 41-52.
48 Caraco NF, Cole J (2004) When terrestrial organic matter is sent down the river: the importance of allochthonous carbon inputs to the metabolism of lakes and rivers. In: Polis GA, Power ME, Huxel GR (eds) Food webs at the landscape level. The University of Chicago Press: Chicago, pp. 301-316.
49 McKergow LA, Weaver DM, Prosser IP, Grayson RB, et al. (2003) Before and after riparian management: sediment and nutrient exports from a small agricultural catchment, Western Australia. Journal of Hydrology 270: 253-272.
50 McDowall RM (2007) On amphidromy, a distinct form of diadromy in aquatic organisms. Fish and Fisheries 8: 1-13.
51 Eikaas HS, McIntosh AR (2006) Habitat loss through disruption of constrained dispersal networks. Ecological Applications 16: 987-998.
52 Jenkins AP, Jupiter SD, Qauqau I, Atherton J (2009) The importance of ecosystem-based management for conserving aquatic migratory pathways on tropical high islands: A case study from Fiji. Aquatic Conservation: Marine and Freshwater Ecosystems. doi: 10.1002/aqc.1086.
53 Ellison JC (1998) Impacts of sediment burial on mangroves. Marine Pollution Bulletin 37: 420-426.
54 Duarte CM, Terrados J, Agawin NSW, Fortes MD, et al. (1997) Response of a mixed Philippine seagrass meadow to experimental burial. Marine Ecology Progress Series 147: 285-294.
55 Terrados J, Duarte CM, Fortes MD, Borum J, et al. (1998) Changes in community structure and biomass of seagrass communities along gradients of siltation in SE Asia. Estuarine, Coastal and Shelf Science 46: 757-768.
56 Fabricius KE (2005) Effects of terrestrial runoff on the ecology of corals and coral reefs: review and synthesis. Marine Pollution Bulletin 50: 125-146.

Due to land clearing for agriculture and development, soil loss rates are at least 10 times greater than rates of soil formation.[57] Coupled with these increases in land clearing and erosion, global fertilizer consumption has increased by over 700% in the past 40 years, and agricultural activities are now the largest sources of excess nutrients to the coastal zone.[58-59] In recognition of the considerable issues associated with land modification in coastal watersheds, many management agencies have tried to initiate integrated catchment management (ICM), with varying success due to the overlap of jurisdictions.

For example, in Australia, water quality is one major focus of the Great Barrier Reef Marine Park Authority (GBRMPA), whose mandate is to: "provide for the long-term protection, ecologically sustainable use, understanding and enjoyment of the Great Barrier Reef through the care and development of the Great Barrier Reef Marine Park."[60] However, the *Great Barrier Reef Marine Park Act 1975*, which created the agency to protect the reef, did not give GBRMPA authority to control land-based activities in the catchments draining into the GBR Lagoon. Management of catchment activities is primarily overseen through the Queensland Environmental Protection Agency and the Queensland Department of Natural Resources and Water, with voluntary community participation in ICM groups.

In Palau, poorly regulated development has resulted in clearing of forest ecosystems, heavy soil erosion and increased sediment loads in rivers and streams. Downstream sedimentation of reefs and seagrass beds has reduced the abundance of fish and *beche-de-mer*, with significant livelihood implications for local communities. The Palau Conservation Society is working with partners to promote sustainable land use planning and reduce downstream impacts of development on freshwater and marine habitats (**Figure 3.7**).

Given Pacific island traditions of community-based management of natural resources, ICM is likely to be more successful where the boundaries of traditional hierarchies have included ridge-to-reef units (i.e. the Fijian *vanua*, the Solomons Islands *puava*, the Yap *tabinau*, the Hawaiian *ahupua'a*).[61-62] In Pacific countries with strong legal recognition of traditional resource tenure, these decision-making bodies may reduce governance complexities, thus facilitating management across boundaries that are both ecologically and socially relevant.[63]

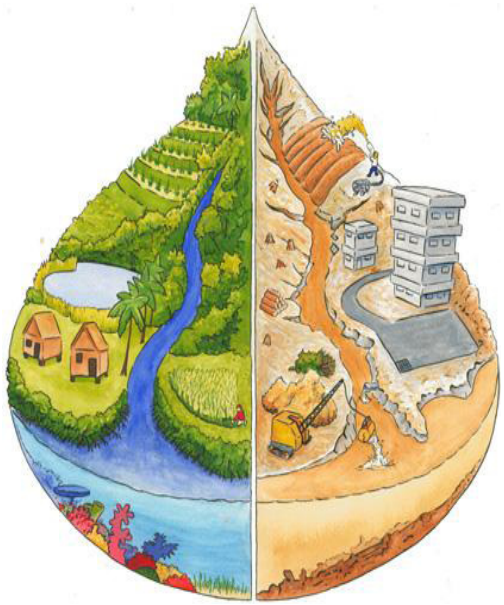


Figure 3.7. Illustration of catchment degradation used by Palau Conservation Society to raise awareness of the importance of ridge-to-reef management.

57 Pimentel D, Allen J, Beers A, Guinand L, et al. (1993) Soil erosion and agricultural productivity. In Pimentel D (ed) World Soil Erosion and Conservation. Cambridge University Press: Cambridge, pp. 277-292.
58 Matson PA, Parton WJ, Power AG, Swift MJ (1997) Agricultural intensification and ecosystem properties. Science 277: 504-509.
59 Bennett EM, Carpenter SR, Caraco NF (2001) Human impact on erodible phosphorus and eutrophication: a global perspective. BioScience 51: 227-234.
60 GBRMPA (2004) Corporate Plan 2004-2009. Great Barrier Reef Marine Park Authority: Townsville. < http://www.gbrmpa.gov.au/__data/assets/pdf_file/0017/1673/gbrmpa_corporate_plan.pdf> accessed 29 October 2009.
61 Ruddle KE, Hviding E, Johannes RE (1992) Marine resource management in the context of customary tenure. Marine Resource Economics 7: 249-273.
62 Berkes F, Colding J, Folke C (2000) Rediscovery of traditional ecological knowledge as adaptive management. Ecological Applications 10: 1251-1262.
63 C Dahl and W Raynor (1996) Watershed Planning and Management: Pohnpei, Federated States of Micronesia. Asia Pacific Viewpoint 37: 235.

Ecosystem-based management incorporates human use and values of ecosystems in management planning and implementation.

Natural resources are fundamental to the livelihoods, lifestyle and culture of local communities in the Western Pacific. In most countries in the region, fish and agricultural crops form the mainstay of local subsistence economies and international exports.

High levels of natural resource dependence in the region demand an approach to EBM that recognises the economic, social and cultural importance of continued resource use, while working to ensure that the use of those resources is sustainable over time.

Protected area networks that are designed for optimal conservation outcomes may result in significant immediate costs to communities, and may be unrealistic or inequitable due to their impact on local livelihoods. Conversely, protected area networks based purely on social or economic considerations may not achieve necessary resource management or conservation outcomes.[64]

It is therefore necessary to identify efficient, equitable and effective management measures that strike a balance between short-term costs and the long-term benefits of maintaining and restoring ecosystem services. These long-term benefits can be measured against the costs of inaction: for example, failure to introduce measures to ensure sustainable exploitation of fisheries stocks can lead to collapse of those stocks.[65]

Socioeconomic surveys are a useful tool for measuring the value and cultural significance of natural resources, understanding local socioeconomic conditions, and identifying the positive and negative impacts of potential management measures. For marine reserves, survey data about where people fish, how much it costs to travel there, what they are catching and how much they sell (at what price) can be used to estimate opportunity costs of different protected area options.

Modelling tools can be used to design protected area networks that minimise hardship to fishers by closing off areas that have optimal fisheries benefits with minimal loss of potential income. The network of marine protected areas in Kubulau (Fiji) was explicitly designed to reduce costs to local communities by locating large reserves offshore, and maintaining access to productive, resilient fishing areas closer to shore.

For poor rural communities, economic costs and benefits will play a key role in decisions about the use and management of natural resources. In the case of marine protected areas, improved fisheries productivity can provide a powerful incentive for the adoption of management measures. By contrast, the benefits of forest conservation tend to be intangible, diffuse and long-term, and are often outweighed by the financial benefits of logging or clearing for agriculture.[66]

To secure community support for ecosystem management measures, practitioners need to clearly identify and communicate the costs and benefits of conservation, and establish mechanisms to ensure that benefits flow to local communities (eg. lease payments, tourism user fees, trust funds, payments for ecosystem services, carbon offsets).[67]

64 Report on the 2009 Pacific Ecosystem-Based Management (EBM) Workshop, 10-11 August 2009, Suva, Fiji.
65 OECD (2008) Costs of Inaction on Key Environmental Challenges. OECD. Paris, France. 213 pp.
66 Wells M (1992) Biodiversity Conservation, Affluence and Poverty: Mismatched Costs and Benefits and Efforts to Remedy Them. Ambio 21(3): 237-243.
67 Lal P (2005) Information, institutions and conflict management in the natural resource sector. Peace Building and Conflict Prevention Workshop, Nadi, Fiji, 25-27 April 2005.

Ecosystem-based management involves engaging stakeholders in participatory management planning processes to find common solutions.

Effectively managing human impacts on ecosystems is a complex process, with many interactions, side-effects and implications. It is important to involve the full range of relevant expertise and stakeholders to promote the sharing of management responsibility between decision-makers and external parties with a interest in the success of natural resource management.[68] Depending on the situation, the decision-makers may be community members empowered with traditional authority (e.g. village chiefs) or government officers in charge of regulation of natural resources under national legal frameworks.

Involving a wide range of stakeholders in management planning processes:

- helps to ensure that the concerns and priorities of those stakeholders are taken into account in management decisions;
- improves the quality of decision-making, by increasing the range of information and perspectives considered; and
- increases awareness, understanding, acceptance and ownership of decisions, with associated benefits for monitoring, compliance and implementation.

Participatory governance processes provide a platform for collaborative decision-making, and enhance transparency and accountability. For instance, the regular meeting of a core group of EBM stakeholders in Palau improved interactions among NGOs and a variety of government agencies.

Bringing stakeholders together also helps to identify conflicts and synergies between their respective roles and activities. In Macuata (Fiji), for example, participation by inland and coastal villagers in management planning has raised awareness of the water quality impacts of logging and burning in the coastal catchment.

Participatory planning processes help to ensure that management measures effectively integrate economic, social and cultural considerations. Direct involvement of local communities in management planning ensures that local knowledge, needs and priorities are incorporated in management decisions in ways that increase community ownership of the management process.[69]

Management planning processes that respect and reinforce the roles of traditional leaders, while providing opportunities for broad community engagement, strengthen long-term prospects for community-based resource governance. Perceptions of inequity, exclusion from decision-making processes or failure to respect traditional resource rights may result in challenges to management institutions. It is important to factor these considerations into management planning processes, and to ensure that costs and benefits are distributed fairly and equitably.[70]

Photo Credit: Kathy Howard

68 Pressey RL, Bottrill MC (2009) Approaches to landscape- and seascape-scale conservation planning: convergence, contrasts and challenges. Oryx 43: 464-475.

69 Drew J (2005) Use of traditional ecological knowledge in marine conservation. Conservation Biology 19: 1286-1293.

70 Information, institutions and conflict management in the natural resource sector. Peace Building and Conflict Prevention Workshop, Nadi, Fiji, 25-27 April 2005.

Ecosystem-based management recognises uncertainty and involves planning to adapt management measures over time, based on continual learning and monitoring.[71,72]

Ecosystem processes and functions are complex and variable. Their level of uncertainty is increased by interaction with human activities. Therefore, ecosystem management must involve a learning process, which helps to adapt methodologies and practices to the ways in which these systems are being managed and monitored.

Adaptive management seeks to improve the effectiveness of management measures over time by monitoring management outcomes, and modifying management measures as new scientific and socioeconomic information becomes available. Adaptive management requires carefully designed monitoring programs, flexible management rules and responsive management institutions.[73]

In the Western Pacific, limited availability of data and the complexity of key ecosystems (especially multispecies coral reef fisheries) require an iterative and adaptive approach to ecosystem management. However, limited financial, human and technical resources in the region makes sophisticated large-scale adaptive management largely unrealistic.

Fortunately, community level adaptation processes present opportunities for a long-term adaptive management approach. Customary management practices are typically dynamic and adaptively evolving to reflect changes in social, political, economic, and cultural conditions.[74]

An adaptive management approach requires flexible decision-making structures that allow for timely management responses to new information about ecosystem conditions, resource use or other factors. In the Solomon Islands, for example, the use of a flexible community-based management planning process for Nusa Hope MPA allowed resource owners to extend the reserve boundaries as information became available about grouper spawning patterns.[75]

Community-based adaptive management that combines scientific survey methods, traditional and local knowledge and responsive decision-making processes provides a strong foundation for improving the management of ecosystems over time and responding to new challenges, including climate change impacts. Changes in ecosystem boundaries and dynamics associated with climate change will demand a flexible and responsive approach to ecosystem management in coming decades.

Photo Credit: Stacy Jupiter

71 Kaufman L, Heneman B, Barnes JT, Fujita R (2004) Transition from low to high data richness: An experiment in ecosystem-based fishery management from Calfornia. Bulletin of Marine Science 74: 693-708.
72 Ruckleshaus M, Klinger T, Knowlton N, DeMaster DP (2008) Marine ecosystem-based management in practice: scientific and governance challenges. BioScience 58: 53-63.
73 Margoluis R, Salafsky N (1998) Measures of success: designing, managing, and monitoring conservation and development projects. Island Press: Washington DC.
74 Cinner J, Aswani, S (2007) Integrating customary management into marine conservation. Biological Conservation 140: 201-216.
75 Aswani S, Albert S, Sabetian A, Furusawa T (2007) Customary management as preventive and adaptive management for protecting coral reefs in Oceania. Coral Reefs 26: 1009-1021.

IN FOCUS | ECOSYSTEM-BASED ADAPTATION TO CLIMATE CHANGE

There is growing recognition of the role that well-managed ecosystems can play in supporting adaptation – through increasing resilience and decreasing vulnerability of people and their livelihoods to the impacts of climate change. Well-managed ecosystems have a greater potential to adapt to climate change, resist and recover more easily from extreme weather events, and provide a wide range of benefits on which people depend. In contrast, poorly managed, fragmented and degraded ecosystems can increase the vulnerability of people and nature to the impacts of climate change.

Policy Briefing: Ecosystem-based Adaptation (2009)
International Union for Conservation of Nature

CLIMATE CHANGE IMPACTS

Island communities are highly vulnerable to the predicted effects of climate change, including sea level rise, coastal erosion, cyclones, floods, droughts, salinisation of water and soils and coral bleaching.

The island ecosystems of the Western Pacific, and the services they provide, will be sensitive to the rate and magnitude of climate change, especially where those ecosystems have been degraded by human activities. For example, coral reef ecosystems which sustain island fisheries are very likely to be affected by increasing sea surface temperatures, cyclone damage and decreases in coral growth rates due to the effects of higher carbon dioxide concentrations on ocean chemistry.[76]

The social and economic impacts of climate change are likely to be severe in the region, with particularly serious impacts on rural communities with a high level of dependence on coral reef fisheries, small scale agriculture and nature-based tourism.[77]

[76] Hoegh-Guldberg O, Mumby PJ, Hooten AJ, Steneck RS, et al. (2007) Coral reefs under rapid climate change and ocean acidification. Science 318: 1737-1742.
77 Fourth Assessment Report of the Intergovernmental Panel on Climate Change (2007), Cambridge University Press.

ECOSYSTEM-BASED ADAPTATION

Climate change directly threatens the services that ecosystems provide including food, clean water, coastal protection and soil stability. Communities which depend directly on natural resources are threatened most severely, and are most likely to lack the resources for costly adaptation measures.

Ecosystem-based adaptation provides a cost effective strategy for reducing vulnerability to climate change impacts and increasing resilience, while maintaining ecosystem services and sustainable livelihoods in the face of climate change.

By maintaining and restoring 'natural infrastructure' such as mangroves, coral reefs and watershed vegetation, ecosystem-based adaptation may reduce vulnerability to extreme weather events, storm surge, rising sea levels and changing precipitation patterns.[78] Three examples include:

1. Following a large cyclone in Orissa, India, researchers found that villages with wider coastal mangrove buffers experienced significantly fewer deaths than villages with narrower or no mangroves.[79]

2. In Samoa, mangroves are being planted as part of a larger restoration project to enhance food security and protect local communities from storm surges, which are expected to increase as a result of climate change.[80]

3. In Kimbe Bay, Papua New Guinea, coral reef resilience principles were applied to design a network of marine protected areas to help ecosystems withstand the

78 IUCN (2008) Ecosystem-based adaptation: An approach for building resilience and reducing risk for local communities and ecosystems. IUCN: Gland, Switzerland.
79 Das S, Vincent JR (2009) Mangroves protected villages and reduced death toll during Indian super cyclone, Proceedings of the National Academy of Sciences 106: 7357-7360
80 Hale L, Meliane I, Davidson S, Sandwith T, et al. (2009) Ecosystem-based adaptation in marine and coastal ecosystems, Renewable Resources Journal 25: 21-28.

impacts of a warming ocean and continue to provide food and other resources to local communities.[81]

The role of forest ecosystems in capturing and storing carbon is well known. Interestingly, well-managed tidal salt marshes, mangroves, seagrass meadows, kelp forests and coral reefs have the potential to perform a carbon storage role that compares favourably with and, in some respects, may exceed the potential of carbon sinks on land.[82]

COMMUNITY-BASED ADAPTATION

Ecosystem-based adaptation and community-based natural resource management are mutually supportive. Strong traditions of local governance, communal resource tenure and traditional and local ecological knowledge present fertile conditions for community-based adaptation in the Western Pacific.

A participatory approach, centred on local communities, has been identified as the best way to assess climate change vulnerability and plan adaptation measures in the Pacific. Recommended steps for vulnerability assessment and adaptation planning include:

- conduct research to identify potential climate change impacts;
- document the historical capacity of the community to respond to changes in climatic conditions;
- document the current exposure and current capacity of the community to cope with climate change;
- engage local stakeholders at each stage of the process;
- implement adaptation measures at the community level; and
- undertake ongoing monitoring, assessment and action.[83]

Community-based learning networks, coordinated at a national and regional level, present opportunities to support community-based adaptation by sharing knowledge, experience and resources and identifying and addressing issues of common concern.

ECOSYSTEM-BASED ADAPTATION AT THE COMMUNITY LEVEL

Examples of ecosystem-based adaption measures that can be implemented at the community level include:

- **Managing fishing pressure to maintain or improve coral reef resilience.** Reducing fishing pressure on herbivorous fish species reduces the likelihood of algal growth following coral bleaching events, maintaining biodiversity and fisheries productivity.[84]
- **Protecting and restoring mangroves.** By prohibiting mangrove clearing and replanting degraded mangrove areas, local communities can reduce their vulnerability to coastal erosion, cyclones and storm surges, while maintaining or improving populations of mangrove dependent fish stocks.[85]
- **Protecting and restoring water catchment areas.** By protecting water catchment areas and replanting native vegetation, local communities can reduce the risk of water shortages, floods and landslides, and reduce sedimentation impacts on coastal marine ecosystems.[86]

81 Green A, Lokani P, Sheppard S, Almany J, etal. (2008) Scientific design of a resilient network of marine protected areas. Kimbe Bay, PNG: The Nature Conservancy. Pacific Island Countries Report No 2/07, 60 pp.
82 Lafoley D, Grimsditch G (2009) The management of natural coastal carbon sinks. IUCN, Gland, Switzerland. 53 pp.
83 SPREP (2006) Community-level adaptation to climate change: action in the Pacific, Apia, Samoa. <www.sprep.org/att/publication/ 000431_CBDAMPIC.pdf>, 30 Sept 2009.
84 Obura D, Grimsditch G (2009) Resilience Assessment of coral reefs: Assessment protocol for coral reefs, focusing on coral bleaching and thermal stress. IUCN working group on Climate Change and Coral Reefs. IUCN, Gland, Switzerland, 70 pp.
85 McLeod E, Salm, RV (2006) Managing Mangroves for Resilience to Climate Change. IUCN. <http://data.iucn.org/dbtw-wpd/edocs/2006-041.pdf>, accessed 30 September 2009.
86 IISD, IUCN and SEI (2003) Livelihoods and Climate Change: Combining disaster risk reduction, natural resource management and climate change adaptation in a new approach to the reduction of vulnerability and poverty, <www.iisd.org/pdf/2003/natres_livelihoods_cc.pdf>, accessed 30 September 2009.

Ecosystem-based management requires all forms of relevant information, including scientific, traditional and local knowledge.

Ecosystems are complex. Understanding human impacts on ecosystems and designing effective management responses is a challenging task, best undertaken with the benefit of the full range of relevant information. Information from all sources is critical for the development of effective management strategies.[87]

The Western Pacific is endowed with a rich heritage of local knowledge and traditional resource management practices, informed by generations of intimate association with terrestrial, freshwater, coastal and marine ecosystems. [88] Local knowledge about wild plants and animals, hunting, fishing, agriculture, weather and changes in the environment over time is enormously valuable for EBM (**Table 4.1**).[89]

EBM presents opportunities for integrating local knowledge with the enormous and growing body of scientific knowledge about ecosystem functions and processes. Scientific principles and research methods are powerful tools for generating new information about local ecosystems, and testing the effectiveness of management interventions.

By sharing research findings from the field, practitioners contribute to the development of management principles and 'rules of thumb' for improving the impact and cost effectiveness of management interventions.

Table 4.1. Examples of traditional and local knowledge relevant to ecosystem-based management.[90]

TYPES OF TRADITIONAL AND LOCAL KNOWLEDGE RELEVANT TO ECOSYSTEM-BASED MANAGEMENT
FISHING: fishing methods and materials; knowledge of fish species and their behaviour, migration and reproduction; best fishing locations, times and techniques for each species; controls on fishing: restricted areas or seasons, catch restrictions; changes in status of fisheries over time, including effects of overfishing.
HUNTING: behaviour of species; hunting or trapping methods; controls on hunting: restricted areas or seasons, protected species; changes in animal populations over time.
PLANTS: useful trees and the qualities and uses of their wood; edible plants and plant parts (nuts, leaves, bark, roots, etc); medicinal plants and their uses; changes in forest cover over time.
AGRICULTURE: crop varieties (including those with salt-resistance) and best places for their utilisation; conditions and times for planting, cultivation and harvesting; control of crop diseases, insects and pests; management of agricultural land; control of erosion and wind damage; water management and irrigation; controls on land use and access to land.
GENERAL: traditional names and classifications of species; calendars related to weather, solar and lunar cycles and natural events; weather patterns and prediction, cycles of rain and drought; changes in climate over time; natural disasters: signs and warnings, historical impacts; environmental and land use changes over time.

87 Convention on Biological Diversity. Ecosystem Approach: Principles. <www.cbd.int/ecosystem/principles.shtml>.
88 Johannes RE (1978) Traditional marine conservation methods in Oceania and their demise. Annual Review of Ecology and Systematics 9:349–364.
89 Berkes F, Colding J, Folke C (2000) Rediscovery of traditional ecological knowledge as adaptive management. Ecological Applications. 10: 1251-1262.

[90] Millenium Ecosystem Assessment (2005) Synthesis Report. Island Press, Washington DC.

5. ECOSYSTEM-BASED MANAGEMENT IN PRACTICE

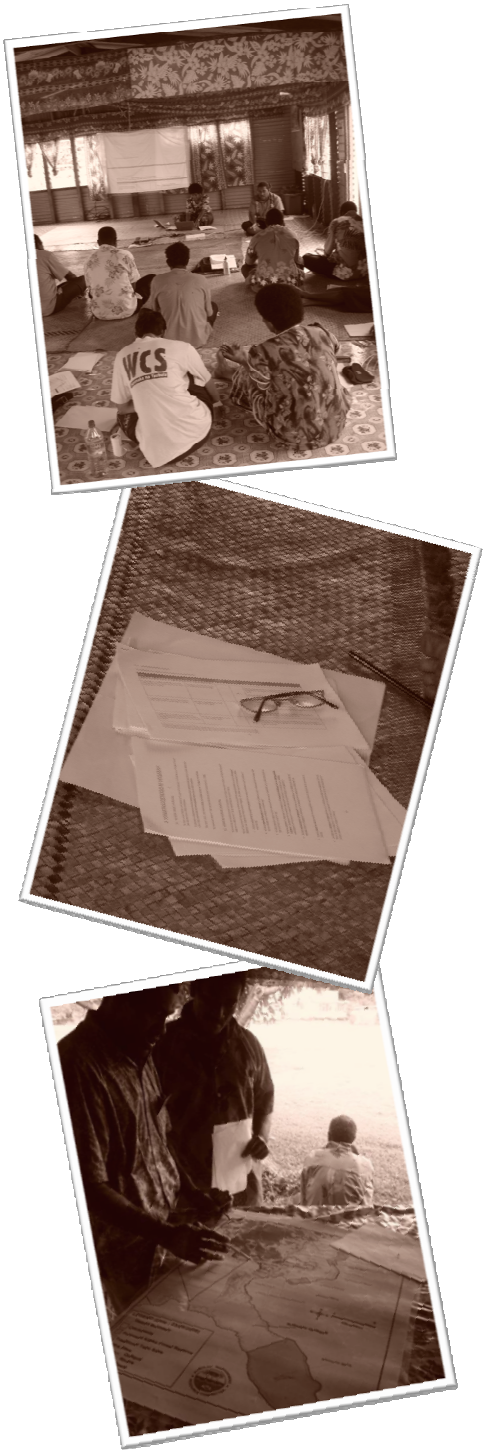
EBM is an approach that can be applied at a range of scales and contexts, from site-based projects to national policies and programmes.

This chapter examines the application of EBM principles to site-based conservation practice in the Western Pacific. The following chapter considers opportunities for integrating EBM principles in national policies and programs.

Drawing on examples from field sites in the region, the chapter outlines the following key steps in the management planning process:

1. Identify and involve stakeholders.
2. Identify ecosystem values.
3. Understand management context.
4. Identify key management institutions.
5. Identify goals, targets and threats.
6. Establish management strategies.
7. Implement management actions
8. Formulate education and communication programs.
9. Set priorities for monitoring and research.
10. Define review and adaptation processes.

These stages need not be followed rigidly, or in order. By its very nature, community-driven ecosystem-based management tends to be 'evolutionary, rather than revolutionary',[91] working incrementally through existing political and economic realities, and building on existing institutions and management measures: 'in the real world, we rarely have the luxury of working on a blank canvass'.[92]



91 Grieve C, Short K (2007) Implementation of ecosystem-based management in marine capture fisheries: Case studies. <http://assets.panda.org/downloads/wwf_ebm_toolkit_2007.pdf>, accessed 1 August 2009.
92 Ibid.

STEP 1 | IDENTIFY AND INVOLVE STAKEHOLDERS AND PARTNERS

IDENTIFYING THE STAKEHOLDER COMMUNITY

EBM seeks to address the full range of activities affecting the health of an ecosytem. Consequently, effective EBM requires identification of the full range of stakeholders, and strategic decisions about engaging stakeholders in the process of change.

To identify the stakeholder community, it is useful to consider the nature and scope of the management process, and to identify those individuals, groups or organisations with:

1. rights, interests or needs that may be affected by the management process – *e.g. local communities, resource owners, fishermen and women, fish traders, logging operators, farmers, tourism operators, developers.*

2. influence, authority or power relevant to the management process – *e.g. traditional chiefs, elected officials, local, provincial and national government*.

3. expertise or resources relevant to the management exercise – *e.g. government agencies, universities, non-governmental organisations, donors*.[93]

Cultural protocols may limit decision-making authority to particular individuals or groups (e.g. chiefs, resource owners). Similarly, certain legal powers may only be exercised by individuals authorised by law (e.g. ministers, government officers). Consultation processes should be designed in collaboration with relevant decision-makers to ensure that continuity is maintained between consultation processes and management decisions.

INVOLVING STAKEHOLDERS

Stakeholders may be involved in management processes to varying degrees, ranging from:

- notification of management decisions;
- participation in periodic consultation;
- providing input on a regular basis;
- being directly involved in decision-making.

As a general rule, consultation processes should be broad, inclusive and participatory. Decision-making and advisory bodies may need to be smaller for practical reasons, but should, wherever possible, include a range of stakeholder groups and interests.

Logistical and financial constraints may prevent some stakeholders from participating in management processes on a regular basis. Traditional hierarchies may discourage active participation by certain stakeholders, particularly women and youth. It may be necessary to adopt special measures to facilitate active and effective participation by stakeholders who may otherwise be excluded from management processes (for example, financial support, focus group consultations and inclusive facilitation techniques).

It is also important to engage actively with resource users, including the private sector (fishing, forestry, agriculture, mining, tourism) and tribal or ethnic groups that do not have legal or traditional resource tenure.[94] In Kubulau (Fiji), engagement with dive operators in the private sector has been a key success factor for marine conservation: users of Namena Marine Reserve pay a small fee to the communities that is used for management activities and local scholarships. In many cases, successful engagement requires visiting with stakeholders (including communities) in their own offices or places of residence.

93 Meffe GK, Nielsen LA, Knight RL, Schenborn DA (2002) Ecosystem Management: Adaptive, Community-Based Conservation. Island Press: Washington DC.

94 Cinner JE (2009) Migration and coastal resource use in Papua New Guinea. Ocean & Coastal Management. 52 (8): 411-416.

BUILDING PARTNERSHIPS

EBM seeks to integrate management activities across sectoral boundaries by promoting partnerships between government agencies, civil society organisations and communities. Stakeholders become partners when they are engaged directly in management activities, with clearly defined roles and responsibilities.

Collaborative partnerships greatly enhance management effectiveness, by bringing together individuals and organisations with diverse expertise, roles and resources. The establishment of partnerships promotes coordination and integration of management activities, improves efficiency and promotes shared solutions to ecological challenges.

In each of the field sites presented in this guide, EBM practitioners have established partnerships between NGOs, government agencies and local communities. These EBM partnerships have provided a flexible platform for collaboration and information exchange. EBM coordinators have been appointed to facilitate collaborative research and management activities, with implementation roles and responsibilities assigned to EBM partners based on their respective capacities.

Conservation practitioners in the tropical Western Pacific have observed that EBM practitioners need to be more engaged with government, including agencies responsible for environment, fisheries, forestry, tourism, agriculture, health, education, public works, culture and heritage, national planning and finance. In many cases, EBM is not a core priority for these agencies, so it may be necessary to identify elements of EBM that are relevant to their strategic priorities and to engage in existing policy processes.

Engagement with regional and international intergovernment organisations, such as the Secretariat of the Pacific Community (SPC), can provide access to expertise and resources, and provides opportunities for integrating lessons learnt in the field into national, regional and international programs.

EXAMPLE | BABELDAOB WATERSHED ALLIANCE

The Babeldaob Watershed Alliance (BWA) is an alliance of seven states on the island of Babeldaob in the Republic of Palau. Formed in 2006, the mission of the alliance is 'to protect, conserve and restore the water resources of Babeldaob through collaborative outreach, education, networking, science information sharing and technical assistance by and for the communities of the island'.

The BWA has become a national model for promoting sustainable water management through the collaborative efforts of a diverse array of stakeholders. Its Steering Committee is made up of representatives of each state, and is supported by a technical committee, which includes the Palau International Coral Reef Center, Belau National Museum, Bureau of Agriculture, and Environmental Quality Protection Board. The Palau Conservation Society and The Nature Conservancy have played an active role in the establishment and development of the alliance, including providing technical and financial support.

The BWA member states have all signed a non-binding agreement that sets out their respective roles and responsibilities, and affirms their shared commitment to protection of Babeldaob's water resources.

IN FOCUS | INITIATING ECOSYSTEM-BASED MANAGEMENT

In the tropical Western Pacific, community-based management has emerged as the most widely accepted approach to natural resource management and biodiversity conservation, recognising that customary resource tenure, local resource management and limited government capacity are common features of most countries in the region.[95]

In practice, site-based conservation in the region tends to reflect a hybrid approach, in which active community involvement and control is combined with varying degrees of external support and influence.

Conservation activities may be initiated in a variety of ways, and by a variety of actors. In particular, management processes may be initiated:

- by *local communities*, in response to new information or changes in local resource availability or environmental conditions;
- by *non-government organisations*, based on organisational objectives and national or international conservation priorities;
- by *government agencies*, consistent with national conservation, natural resource management or development priorities.

Locally managed marine areas, for example, are often initiated by local communities who have learnt about the livelihood benefits of managing coastal fisheries, usually from other communities who have already implemented management measures. If a community decides to manage their local marine area, they can then request assistance from LMMA partner organisations, including NGOs, universities and government agencies.[96]

Ecosystem-based management processes unfold differently in different circumstances, and the scope of the management process may evolve over time. Over the last ten years, the focus of management activities in Kubulau (Fiji) has widened from Namena Marine Reserve to the entire fishing ground, and later to coastal, freshwater and terrestrial ecosystems.

Opinions vary about the merits of 'top down' and 'bottom up' approaches to conservation, but it is likely that most practitioners in the Western Pacific will need to adopt a hybrid approach that reflects the priorities of their own organisation, the priorities of donors, and the priorities of local resource owners.

Regardless of the manner in which they are initiated, it is essential that natural resource management processes respect the needs, interests, rights and aspirations of local resource owning communities, and contribute to local conservation and development goals, not just national and international targets. [97]

Photo Credit: Stacy Jupiter

95 Govan H, Tawake A, Tabunakawai K, Jenkins A, et al. (2009) Status and potential of locally-managed marine areas in the South Pacific. SPREP/ WWF/ CRISP/ Worldfish.
96 Aalbersberg W, Tawake A, Parras T (2005) Village by Village: Recovering Fiji's Coastal Fisheries. In: The Wealth of the Poor: Managing Ecosystems to Fight Poverty. United Nations Development Programme, United Nations Environment Programme, the World Bank and World Resources Institute.

97 Govan H, Tawake A, Tabunakawai K (2006) Community-based marine resource management in the South Pacific, Parks 16: 63-67.

STEP 2 | IDENTIFY ECOSYSTEM VALUES

NATURAL VALUES

Effective ecosystem-based management requires an understanding of the species, habitats and ecosystem processes in the management area. Biological surveys and local ecological knowledge are both useful tools for identifying conservation values and threats, and informing conservation targets and management measures.

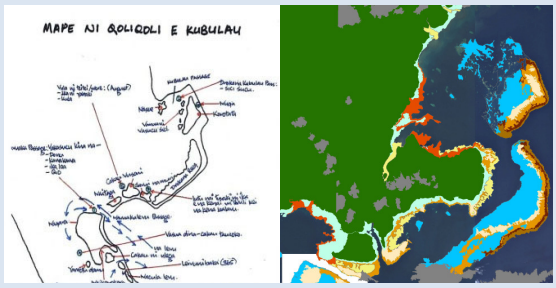
Examples of important natural values include:

- threatened and endemic species
- economically important species
- culturally important species
- legally protected species
- critical species habitat
- highly productive habitats
- feeding, breeding or nesting areas
- migration corridors and recruitment areas
- traditional fishing or hunting grounds
- commercial fishing grounds
- water catchment areas
- marine and terrestrial protected areas.

By facilitating stakeholder discussion about the natural values of an ecosystem, EBM partners can develop a shared understanding of the natural values of an ecosystem. It is useful to represent this information on a map, to assist stakeholders to visualise the natural values of the area and to facilitate subsequent spatial planning and management.

This information may be derived from local and traditional knowledge and scientific research. Resource users are important sources of detailed information about the local environment. Clearly understanding ecosystem functions and processes (including connectivity) in a particular area may require original research. However, it is important to thoroughly review existing scientific literature to ensure that any field research is focused and cost-effective, and does not unnecessarily duplicate earlier work.

EXAMPLE | HABITAT MAPPING IN KUBULAU



LEFT: Map of Kubulau reefs and oceanographic conditions drawn by community members.
RIGHT: Map of Kubulau geomorphic reef classes made from satellite imagery (courtesy: C. Roelfsema, University of Queensland).

A basic understanding of the types and extent of habitats within the management area is essential is order to prioritize areas for protection and management. This can be accomplished through mapping exercises to document habitat types and features. Selection of mapping methodology will often depend on the type of resources available and the preference of the users.[98] At one extreme, maps can be drawn by hand based on local knowledge. For example, the map on the left drawn by fishers that indicates oceanographic conditions was used to assist with MPA network design in Kubulau. While this type of community-mapping might not accurately represent the physical extent of each habitat, community members often feel more comfortable with the overall map output since they have participated in its production. At the other extreme, maps can be made from high resolution satellite or aerial imagery using software that clusters areas together based on similarities in the way that light reflects off of the different types of habitats, such as the map on the right. While these maps may yield a truer representation of habitat diversity, they may be costly and time consuming to produce.

[98] Roelfsema CM (2009) Integrating field and remotely sensed data for assessment of coral reef and seagrass habitats. PhD thesis. University of Queensland, Brisbane, Australia, 131 pp.

ECONOMIC, SOCIAL AND CULTURAL VALUES

Integration of economic, social and cultural values into management processes is a central tenet of EBM. By understanding the values that people place on an ecosystem, EBM practitioners are better able to understand the drivers of change in the ecosystem, and constraints on management responses.

Socioeconomic research and participatory planning processes can provide invaluable information about the use and management of resources, and potential costs and benefits of management intervention. For example, catch per unit effort (CPUE) data can be used to estimate the opportunity costs of fisheries management measures, including alternative marine protected area configurations.

In Kubulau (Fiji), household surveys were used to collect a wide range of information about resource use, economically and culturally important species and perceived threats. Survey data about distribution of fishing effort across the management area is being used in the management planning process to determine the optimal reserve configuration so conservation benefits do not come at a price to local community needs.

Unlike conventional resource management, which tends to focus on a single resource type, such as timber or fish, EBM involves an integrated approach that addresses the biotic and abiotic elements of an ecosystem, and connections between them. Consequently, socioeconomic research for EBM seeks to understand resource use across different ecosystem types, the relative value that people place on different elements of the ecosystem, and their understanding of key ecosystem processes and connectivity.

By investigating and documenting the economic, social and cultural values that people place on different elements of an ecosystem, EBM practitioners can help to persuade decision-makers to take action to conserve ecosystems.

EXAMPLE | ECONOMIC VALUATION IN BIRD'S HEAD SEASCAPE, PAPUA PROVINCE

Economists from Conservation International and the University of Papua completed an extensive study into the economic values of ecosystem services in the Raja Ampat Islands.[99]

The study utilised natural resource valuation methods and intensive surveys and interviews with stakeholders to gain a comprehensive estimate of the economic value derived from natural resource use and ecosystem services.

The major finding was that the fisheries sector is the most important direct contributor to local communities, providing livelihoods for 80% of the population. Direct utilisation of marine resources was found to have a total economic value of Rp.126 billion per year, and accounts for 50% of GDP in Raja Ampat.

Tourism is the second most important sector, with a total economic value of Rp.14 billion per year. Tourism contributes significantly to local income and government revenues.

While mining, oil drilling and logging make substantially smaller contributions to the local economy (with less than 10% of the revenue flowing to local communities), they have strong negative effects on fisheries and tourism sectors that need to be accounted for during a complete economic valuation. Once the full range of negative impacts are accounted for, mining and logging were found to result in a massive net economic loss.

The study clearly demonstrated the need to consider the impacts of destructive industries on other economic sectors and ecosystem services when making land use decisions.

[99] Conservation International (2009) Valuation of Ecosystem Services in the Seascape. EBM Bird's Head Information Sheet Series. Conservation International, Sorong, Indonesia.

IN FOCUS | SOCIOECONOMIC ASSESSMENT AND MONITORING

WHAT IS SOCIOECONOMIC ASSESSMENT?

Socioeconomic assessment is a way to learn about the social, cultural, economic and political conditions of individuals, households, groups, communities and organizations. Socioeconomic assessment usually refers to a one-time data collection effort, while socio-economic monitoring involves repeated data collection over timeusually at set intervals.

WHY DO A SOCIOECONOMIC ASSESSMENT?

Socioeconomic information can be used by managers for a range of purposes, such as:

- determining the value and cultural significance of resources and their uses
- identifying threats, problems, solutions and opportunities
- assessing ecological awareness and understanding of management rules
- assessing positive and negative impacts of management measures
- informing development of appropriate education and awareness programs
- understanding community dynamics, , including linkages within and between social networks.[100]

SOCIOECONOMIC ASSESSMENT PROCESS

The process for conducting a socioeconomic assessment will vary widely depending on local conditions and research objectives. Key phases in the process may include: defining assessment objectives; identifying site and population; identifying indicators; consulting with stakeholders; collecting data; analysing data; communicating results; and, using results for adaptive management.

SOCIOECONOMIC INDICATORS

Socioeconomic assessments vary in the topics that they cover, and this will depend on the purpose of the assessment and resources available to conduct it. Examples of indicators relevant to coastal and marine resource management in the Western Pacific include:

Demographics: population, age, sex, education/literacy, ethnicity, language, occupation, sources of household income.

Coastal and marine activities: goods and services, means of production, location, resource dependence, resource use by outsiders, market for goods and services, gender roles and responsibilities, knowledge of resources, attitudes towards resources, non-market and non-use value, alternative and supplementary livelihoods.

Threats: resource conflicts, perceived community problems, perceived resource conditions, perceived threats to resources, perceived coastal management problems.

Management: management institutions, budget, personnel, management plan, formal rules and regulations, tenure and resource rights, local customs and traditions, awareness of rules, enforcement, compliance, management successes, failures, credibility, effectiveness, compatibility with local values and beliefs.

Given the sensitivity of collecting personal information, the importance of confidentiality should be emphasised by those conducting socioeconomic surveys in order to build trust. As some information may be difficult to obtain directly, it is advisable to build relationships with key informants within communities who can advise on the acceptable uses of the data.

It is important to note that community perceptions of resource conditions, threats and ecological responses to management interventions are not always accurate. Caution should therefore be exercised in using perception studies as the sole source of information on resource conditions.

100 Secretariat of the Pacific Regional Environment Program. 2008. Socioeconomic Monitoring Guidelines for Coastal Managers in Pacific Island Countries (SEM-Pasifika). <www.sprep.org>, accessed 1 August 2009.

STEP 3 | UNDERSTAND THE MANAGEMENT CONTEXT

EBM cuts across sectoral boundaries and may not fit neatly into existing institutional categories. EBM practitioners must have a clear understanding of the management context in which they operate and identify opportunities to link their work with existing laws, policies, programmes, institutions and decision-making processes.

It is important to understand the legal, policy and institutional context for management. In particular, it is useful to conduct a review of laws and policies dealing with: land tenure, fisheries, forestry, mining, environmental impact assessment, pollution control, species protection and protected areas. It is also important to understand the rights, roles and responsibilities of state and non-state actors, including government agencies, traditional leaders and local communities.

In the tropical Western Pacific, resource tenure is a fundamental issue for conservation and natural resource management initiatives. It is important to gain a clear understanding of the legal and *de facto* status of tenure claims in the management area. Conflicting marine resource tenure claims in Kubulau have led to conflict over the management of the Namena Marine Reserve. In Kadavu, community mapping exercises have been used to identify overlapping marine tenure claims, and, due to the potential for conflict, reserves have not been established in these areas of overlap.

Gaining a clear understanding of decision-making processes can greatly enhance the effectiveness of EBM initiatives. In Macuata and Kadavu, local staff have provided vital insights into traditional authority structures and community decision-making processes. In Bird's Head, understanding government policies, priorities and decision-making processes has been a key factor in securing early conservation wins and laying the ground for integrating EBM principles and lessons learnt into government programmes.

EXAMPLE | LEARNING ABOUT MANAGEMENT CONTEXT IN BABELDAOB ISLAND, PALAU

Photo Credit: Palau Conservation Society

In Babeldaob, the EBM partners sought to understand the management context more clearly by conducting social research to:

- map and describe key stakeholders with an interest in resource management
- analyse decision-making processes related to natural resource management
- describe and map historic and present resource uses of Babeldaob Island to be used as a basis for land use planning
- assess demographic changes and trends on Babeldaob in order to determine potential resource management needs
- describe and assess traditional and other resource management techniques.

This research helped to identify strategic issues and priorities, and guided subsequent development of the initiative, including the establishment of collaborative relationships with key decision-making bodies.

IN FOCUS | LAW, CUSTOM AND ECOSYSTEM-BASED MANAGEMENT

Customary land and resource tenure is a key factor in community-based natural resource management in the Western Pacific. In many cases, effective conservation practice requires an understanding of both legal and traditional resource rights and decision-making processes.[101]

Community level governance systems have regulated natural resource use in the Pacific for centuries.[102] These governance systems were modified and eroded during the colonial era, and the contemporary legal systems of Western Pacific states and territories vary in the extent to which they recognise customary law and traditional resource tenure.[103]

National legislation in nearly all Pacific island states recognises indigenous land tenure, which accounts for the large majority of holdings in most cases. Recognition of traditional marine tenure has been more uneven, reflecting a historical conflict between Pacific marine tenure systems and the 'open access' traditions of colonising European states (**Table 5.1**).[104]

In practice, traditional governance systems remain the primary mechanism for regulating the use of terrestrial and marine resources in many contemporary Pacific island societies.[105] Respect for customary law and institutions is an integral feature of most rural communities, where the overwhelming majority of disputes are resolved by customary means.[106]

In remote areas, daily life is almost entirely governed by custom and customary processes, and even where state institutions do exist at the local level, they co-exist with customary institutions.[107]

In recent years, recognition of the central role of traditional governance systems in the management of natural resources and ecosystems has resulted in a strong shift in towards community-based natural resource management in the region. This rapid expansion of community-based resource management initiatives presents important questions regarding interaction, and potential conflict, between national laws and local governance systems in the Pacific.

Legal recognition of traditional resource tenure and decision-making processes can enhance the effectiveness of community-based natural resource management.[108] Conversely, failure to recognise traditional resource tenure and decision-making processes may lead to resource conflict and, when combined with limited government capacity, can result in poor resource management outcomes. In Kubulau, limited recognition of customary marine tenure has been a key factor in local resource conflict and has presented significant management challenges for Namena Marine Reserve.[109]

Management planning processes provide opportunities for discussing interaction of community management targets with national laws and instititutions. Integration of national laws and community rules in management plans, and development of compliance and enforcement protocols, may enhance management effectiveness and reduce conflict risk.

101 This section is summarised from: Clarke, P. and Jupiter, S. (in press) Law, custom and community-based natural resource management in Kubulau District, Republic of Fiji Islands. Environmental Conservation.
102 Veitayaki J (1997) Traditional marine resource management practices used in the Pacific Islands: an agenda for change. Ocean & Coastal Management 37:123-136
103 Care JC, Zorn JG (2001) Legislating pluralism - Statutory developments in Melanesian customary law, Journal of Legal Pluralism & Unofficial Law 46: 49-101.
104 Govan H, et al (2009) supra n.23.
105 Cinner JE, McClanahan TR (2006) Socioeconomic factors that lead to overfishing in small-scale coral reef fisheries of Papua New Guinea. Environmental Conservation 33:73-80.
106 New Zealand Law Commission (2006) Converging currents: Custom and human rights in the Pacific. Study Paper 17. New Zealand Law Commission, Wellington, New Zealand.
107 Scaglion R (2003) Legal Pluralism in Pacific Island Societies. In: Lockwood V (ed) Globalization and Culture Change in the Pacific Islands. Pearson Prentice Hall.
108 Reti J (1993) The role of custom in environmental management and law in the Pacific. In: Boer B (ed) Strengthening environmental legislation in the Pacific Region. Workshop Proceedings. SPREP.
109 Clarke P, Jupiter S (in press) supra, n.99.

Table 5.1: Comparison of property and resource management rights for land and sea under custom and national legislation, Republic of Fiji Islands.

	Land		Sea	
	Custom	*Law*	*Custom*	*Law*
Property Rights				
Ownership	Clan (*mataqali*)	Clan (*mataqali*)	Tribe (*yavusa*)	State
Occupation	Clan (*mataqali*)	Clan (*mataqali*)	-	-
Right to exclude others	Clan (*mataqali*)	Clan (*mataqali*)	Tribe (*yavusa*)	Open access.
Resource Management				
Resource use rights (traditional resource owners)	Land use decisions by chief (*turaga ni mataqali*).	Land use decisions by clan, subject to state regulation.	Resource use decisions by chief (*turaga ni yavusa*)	Subsistence fishing rights recognised. Commercial fishing requires state approval.
Resource use rights (non-resource owners)	Use rights granted by chief (*turaga ni mataqali*).	Use rights granted by state, with consent of majority of resource owners.	Use rights granted by chief (*turaga ni yavusa*).	Fishing rights granted by state, following consultation with resource owners.
Protected areas	Traditional *tabu* areas, declared by chief (*turaga ni mataqali*).	*Conservation leases:* granted by NLTB with consent of majority of resource owners. *Nature reserves, catchment areas:* declared unilaterally by state.	Traditional *tabu* areas, declared by chief (*turaga ni yavusa*).	*Restricted fishing areas:* may be declared unilaterally by state. *Fishing licence conditions:* set by state, following consultation with resource owners.

Photo Credit: Brigette Martini

Clearly articulating the relationship between local decision-making processes and government regulation can help to integrate local adaptive management and effective enforcement. In Fiji, the use of fisheries licence conditions to control fishing in district marine reserves has been a useful mechanism for linking community management decisions with government regulation, and legally empowers community fish wardens to control fishing in those areas.

However, it is important that conservation practitioners are transparent about the costs and benefits of legal protection measures, and understand that certain measures may be perceived as a threat to traditional resource management rights.

Compliance with local management rules relies to a significant extent on respect for traditional authority and decision-making processes.[110] Customary institutions, already undermined by a range of historical factors, may be further eroded by with access to new markets for natural resources.[111]

Long-term effectiveness of community-based national resource management initiatives in the Western Pacific requires significant legal and institutional reform. Local conservation initiatives provide insights into practical barriers to effective resource management and opportunities for engaging with government to resolve these issues.

Ultimately, effective resource management is likely to rely on the emergence of hybrid models of governance, which respect local traditions, practices and rights and share responsibility for planning, implementation and enforcement of management measures between communities and government institutions, taking into account their respective strengths and limitations.[112]

110 Hoffman TC (2006). The reimplementation of the Ra'ui: Coral reef management in Rarotonga, Cook Islands. Coastal Management 30: 401-418

111 Cinner JE, Sutton SG, Bond TG. (2007) Socioeconomic thresholds that affect use of customary fisheries management tools. Conservation Biology 21: 1603-1611

112 Reti J (1993) The role of custom in environmental management and law in the Pacific. In: Boer B (ed) Strengthening environmental legislation in the Pacific Region. Workshop Proceedings. SPREP.

EXAMPLE | MAPPING OF TRADITIONAL TENURE SYSTEMS IN BIRD'S HEAD SEASCAPE

Photo Credit: M. Korebima, The Nature Conservancy

In the Bird's Head Seascape (Indonesia), Conservation International conducted a comprehensive two year participatory rural appraisal in all 89 coastal villages of Raja Ampat.

An important component of the appraisal was the mapping of traditional coastal and marine tenure systems through discussions with village elders about the origin of inhabitants and patterns of ownership vs user rights.

The results from this study have been invaluable during the designing of Raja Ampat's Marine Protected Area (MPA) network as well as for development of a marine resource management scheme.

For example, the mapping exercise found that the entire Wayag-Sayang-Uranie- Kawe island chain in NW Raja Ampat (consisting of approximately 100 uninhabited islands and extensive reef) is owned by the families from two villages in Aljui Bay (with no conflicting claims from other groups).

This has greatly clarified discussions with local communities on MPA gazettal in this area, and led quickly to the gazettal of the 155,000 hectare Wayag-Sayang-Uranie MPA. The two villages have now committed to establishing the entire MPA as a no-take zone.[113]

113 Conservation International, Mapping of Traditional Coastal and Marine Tenure Systems in Raja Ampat, Information Sheet.

STEP 4 | IDENTIFY AND ESTABLISH MANAGEMENT INSTITUTIONS

Effective EBM requires clearly defined institutional roles and responsibilities. Due to its cross-sectoral nature, EBM may require the involvement of a number of existing institutions, or the establishment of new institutions or coordination mechanisms.

IDENTIFYING EXISTING INSTITUTIONS

To identify relevant management institutions, it is useful to consider the full range of entities that have the authority to influence the use and management of the ecosystem and its resources. Relevant institutions may include national, provincial or local government, traditional leaders, resource owners and non-government organisations.

In each case, it is necessary to consider the source of the institution's authority or influence, and its interactions with other management institutions. In the Western Pacific, interactions between traditional institutions and government are particularly important – in many rural communities, traditional leaders exercise greater influence than government agencies. In this context, engaging traditional leaders in management planning and decision-making is an essential element of effective EBM practice.[114]

In Babeldaob (Palau), the EBM partners undertook extensive research into local decision-making processes related to ecosystem management, with a particular emphasis on the interactions between traditional social systems and the state and national governments. Interviews and case studies were used to 'map' the roles of each institution in the decision-making process. This research has played a vital role in the development of communication and advocacy strategies and will inform the development of effective and culturally appropriate management processes.

ESTABLISHING NEW INSTITUTIONS

Effective EBM may, in some circumstances, require the establishment of new institutions. In Bird's Head Seascape (Indonesia), for example, EBM partners are working closely with national, provincial and local governments to establish a management authority for the Raja Ampat marine protected area (MPA) network, to ensure coordinated management of fisheries and biodiversity across the MPA network.

Before establishing any new management entity, it is important to carefully consider whether the new entity is really needed, or whether its functions could be performed by existing institutions. In some cases, the establishment of a coordinating mechanism (e.g. an inter-agency committee) may be a practical way to improve cooperation and integration of management functions.

It is also important to consider whether the management entity has the authority to make management decisions. Does the entity have the legal or traditional authority to make binding management decisions? What is the source of this authority? In most cases, the authority of a management entity will be derived from an existing institution whose legitimacy is acknowledged (e.g. statutory authority granted by the national legislature, traditional authority granted by clan chiefs).

To effectively implement an EBM approach, it may be necessary to build the capacity of new or existing management entities. In each of the field sites described in this guide, the EBM partners have worked to strengthen local management capacity by providing scientific and technical advice, delivering training and capacity-building programs, and liaising with donors and other partners to secure funding and in-kind support.

[114] Colding J, Folke C, Elmqvist T (2003) Social institutions in ecosystem management and biodiversity conservation. Tropical Ecology 44: 25-41.

EXAMPLE | KUBULAU RESOURCE MANAGEMENT COMMITTEE

In Kubulau, Fiji, the Council of Chiefs (*Bose Vanua*) established the Resource Management Committee (KRMC) to promote and support the sustainable management of resources in District.

The Bose Vanua consists of the paramount chief (*Tui Kubulau*) and clan chiefs (*turaga ni yavusa*) of Kubulau, and is widely respected as the traditional decision-making body for the district. The Bose Vanua has endorsed the 2009 *Kubualu Ecosystem-Based Management Plan*, and entrusted the KRMC with primary responsibility for its implementation.

The KRMC consists of one representative from each village, nominated by their village and appointed by the Bose Vanua. The functions of the committee are set out in the plan, and include: implementation of management activities, awareness raising, enforcement, assessment of proposed developments, training, stakeholder liaison, financial management, monitoring and reporting.

The KRMC meets periodically with an external stakeholder consultative group that includes government agencies, non-government organisations and the private sector. The KRMC Chair reports to the Bose Vanua and attends Bose Vanua meetings as an observer.

In 2009, to increase community involvement in resource management activities, and to provide a focus for management activities, KRMC established five sub-committees to take the lead on resource management, science, community development, education and communication respectively.

The KRMC has taken a central role in the development of the EBM plan for Kubulau and is the key contact point for external EBM partner organisations and other stakeholders.

Photo Credit: Stacy Jupiter

STEP 5 | IDENTIFY CONSERVATION GOALS, TARGETS AND THREATS

Identification of conservation goals and targets is a vital step in the management planning process. Effective EBM requires the identification of goals and targets that reflect the interconnected nature of ecosystems and their multiple natural, social, cultural and economic values.

Clearly defined goals and targets provide a basis for identifying threats and prioritising management responses. Engaging resource owners and users, experts and management agencies in collaborative planning processes provides opportunities for identifying goals and targets that integrate stakeholder concerns and priorities with scientific and traditional ecological knowledge.

CONSERVATION GOALS

Conservation goals are intended to set the overarching direction for management planning and implementation. They should be defined clearly, but broadly. For example, the goal of an EBM initiative may be 'maintaining a healthy and resilient coastal ecosystem'.

EBM goals focus on maintaining or restoring the natural structure of ecosystems to sustain ecosystem services over time. The goal may also define the geographic scope of the initiative, and refer broadly to the method for achieving the goal (see text box example).

MANAGEMENT TARGETS

Management targets provide a specific focus for management action. Targets should be measurable and time-bound. Targets for EBM focus on maintaining the health, productivity and resilience of ecosystems, and may incorporate economic, social and cultural values. In particular, it is useful to identify targets that reflect ecological processes and structures, and emphasis the maintenance of ecosystem services (see text box example).

EXAMPLE | MANAGEMENT GOALS AND TARGETS IN KUBULAU DISTRICT

Ecosystem-based management in Kubulau (Fiji) is community-driven, and centres around a shared vision of 'healthy people, processes and systems'.

The overarching goal of ecosystem-based management in Kubulau is 'preservation of the functional integrity of Kubulau's ecosystems, from the ridge to the reef, through community-based management'.

Using a simple conceptual modelling process, community members identified management targets for terrestrial, freshwater, coastal, estuarine and marine ecosystems. For example, community members identified the following targets for terrestrial ecosystems:

1. Maintain or restore riparian vegetation.
2. Maintain or restore drinking water catchments, including groundwater catchments.
3. Maintain or restore populations of indicator species, including tree frogs and banded rails.
4. Maintain the availability of non-timber forest products, including edible ferns and wild yams.
5. Maintain or improve the availability of sandalwood.

Based on these targets, community members used a conceptual modelling process to identify key threats, contributing factors, and relevant management responses.

Biodiversity targets are an important element of EBM planning. Biodiversity loss is closely linked to loss of ecosystem services, while protection and recovery of populations, species and ecological communities enhances ecosystem productivity and resilience.[115] Targets should be monitored to measure progress over time. The number and type of targets selected should realistically reflect local capacity for ongoing monitoring, while capturing the key values of the ecosystem: in many cases, a succinct list of four to eight targets is likely to be adequate.

THREATS AND CONTRIBUTING FACTORS

Conceptual modelling is a simple and effective tool for linking conservation goals and targets with management responses. By engaging participants in a structured step-wise process, conceptual modelling seeks to ensure that management responses are focused, and make efficient use of resources to address shared conservation priorities.

Once management targets have been identified, participants in the management planning process are asked to identify key threats to the realisation of these targets. In Kubulau, for example, community members identified the following threats to the health and productivity of terrestrial ecosystems:

- shifting cultivation;
- farming in riparian areas;
- farming in water catchments;
- unsustainable burning;
- unsustainable logging practices; and
- invasive species.

Participants are then asked to identify factors that contribute to each threat. For example, community members in Kubulau identified 'lack of awareness of sustainable farming methods' as a contributing factor for unsustainable farming practices, including burning to clear land for shifting cultivation (**Figure 5.1**).

SCIENCE AND MANAGEMENT PLANNING

Scientific principles, knowledge and research methods are powerful tools for management planning, and have a central role to play in the identification of management targets, threats and responses. To increase the likelihood of implementation of recommendations of scientific studies, science needs to address the highest priority management questions, including social and economic issues. Research questions should be applied, not theoretical, and research findings and their implications must be clearly communicated to decision-makers.

Scientific research is most useful when: studies are based on sound principles and are well-designed; the results reflect a consensus of expert opinions; research outcomes can be easily interpreted and turned into targets that can be monitored; and management strategies based on the findings can be applied generally, taking into account local context. Science is best understood and most likely to be applied when the local managers and scientists are able to participate in data collection and experiential learning. Uptake of the science may occur more readily if the outcomes of management actions have a positive impact on local livelihoods or human well-being.

In Bird's Head Seascape, the EBM partners used satellite tagging to learn about the nesting, feeding and migration patterns of endangered green turtles. Remarkably, one of the turtles travelled more than 5,000 km in 80 days. Data obtained from this research played a critical role in convincing provincial government officials and local villagers to protect an important turtle rookery within the boundaries of a 155,000 ha marine protected area. The research findings also formed the centrepiece of a community engagement strategy that has inspired the establishment of a community-led anti-poaching program and a significant decline in turtle hunting.[116]

115 Worm B, Barbier EB, Beaumont N, Duffy JE, et al. (2006) Impacts of biodiversity loss on ocean ecosystem services. Science 314: 787-790.

116 Conservation International (2008) Identifying turtle nesting and feeding habitat and migration corridors in the Bird's Head Seascape. Conservation International, Sorong, Indonesia.

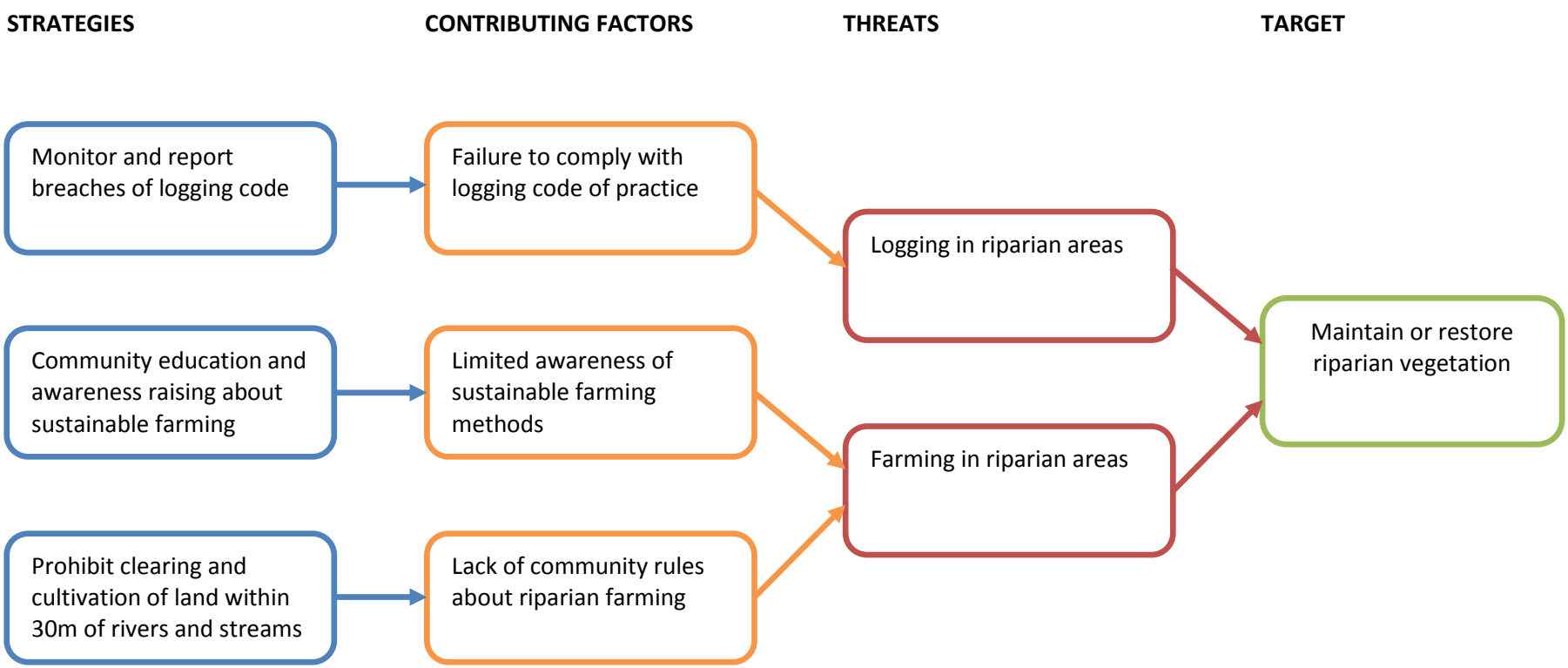


Figure 5.1. Simplified conceptual model for riparian vegetation in Kubulau District, illustrating threats, contributing factors and strategies.

EXAMPLE | USING SCIENTIFIC RESEARCH IN MANAGEMENT PLANNING PROCESSES

In Fiji, scientific studies by EBM partners found that declining catchment forest cover is associated with reduced numbers of freshwater fish species in catchment streams.[117]

In **Figure 5.2** (below), orange circles indicate sampling sites where invasive fish (tilapia) were present. Tilapia both do better in degraded stream conditions and themselves have negative direct and indirect effects on native fish fauna.

The results also show that traditional community-based management can help preserve native fish diversity in freshwater systems: the green square represents fish species numbers from the small coastal catchment of Macuata-i-Wai, which is surrounded by heavily cultivated and degraded land. For two years before sampling, the community leaders had strictly enforced a ban on logging, fishing and waste disposal within the vicinity of the stream. Consequently, the number of fish species found was much higher than would be predicted by the catchment forest cover.

These results were presented back to communities in Kubulau and Macuata to help design management rules for their EBM plans. For instance, the Kubulau EBM plan now prohibits clearing or burning vegetation within 30 m of rivers and streams throughout the district. In addition, the communities of Kubulau have banned the introduction of tilapia throughout the district.

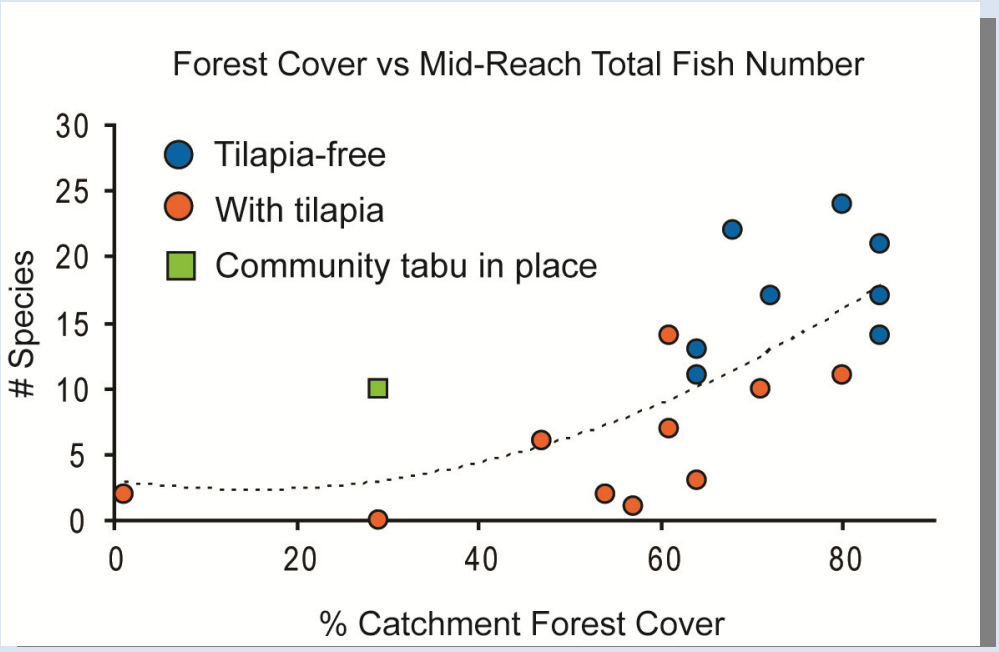


Figure 5.2. Relationship of catchment forest cover in Fiji with freshwater fish species richness.[118]

117 Jenkins AP, et al. (2009) supra n. 14

IN FOCUS | ECOSYSTEM APPROACH TO FISHERIES MANAGEMENT

In the tropical Western Pacific, there is a high reliance on fisheries - from coastal subsistence fisheries to offshore commercial activities. Fish are the main source of protein and cash income for many local communities and fisheries form the basis of local, regional and sometimes national economies. In some areas, coastal fishing is a popular recreational pastime and an important part of local cultures.

Unfortunately, fisheries in the tropical Western pacific are following a global trend of decline of commercial fish stocks. There are many reasons for this including: overharvesting; illegal, unreported and unregulated (IUU) fishing; targeting of spawning populations; loss of habitat due to destructive fishing (bomb fishing, poison fishing, trawling); and loss of nursery habitats such as mangrove and seagrass due to coastal development and pollution. In addition, overfishing, IUU fishing and destructive fishing are identified as some of the most important threats to the health and biodiversity of coral reefs and associated ecosystems in this region. Fishing gears such as gill nets, long lines and trawls kill thousands of endangered species including turtles, whales, dolphins and dugongs each year.

There is a strong link between fisheries and marine and coastal ecosystems. It has been clearly demonstrated that healthy ecosystems support healthy fisheries and that fish play a critical role in ecosystem function and balance. Hence there is a growing recognition that existing fisheries management tools need to be expanded to incorporate an ecosystem approach to fisheries management (EAF)[118].

EAF is especially relevant in the tropical Western Pacific. Conventional fishery management regulations such as limits on catch, size of fish, size and number of boats, types of fishing gear and closed seasons requires good knowledge of the biology and life history of the target species and the amount of fishing effort and catch rates for different species. On the basis of this information, regulations are applied and modified to manage fishing effort at a sustainable level. However, in the western Pacific (and many other parts of the world), fisheries are based on multiple species for which there is little life history information, multiple gear types and a relatively large proportion of the catch is taken by unregulated artisanal fisheries in remote regions who do not report their catch to local authorities. In addition, in some countries and for some fisheries, IUU is likely to make up a significant proportion of the catch but is not included in fisheries assessments. In many cases, application of fishery regulations based on inadequate and inaccurate information leads to an overestimation of the fish stocks, licencing policies which are not sustainable and, ultimately, fisheries decline.

The basis of EAF is consideration of the connectivity between fisheries and ecosystems, including people and economics in both space and time. This includes consideration of: the relationship between the target species and its prey; the habitats used at different stages of its life cycle; and its movement between different geographic locations. It considers the importance of protecting spawning stocks and sites of spawning aggregations to allow replenishment of stocks in that area and adjacent areas though larval dispersal. Importantly, it considers the dependence of local communities and economies on sustainable fisheries and the consequences of fisheries collapse, unregulated and illegal fishing for local people, the maintenance of healthy ecosystems for alternative income generating activities such as tourism and the issues of local tenure and traditional ownership.

[118] Pitcher TJ, Kalikoski D, Short K, Varkey D, Pramod G (2009) An evaluation of progress in implementing ecosystem-based management of fisheries in 33 countries. Marine Policy 33: 223-232.

Preston recently published a comprehensive guide to Ecosystem Approach to Fisheries in Pacific Island Countries and Territories.[119]

This guide recommends that an EAF include:

- cross-sectoral management of fisheries and coastal ecosystem health;
- increased stakeholder participation in decision making to promote compliance;
- allocation of user rights to marine resources using traditional or customary law where possible and through licences and quotas;
- alignment of fisheries policies at local, regional, national and international levels;
- reductions in overfishing;
- reductions in fisheries impact on ecosystems and ecosystem processes;
- development of fishery management plans;
- use of multiple use marine protected areas and locally management marine areas as fisheries management tools;
- integrated coastal management to address impacts of coastal development on fisheries and vice versa.

This last point is particularly important in the tropical Western Pacific as most countries are island states with a high ratio of coastline to land areas and a pressing need to develop local economies to alleviate poverty. There is generally a low understanding and awareness of the impact of runoff on marine communities. Controls on road construction and clearing are usually limited or not enforced and the combination of steep terrain, highly erodible soils and high seasonal rainfall result in extensive erosion and sedimentation of coastal habiats.

An ecosystem approach to fisheries can be introduced step by step into current fisheries management to complement and improve existing regulations. It is not necessary to wait until specific legislation is introduced.

Examples of fishery regulations which would improve ecosystem health and sustainability of fisheries include:

- bans, enforcement and strong penalities used to eliminate destructive fishing and other gear types which have high rates of bycatch, such as longlines, bottom trawls, drifting gill nets and bomb fishing – where this is not possible, modifications to fishing gear and fishing practises should be made to reduce bycatch, for example, through the use of circle hooks, turtle exclusion devices and seaonal closures during migratory and/or breeding seasons;
- protection of spawning populations through seasonal or spatial closures;
- conditions on licences which apply to specific areas and which recognise no take zones or MPAs as protected for fish stock recovery; and
- regulation of fisheries on which target species prey (e.g. regulation of anchovy harvest which is a food source for tuna and endangered species such as cetaceans and sharks).

Examples of coastal management regulations which would confer benefits to fisheries include:

- protection of mangroves from harvesting, clearing and changes in tidal flushing (e.g. from seawall construction);
- controls on sediment and nutrient runoff to coastal waters from coastal development, cities, villages to prevent loss of mangrove, seagrass and coastal reefs;
- enforceable measures to ensure that river and creek crossings do not restrict water flow or movement of fish between nursery and adult habitats along the length of the waterway; and
- recognition within coastal spatial plans of the economic benefits of healthy ecosystems for alternative industries, such as low impact aquaculture and tourism.

[119] Preston G (2009) The Ecosystem Approach to Coastal fisheries and Aquaculture in Pacific Island Countries and Territories – Part 1: A review of the current status – Part 2: Principles and approaches for strategic implementation/report to the Secretariat of the Pacific Community and The Nature Conservancy prepared by Garry Preston, Gillett, Preston and Associates. The summary and full report can be downloaded from: <www.spc.int/coastfish/Reports/EAFM_Workshop/Ecosystem_rpt1.pdf>.

STEP 6 | AGREE ON MANAGEMENT RULES AND ACTIONS

Management plans ordinarily include two operative components: management rules and management actions. These rules and actions should be clearly linked to the goals, targets and threats identifed earlier in the management planning process.

The level of detail contained in a management plan should reflect the management capacity of the relevant management institutions. For example, a local village which is engaging in a structured management planning process for the first time may be able to capture its management priorities in a two page table. More experienced management institutions may develop detailed management plans to reflect the full range of values, threats, rules and actions relevant to the management area.

MANAGEMENT RULES

EBM management rules respond to threats by seeking to regulate human activities that may negatively affect the health and integrity of ecosystems. Emphasising the links between community-identified management goals and management rules improves compliance by encouraging ownership of the rules, and promoting local monitoring and reporting.

Examples of management rules include:

- spatial planning, including protected areas, management zones and buffers;
- seasonal restrictions and harvest limits;
- regulating the taking of particular species;
- regulating particular harvest methods;
- regulating development and pollution.

In the Western Pacific, a variety of traditional fisheries management measures have been used for centuries, including no take zones, seasonal bans, temporary closures, effort controls, gear controls and catch limits.[120]

The establishment and management of protected area networks is an important strategy for maintaining ecosystem integrity. The principles and practice of protected area network design are discussed in detail below.

Management rules may define exceptions (e.g. local resource owners allowed to fish for subsistence purposes) and approval processes (e.g. government approval required for tourism operations within a protected area).

In the management plan, it is useful to identify the source of each rule. This is particularly important if the legal status or enforcement options varies between rules. In the Western Pacific, the ability of local communities to create legally binding management rules varies between countries, and between ecosystem types. In many cases, local communities have the power to make legally binding decisions about use of their land, but lack legal authority to regulate use of their traditional fishing grounds. Lack of formal legal authority does not prevent local communities from adopting management rules, but it may limit the range of lawful enforcement options.

In Kubulau (Fiji), the management rules set out in the management plan represent a synthesis of community rules and national laws relevant to ecosystem management. The community rules are based on extensive consultation and have been endorsed by the district council of chiefs (**Figure 5.3**). The options available for enforcement of management rules depend on whether the rule is a community rule and/or a national law. The management rule tables in the plan indicate whether each rule is a 'national' law or a 'district' community rule (**Table 5.2**).[121] Examples of management rules for marine ecosystems from the Kubulau management plan are set out below (**Table 5.3**).

120 Aalbersberg, W, Tawake, A and Parras, T (2005) Village by Village: Recovering Fiji's Coastal Fisheries. In: The Wealth of the Poor: Managing Ecosystems to Fight Poverty. United Nations Development Programme, United Nations Environment Programme, the World Bank and World Resources Institute.

[121] Wildlife Conservation Society (2009) Ecosystem-Based Management Plan: Kubulau District, Vanua Levu, Fiji, Wildlife Conservation Society, Suva, Fiji.

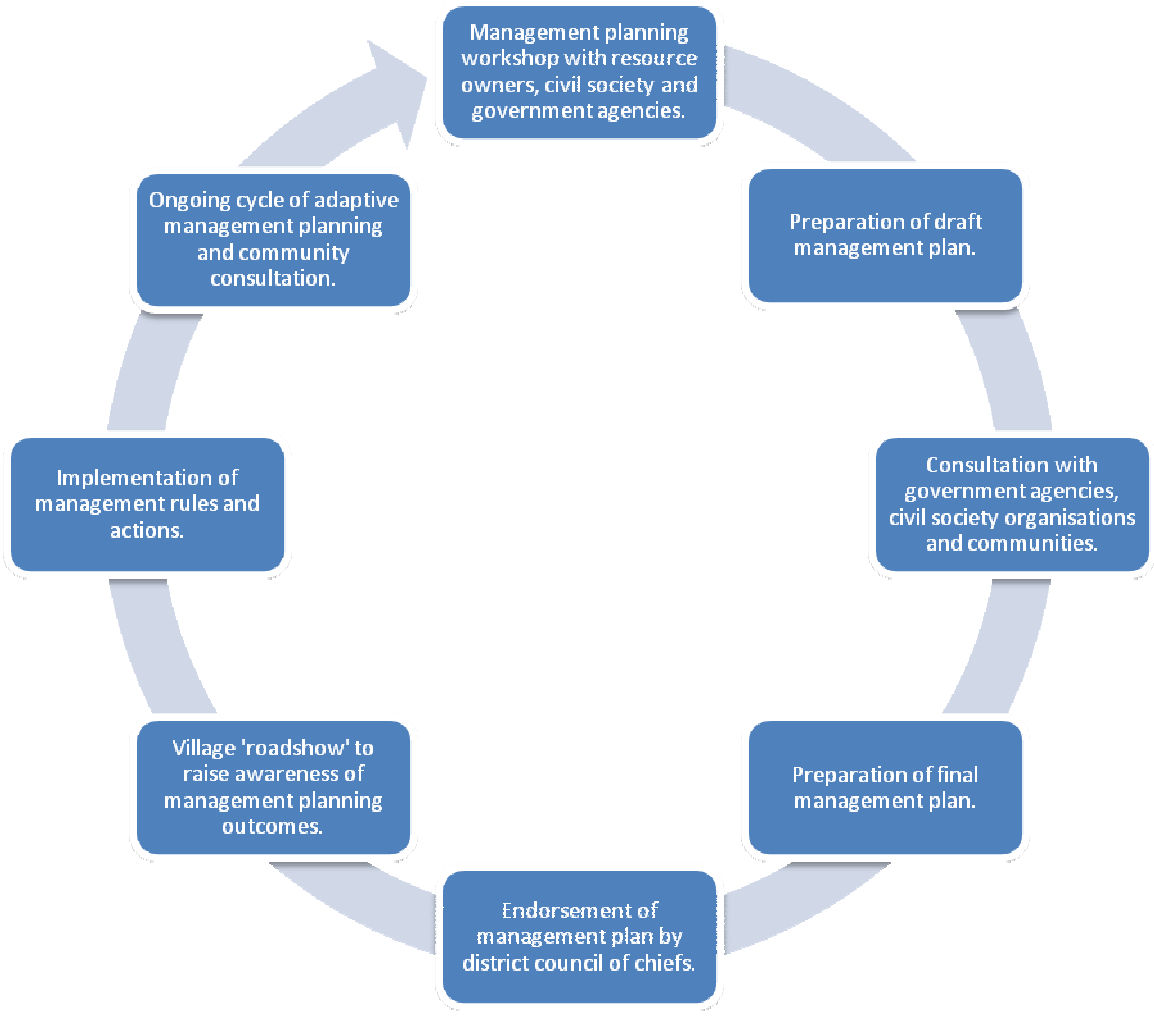


Figure 5.3. Overview of Kubulau ecosystem-based management planning process.

Table5.2. Extract from management rule table, *Ecosystem-Based Management Plan, Kubulau District*.

RULE	EXCEPTIONS	NATIONAL	DISTRICT
Taking triton shell is prohibited.		✘ [1]	
Taking any species of grouper during the month of August is prohibited.			✘ [2]
Dynamite fishing is prohibited		✘ [3]	✘ [4]

NOTES

[1] *Fisheries Regulations* r.22.
[2] Kubulau Management Plan Review Workshop, January 2007
[3] *Fisheries Act (Cap 158)* s 10(4).
[4] Kubulau Management Plan Review Workshop, January 2007

MANAGEMENT ACTIONS

The EBM planning process also involves identifying specific actions to maintain or restore the health of the ecosystem. These actions should be related to management targets, and may seek to address direct threats or contributing factors. Responsibilities and timeframes for implementation must be agreed and clearly defined. Participants in the planning process should consider whether additional resources will be required to implement the actions and, if so, potential sources of financial or in-kind support.

In Kubulau, the management plan sets out a range of management actions for marine, estuarine, freshwater and terrestrial ecosystems (**Table 5.4**). These actions are explicitly linked to particular threats or contributing factors. Responsibilities and timeframes for implementation were defined in a series of implementation planning meetings, and EBM partners have started fundraising for activities requiring external support. The management plan also contains 'best practice' recommendations, which go beyond the agreed management rules (e.g. contour planting, 100 metre stream buffers).

Table 5.3. Selected management rules for marine ecosystems, *Kubulau Ecosystem-Based Management Plan*

MARINE ECOSYSTEMS
Fishing for trade or business without a fishing licence is prohibited.
Dynamite fishing, fishing with poison and fishing with SCUBA equipment is prohibited.
Longline fishing, trawling and shark finning is prohibited.
Using undersized fishing nets is prohibited.
Taking undersized fish, crabs, shells or beche-de-mer is prohibited.
Taking humphead wrasse, bumphead parrotfish, turtles, triton shell or giant helmet shell is prohibited.
Taking any aquatic animal, including *beche-de-mer*, is prohibited within marine reserves and *tabu* areas.
Marine recreation providers must comply with the Namena Marine Reserve Recreational Guidelines.
Diving, snorkelling or kayaking in the Namena Marine Reserve without a user tag is prohibited.
Use of anchors within marine reserves is prohibited.

Table 5.4. Selected management actions for marine ecosystems, *Kubulau Ecosystem-Based Management Plan*

MARINE ECOSYSTEMS
Visit neighbouring districts to raise awareness of local reserves and fisheries management rules.
Produce and distribute flyers to raise awareness of management rules.
Increase number and effectiveness of patrols by securing funds for radios, fuel and additional boats.
Mark MPA boundaries using buoys and lines donated by local communities.
Raise awareness of size limits by producing and distributing size limit flyers/posters and fish rulers.
Use income from marine reserve user fees to provide scholarships for local youth.

IN FOCUS | DESIGNING PROTECTED AREA NETWORKS

Because protected areas (PAs) are such an important tool in implementing EBM, this section focuses on some of the principles of their design, including: differences in design criteria for terrestrial and marine protected areas (MPAs); specific considerations for designing marine reserve networks that are resilient to climate disturbance; and limitations for PA design within the tropical Western Pacific.

TERRESTRIAL VERSUS MARINE PROTECTED AREA DESIGN

Terrestrial and marine PAs often have different overarching goals and therefore different design requirements (**Table 5.5**). For terrestrial systems, the goal has typically been biodiversity conservation. Thus, terrestrial reserve design has focused on trying to maximize biodiversity within protected areas while maintaining its persistence over time.[122] Typical reserve selection methods, such as gap analysis,[123] are used to prioritize sites for protection to increase representativeness of particular species or habitats over the possible landscape in which they occur. Such tools can also be used to prioritize areas for protection that maintain ecosystem function by ensuring representation and redundancy across functional groups and key ecosystem processes (e.g. terrestrial-freshwater connectivity).[124]

Because of the limited dispersal of many terrestrial species and the grave concern about habitat degradation worldwide, many early terrestrial PAs were designed to be self-sustaining. That is, they covered an area of good quality habitat broader than the dispersal distance of key species so that populations could maintain their numbers. Recognition of importance of dispersal between populations for long-term persistence ignited debates on whether it is better to have a few large or many smaller reserves[125] and the costs of maintaining migration corridors between them.[126] As recent evidence suggests that increased isolation reduces the likelihood of persistence for some species,[127] current design theory has placed increasing emphasis on connectivity between reserves.[128]

The concepts of representation, persistence and connectivity are equally appropriate in the marine realm for biodiversity conservation. For long-term survival of marine biodiversity, “bigger is better” as larger reserves contain: (1) greater proportions of critical habitats and ecological processes needed to sustain multiple species; and (2) larger populations with higher genetic diversity.[129] Yet because marine environments are typically more connected than terrestrial systems due to the flow of water, and because marine larvae and adults of pelagic species may travel between tens and hundreds of kilometers[130], it is not necessarily practical to create MPAs with boundaries that encompass these dispersal distances within a single reserve. There are exceptions, of course, such as the newly created Phoenix Islands Protected Area, covering some 410,500 km^2 within the Exclusive Economic Zone of the island nation of Kiribati.

122 Soulé ME, Terborgh J (1999) Continental conservation. Island Press: Washington DC.
123 Dudley N, Parish J (2006) Closing the Gap. Creating Ecologically Representative Protected Area Systems: A Guide to Conducting the Gap Assessments of Protected Area Systems for the Convention on Biological Diversity. Secretariat of the Convention on Biological Diversity, Montreal, Technical Series no. 24, vi + 108 pp.
124 Walker B (1995) Conserving biological diversity through ecosystem resilience. Conservation Biology 9: 747-752.

125 Soulé ME, Simberloff D (1986) What do genetics and ecology tell us about the design of nature reserves? Biological Conservation 35: 19-40.
126 Simberloff D, Cox J (1987) Consequences and costs of conservation corridors. Conservation Biology 1: 63-71.
127 Davies KF, Margules CR, Lawrence JF (2000) Which traits of species predict population declines in experimental forest fragments? Ecology 81: 1450-1461
128 Margules CR, Pressey RL (2000) Systematic conservation planning. Nature 405: 243-253.
129 Almany GR, Connolly SR, Heath DD, Hogan JD, et al. (2009) Connectivity, biodiversity conservation and the design of marine reserve networks for coral reefs. Coral Reefs 28: 339-351.
130 Palumbi SR (2004) Marine reserves and ocean neighborhoods: the spatial scale of marine populations and their management. Annual Review of Environment and Resources 29: 31-68.

Table 5.5. Factors influencing design criteria for terrestrial vs. marine reserves[131]

Feature	Terrestrial Ecosystems	Marine Ecosystems
Reserve objectives		
Spatial focus for protection	Within reserves	Within and outside reserves
Emphasis on export	Low	High
Status of knowledge		
Patterns of species distribution	Good	Poor to moderate
Patterns of ecosystem diversity	Good	Poor
Design Criteria		
Importance of connectivity	Less	Greater
Size sufficient for local replenishment (within single reserves)	Smaller	Greater
Habitat diversity necessary for resource requirements	Smaller	Larger
Sensitivity to biogeographic Transitions	Less	Greater
Importance of import-export processes (i.e. winds, currents)	Low	High

Photo Credit: Lill Haugen

131 Carr MH, Neigel JE, Estes JA, Andelman S, et al. (2003) Comparing marine and terrestrial ecosystems: implications for the design of coastal marine reserves. Ecological Applications 13: S90-S107.

For the majority of cases in the tropical Western Pacific, socio-political considerations demand smaller MPAs. Additionally, the foremost objective of MPAs for many Pacific Island communities is not biodiversity conservation but rather maximizing the export of adults and larval supply for fisheries benefits.[132] Many small reserves can, in fact, maximize fisheries yields.[133] Yet it is important to be aware that these benefits will be outweighed by negative edge effects as reserve sizes shrink: skilled fishers may concentrate their efforts at MPA boundaries[134] and may overexploit stock if the reserves are smaller than the foraging ranges of mobile, target species. [135]

An optimum solution for both biodiversity and fisheries benefits will likely include a network of MPAs of variable sizes, spaced at distances from a few to a few tens of kilometers to account for both short- and long-distance dispersers and variability in larval retention.[136] Networks should include representation of every habitat, particularly those that are physically and ecologically connected: 20-50% representation of each habitat is recommended, though management capacity will ultimately determine the amount of area in reserves. Specific considerations for how these networks of MPAs can be designed to improve resilience to climate-related disturbance are described below.

132 Ibid.
133 Hastings A, Botsford LW (2003) Comparing designs of marine reserves for fisheries and for biodiversity. Ecological Applications 13: S65-S70.
134 McClanahan TR, Kaunda-Araura B (1996) Fishery recovery in a coral reef marine park and its effect on the adjacent fishery. Conservation Biology 10:1187-1199.
135 Roberts CM, Halpern B, Palumbi SR, Warner RR (2001) Designing marine reserve networks: why small, isolated protected areas are not enough. Conservation in Practice 2: 12-19.
136 Jones GP, Almany GR, Russ GR, Sale PF, et al. (2009) Larval retention and connectivity among populations of corals and reef fishes: history, advances and challenges. Coral Reefs 28: 307-325.

CRITERIA FOR RESILIENT MPA NETWORK DESIGN

There is compelling evidence that coastal and marine areas around the globe will be faced with warming seas, increased exposure to ultraviolet light, sea level rise and reduced alkalinity during the 21st century.[137] In response, scientists and managers are trying to take action: key MPA network design criteria to improve the resilience of coral reefs and coastal habitats to climate-related disturbance are becoming well recognized and included in tools, such as the Reef Resilience (R2) toolkit and rapid assessment protocols recently available to practitioners.[138] Their broad-scale recommendations for resilient MPA design include:

- large areas in simple configuration to ease enforcement;
- representation and replication of multiple habitats and physical parameters, spread across wide geographic distances to minimize risk;
- ecological features that promote resistance to or recovery from disturbance (e.g. spawning aggregations);
- maintenance of habitat connectivity and ecological processes that support healthy populations of key functional groups, particularly herbivorous fishes.[139-140]

Examples of how specific factors have protected tropical Western Pacific coral reef systems from climate-related disturbance are described below.

137 Hoegh-Guldberg O, Mumby PJ, Hooten AJ, Steneck RS, et al. (2007) Coral reefs under rapid climate change and ocean acidification. Science 318: 1737-1742.
138 http://www.reefresilience.org/Toolkit_Coral/C1_Intro.html <accessed 18 November 2009>
139 Obura DO (2005) Resilience and climate change: lessons from coral reefs and bleaching in the Western Indian Ocean. Estuarine, Coastal and Shelf Science 63:353-372.
140 McLeod E, Salm R, Green A, Almany J (2009) Designing marine protected area networks to address the impacts of climate change. Frontiers in Ecology and the Environment 7: 362-370.

Upwelling of cooled waters: Following the 1998 El Niño-Southern Oscillation event, reefs of central Indonesia strongly influenced by upwelling were protected by the severe bleaching that affected large portions of the Western Pacific.[141]

Flushing by strong currents: Similarly, coral reefs in Palau (e.g. reef flats and crests east of Ebiil Channel off northwest Babeldaob) and in Indonesia (Komodo National Park and Nusa Peninda Island) that were regularly flushed by strong currents and vertical mixing of cool waters experienced reduced temperature-related mortality after the 1998 bleaching event.[142]

Shading to reduce light stress: At Nikko Bay, in the Rock Islands of Palau, shading from trees growing on steep slopes reduced bleaching and associated mortality of corals on fringing reefs as the corals were protected from the detrimental affects of ultraviolet light. Suspended particulate matter in the water column may also offer similar protection: in parts of the Rock Islands and sheltered bays off Babeldaob, species sensitive to bleaching in clear water survived in areas with increased turbidity.

Identifying thermal refugia and bleaching resistant communities: Some coral reef environments, due to a combination of synergistic factors, are naturally better able to resist the large and prolonged temperature anomalies associated with mass bleaching.[143] For example, a 17 year temperature record (1985-2001) from the south end of Sulawesi in Indonesia showed no thermal anomalies larger than 1^{o}C .[144]

141 Goreau T, McClanahan T, Hayes R, Strong A (2000) Conservation of coral reefs after the 1998 global bleaching event. Conservation Biology 14: 5-15.
142 Salm RV, Done T, McLeod E (2006) Marine protected area planning in a changing climate. pp. 207–221 in Coral Reefs and Climate Change: Science and Management. Coastal and Estuarine Studies 61, American Geophysical Union.
143 McClanahan TR, Ateweberhan M, Muhando CA, Maina J, et al. (2007) Effects of climate and seawater temperature variation on coral bleaching and mortality. Ecological Monographs 77: 503-525.
144 WWF (2003) Buying time: A user's manual for building resistance and resilience to climate change in natural systems. Hansen LJ, Biringer JL, Hoffman JR (eds). World Wildlife Fund for Nature. 244 pp.

At a more local scale, specific ecological indicators of resilience may be evaluated by measuring differences in:

- percent cover of major benthic classes (e.g. live hard coral versus fleshy algae);
- reef complexity and topographic variability;
- sediment type and accumulation;
- proximity to flushing;
- relative shading;
- prior acclimatization;
- coral population structure and species susceptibility to disturbance;
- presence and number of coral associates;
- redundancy within fish functional groups; and
- degree of habitat connectivity.[145]

Both ecological and social resilience principles were used by The Nature Conservancy to identify priority regions for placement of MPAs in Kimbe Bay, Papua New Guinea.[146] The final design included 14 areas of interest chosen for their representativeness, replication, capture of critical areas (e.g. spawning aggregations, turtle nesting beaches), and minimal cost to the Kimbe Bay communities in terms of impacts on existing livelihoods and potential boundary conflicts. The actual design of the MPAs within each area of interest has been determined in consultation with the Kimbe communities to strengthen local ownership and participation in management implementation.

145 Obura D, Grimsditch G (2009) Resilience assessment of coral reefs -- Assessment protocol for coral reefs, focusing on coral bleaching and thermal stress. IUCN Working Group on Climate Change and Coral Reefs, Gland, Switzerland 70.
146 Green A, Smith SE, Lipsett-Moore G, Groves C, et al. (2009) Designing a resilient network of marine protected areas for Kimbe Bay, Papua New Guinea. Oryx 43: 488-498.

HOW DO LARGER POPULATIONS PROMOTE PERSISTENCE?

Populations of species may decline from natural or human causes. As individuals are lost from populations and opportunities become restricted for reproducing with individuals from other populations, genetic diversity is lost. Loss of genetic diversity can decrease the ability of populations to adapt to changed environmental conditions.[147]

Additionally, for some species, when population sizes fall below critical levels, reproduction fails. This is known as an Allee effect.[148] When the population density of broadcast spawners like giant clams falls too low, sperm concentrations in the water column are inadequate to fertlize eggs. Due to the combination of overexploitation and Allee effects, the largest of the giant clams, *Tridacna gigas*, is already locally extinct in the Western Pacific in Guam, Mariana Islands, Federated States of Micronesia, Fiji, New Caledonia and Vanuatu.[149]

In order to avoid these perils, it is imperative to put protection into place before stocks reach critically low densities.

SPECIFIC CONSIDERATIONS FOR THE TROPICAL WESTERN PACIFIC

In many places in the world, particularly in the tropical Western Pacific, socioeconomic and governance constraints will play a larger role than ecological considerations in determining the ultimate size, shape and placement of protected areas.

MPA effectiveness and persistence in much of the Western Pacific depends upon making the networks socially acceptable within a customary marine tenure framework. Furthermore, it is important to recognise that customary sea tenure varies by location and is differentially affected by population growth and access to markets.[150] The success of MPA networks will therefore largely rely on whether entitlements within marine tenure regimes are secure.[151] To avoid conflict among users, MPAs should be placed within marine tenure institutions that are based on clearly delineated boundaries and managed by a central authority that is widely respected by those both inside and outside the community.

Secondly, successful management implementation will also require that the users perceive equitable distribution of biological and social costs and benefits of closures from protected areas. Very large protected areas may displace the cost burden and access restrictions onto only a few stakeholders while neighbouring villages and entitled users would benefit from any spillover effects. Case studies from the Western Province of the Solomon Islands have found that smaller MPAs scattered within tenure boundaries share the cost burden among all users and also ensure fishers have access to alternative fishing grounds.[152]

147 Frankham R (2005) Genetics and extinction. Biological Conservation 126: 131-140.
148 Allee WC, Emerson AE, Park O, Park T, et al. (1949) Principles of Animal Ecology. Saunders Publishing Company: Philadelphia, 837 pp.
149 Teitelbaum A, Friedman K (2008) Successes and failures in reintroducing giant clams in the Indo-Pacific region. SPC Trochus Information Bulletin 14: 19-26.

150 Aswani S (2002) Assessing the effect of changing demographic and consumption patterns on sea tenure regimes in the Roviana Lagoon, Solomon Islands. Ambio 31: 272-284.
151 Aswani S, Hamilton R (2004) The value of many small vs. few large marine protected areas in the Western Solomon Islands. SPC Traditional Marine Resource Management and Knowledge Information Bulletin 16: 3-14.
152 Ibid.

Although comprehensive ecological and environmental data is scarce for many areas of the tropical Western Pacific, land owners and fishers with sea tenure rights have a vast amount of traditional and local knowledge that may be used to guide placement of PAs.[153] One of the most important considerations may be to place the PAs within visual distance of the village or individuals given the authority to enforce management rules. This has been an important lesson from the Kubulau MPA network where poachers from the adjacent district have been repeatedly caught fishing within the Nasue MPA, which is not visible from land.

Lastly, while the benefits of terrestrial and marine protected areas are well-recognized, it is important to note that PAs alone are not sufficient to ensure persistence of species and ecosystem functions.[154] Conservation practitioners and resource managers are now recognizing the importance of embedding PAs within broader ecosystem management to provide some form of protection outside of reserves[155] (for example, the Kubulau EBM plan includes rules against logging trees adjacent to waterways to preserve clean water to the nearshore). Often this type of management is easier to implement where the boundaries of traditional hierarchies include ridge-to-reef units, as is the case for parts of the tropical Western Pacific.

Photo Credit: Lill Haugen

153 Johannes RE (1998) The case for data-less marine resource management: examples from tropical nearshore finfisheries. Trends in Ecology and Evolution 13: 243-246.

154 Allison GW, Lubchenco J, Carr M (1998) Marine reserves are necessary but not sufficient for marine conservation. Ecological Applications 8: S79-S92.

155 McLeod E, Salm R, Green A, Almany J (2009) Designing marine protected area networks to address the impacts of climate change. Frontiers in Ecology and the Environment 7: 362-370.

STEP 7 | IMPLEMENTING MANAGEMENT RULES AND ACTIONS

Effective EBM requires careful attention to implementation of management rules and actions. Responsibilities and timeframes for implementation should be clearly identified, with mechanisms for periodically reviewing progress on implementation. Management rules are unlikely to be effective without active efforts to promote compliance, including awareness raising, monitoring, surveillance and enforcement. Management activities can be resource intensive, and consideration should be given to appropriate sustainable financing models.

IMPLEMENTATION PLANNING

It is essential that management planning processes result in a shared understanding of implementation responsibilities. The cross-sectoral nature of EBM means that these responsibilities may be shared across a number of institutions. Each institution needs to clearly understand and accept its role(s) in the management process. In some cases, it may be appropriate to formalise these roles through memoranda of understanding or binding management agreements.

Once the district EBM management plan for Kubulau was complete, the Kubulau Resource Management Committee (KRMC) held a two day implementation planning workshop. During the workshop, the participants:

- confirmed the roles and membership of KRMC sub-committees;
- reviewed management actions identified in the management plan and agreed on the level of priority for each action;
- allocated responsibility for management actions to relevant sub-committees;
- identified the main steps needed to take to implement each management action;
- agreed on the start date and finish date for each action – or, for ongoing actions, frequency (e.g. monthly, annual).
- identified the knowledge, skills and resources required for implementation of each management action;
- identified which knowledge, skills and resources already exist within the community;
- for needs that cannot be met from within the community, identified priorities and options for meeting those needs.[156]

PROMOTING COMPLIANCE

Effective implementation of management rules – both legislation and customary law – requires action to encourage compliance. In many cases, people will comply with the law if they are aware of the law, understand the reason for the law and respect the source of the law. For people who do not respect the law, compliance is likely to depend on: the benefits of breaking the law; the penalty for breaking the law; and, the chance of being caught and successfully prosecuted.

In Kubulau, the KRMC is responsible for coordinating activities to raise awareness of management rules and to promote voluntary compliance with the rules. In particular, KRMC is responsible for: posting copies of the management rules in every village hall in the district; organising meetings to explain the management rules in every village in the district; organising meetings in neighbouring districts to explain the management rules; and, producing flyers and other materials to raise awareness of the management rules.

[156] Wildlife Conservation Society (2009) Outcomes Report: Management Support Workshop, Kubulau District, 13-14 August 2009. Wildlife Conservation Society, Suva, Fiji Islands.

Communication of management rules should emphasise communities' common interest in sustainable management of natural resources and ecosystems. In the Western Pacific, it may be useful to work with chiefs, church leaders, government officers and other stakeholders to promote awareness of, and respect for, management rules.

MONITORING AND ENFORCEMENT

The options available for enforcement of management rules will depend on whether the rule is a national law or community rule.

Government officers and police are responsible for enforcing national laws. The responsibilities of government enforcement officers are to: monitor compliance with the law; investigate breaches of the law; and prosecute offenders for breaching the law. Courts may impose penalties for breaches of national laws, including fines and prison sentences, and may make other orders, including cancellation of certain types of licence. In some cases, government agencies have the power to suspend or cancel licences or issue binding orders and notices. Members of the public, including resource owners, can improve law enforcement by monitoring and reporting breaches, and advocating for stricter enforcement by government.

In most countries in the region, community rules are not enforceable in the courts, and use of traditional enforcement methods is limited by the criminal law. Traditional penalties for breaching customary law included beatings, execution, banishment or seizure and destruction of property.[157] Today, community-based rules must be enforced in a manner that does not breach national laws. In all countries in the region, it is a criminal offence to assault or detain a person or take their property without legal authority. This means, for example, that it is illegal to seize a vessel only because it was found fishing in a community-declared marine reserve.

Examples of lawful community sanctions include verbal warnings, public shaming, and removal of traditional titles or entitlements. In some cases, resource owners may be able to exercise legal rights to withdraw access to the relevant resource (e.g. cancelling land leases, withholding consent for fishing licences).

Discussion of national laws and community rules during the management planning process can help to identify synergies between the national legal framework and local institutions and decision-making processes. In Fiji, for example, inclusion of community-declared reserves on commercial fishing licences provides a flexible mechanism for recognising and enforcing local management decisions.

To improve local compliance with national laws and community rules, it may be useful to develop enforcement protocols. Enforcement protocols provide guidance on monitoring and reporting breaches, and provides examples of lawful sanctions that may be imposed in response to breaches of management rules.

Management institutions should take active measures to ensure that: individuals with monitoring and enforcement functions are adequately trained; resources are available for regular monitoring patrols; breaches are adequately recorded and reported; breaches are appropriately investigated and punished.

In the Western Pacific, resource owners often identify poor enforcement of national laws by government agencies and police as a key challenge for effective resource management. To improve enforcement of environmental and natural resource laws, it may be useful to engage actively with police and the judiciary. In Fiji, poor enforcement of fisheries law by police has been identified as a key barrier to sustainable management of coastal fisheries, prompting conservationists to recommend fisheries enforcement training for police. In Indonesia, to encourage higher penalties for illegal dynamite fishing, conservation groups have taken magistrates to see the impacts of this banned fishing method on coral reefs.

[157] Tiraa A (2006) Ra'ui in the Cook Islands: today's context in Rarotonga. SPC Traditional Marine Resource Management and Knowledge Information Bulletin. Noumea, New Caledonia 19: 11-15.

SUSTAINABLE FINANCING

Long-term sustainable management of an ecosystem often requires a significant investment of time, effort and resources. The strong emphasis on community-based management in the Western Pacific raises important questions about the ability of local management institutions to mobilise resources for effective management.

In many cases, local communities will be able to implement key management actions using the skills, knowledge and resources already present in the community. In other cases, communities may need to identify other sources of financial or in-kind support.

Potential financing sources include:

- government funding programs
- public and private donors
- partner organisations
- income generating activities.

If participants in the management planning process identify a need for financial support, responsibilities and timelines for fundraising should be clearly defined and adhered to. Proposals for income generating activities must be carefully examined to ensure that expectations of success are founded on sound market analysis.

Professional, transparent accounting and reporting is needed to ensure efficient and equitable use of funds, and to support sustainable resource management and community development.

In Kubulau, KRMC's primary sources of income have been user fees for Namena Marine Reserve and external funding from partner organisations and donors. Partner organisations and community members also make significant in-kind contributions, including equipment, time and labour. In the long-term, KRMC aims to make its activities self-sustaining, with little or no reliance on external funding sources.

To maintain Namena Marine Reserve's reputation as a premiere diving destination, income from user fees is re-invested in its management. Income from user fees is also used to support local development initiatives:

- scholarships for tertiary education;
- small grants and loans for sustainable microenterprise initiatives; and
- management and restoration of terrestrial, freshwater and marine ecosystems.

The Namena Marine Reserve website, maintained by the Coral Reef Alliance, is a key marketing tool for the reserve (**Figure 5.4**).

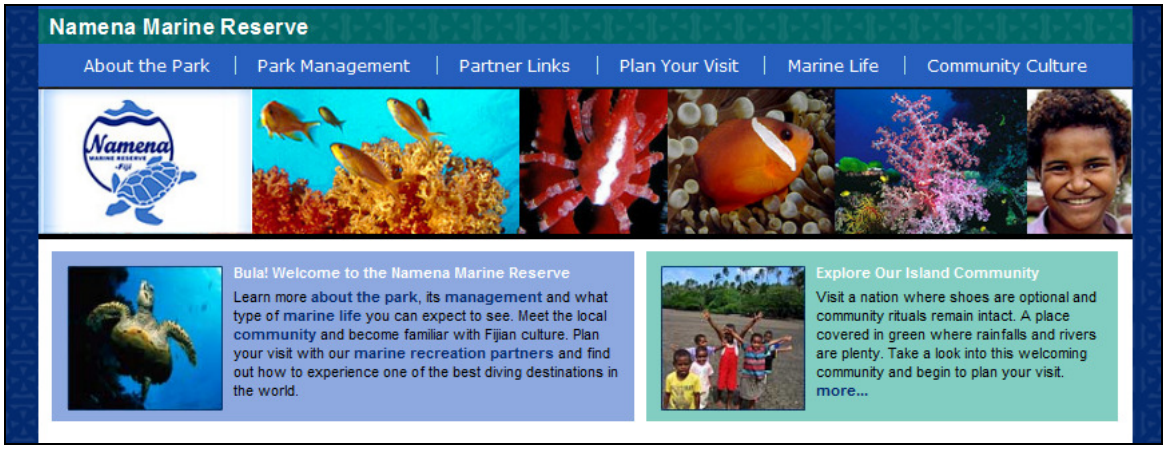


Figure 5.4. Namena Marine Reserve Website (www.namena.org).

STEP 8 | ESTABLISH EDUCATION AND COMMUNICATION PROGRAM

Education and communication programs play a vital role in ecosystem-based management. In particular, well-planned education and communication programs: raise awareness of ecosystem values, threats and contributing factors; encourage behavioural or policy change; and, build capacity to effectively implement management responses.

WHAT WORKS?

Conservation practitioners have identified a range of communication techniques that work well in the Western Pacific:

- key messages are often best communicated during **informal or social gatherings**, whether this is at a soccer match or sitting around the *kava* bowl late into the evening;
- **logos** and **slogans** can be an effective way to communicate general concepts to a wide audience;
- **newsletters** and **fact sheets** (in the local language) focused on key messages are effective within communities, particularly when they have the opportunity to respond and receive feedback; and
- **verbal communication** (in person, telephone, radio) is important to reinforce messages delivered in printed material.

Examples of innovative communication tools that have been used by EBM partners in the region include: DVDs; conceptual diagrams; newspaper articles; radio messaging; interactive games; using celebrities to attract interest; documentaries with personal stories; comic books; incorporating environmental themes into popular television programs; integrating conservation principles into curriculum for government training and schools or religious sermons; hosting public events; social marketing tools; talk back shows; and, opinion pieces written by experts.

The relevance and effectiveness of these communication methods may vary within and between countries. Therefore, before deciding on what methods and media to use, it is most important to identify the target audiences and key messages.

Religion plays a prominent role in the lives of many people in the tropical Western Pacific. Religous institutions, such as churches and mosques, are highly influential and can play an important role in encouraging people to be responsible stewards of the natural world. In the Pacific islands, conservation groups are working with the Pacific Theological College to develop sermon notes and other materials dealing with conservation themes.

WHAT DOESN'T WORK?

Documents or broadcasts produced in a single language will not have broad regional reach across the western Pacific. If materials are intended for a regional audience, they should ideally be translated to English, Pidgin, Bahasa Indonesian and French, while media targeted more locally should always be translated into the local vernacular.

In parts of the Western Pacific with relatively high illiteracy rates (including rural areas), radio or visual messages are likely to be more effective than printed materials. In some countries, theatre productions have been used successfully (e.g. Vanuatu), but may be less effective in other countries (e.g. Palau).

Internet based communication tools have limited application in the region, due to slow internet speeds and unreliable connectivity, but may still be useful for communicating with specific audiences (e.g. full-time conservation practitioners). Similarly, email is not generally useful for communicating with non-specialist audiences, particularly in rural areas.

The term 'ecosystem-based management' and the abbreviation 'EBM' should be avoided with non-specialist audiences as they often create confusion. Focus on key messages instead.

Complex conceptual diagrams can be difficult to understand. Most resource managers in the region are more accustomed to using a simple table format.

Lastly, effective communication is often undermined by a failure to allocate adequate time and money allocated to communication activities in project proposals and work plans.

EXAMPLE | COMMUNICATIONS AND COMMUNITY MESSAGING IN MACUATA

The communities of Macuata Province in Fiji are geographically dispersed and have limited communications infrastructure. Many villages don't even own one telephone, meaning people may have to walk some distance to another village just to make a call.

To promote community participation in EBM management processes, and to ensure that management measures are clearly communicated to local communities, WWF has used a number of different communication methods. Firstly, the EBM partners raised funds for villagers to travel to planning meetings. Secondly, discussion of EBM activities was integrated into existing district and provincial government meetings. This approach makes efficient use of limited resources, and mainstreams EBM issues.

Initially, the EBM partners relied on village and district leaders to convey information to local communities via existing provincial, district and village meetings. However, it became apparent that information was not 'trickling down', with villagers complaining that they were uninformed about fisheries management rules and other measures.

To increase community awareness and ownership of EBM in Macuata, WWF established a 'Community Messaging' network to narrow the information gap between project managers, stakeholders, resource owners and settlers in Macuata. The network engages the services of village leaders to disseminate project information to each household in the 37 villages, and enables information to be distributed, feedback to be received and monitoring to occur.

The community messaging system is based around a 3-4 page newsletter, written in the local vernacular and produced every two months. Sufficient copies for every household are posted to each village headman, who distributes the newsletter to each household and obtains a signature from the head of each household to confirmed that they have been delivered. If the newsletter has questions requiring responses from the households, the responses are given to the village headman who posts them back to WWF, using a stamped, self-addressed envelope provided.

Community comments are published in the newsletter, and villagers are encouraged to submit questions about issues they would like addressed in the newsletter. Community messaging provides an opportunity for a diversity of voices to be heard, without overstepping customary protocol. In particular, community messaging has increased opportunities for women and youth to participate in management debates.

Community messaging has opened and maintained a direct line of communication between the project management team and every household in all 37 villages in the province, and has proved a very successful method for disseminating information and increasing understanding of natural resource management issues.

To date, the community messaging system remains reliant on WWF. However, it is a surprisingly inexpensive communications tool, requiring only the cost of printing (on an office printer), paper and postage. Thus, it could potentially be taken up by the provincial resource management committee or provincial government, if there is the will and the skills available to do so.

STEP 9 | ESTABLISH MONITORING AND RESEARCH PRIORITIES

To measure the effectiveness of ecosystem-based management, it is necessary to establish a plan for ongoing monitoring of key indicators. Improving the effectiveness of EBM over time, both within the management area and more broadly, may require further applied research.

MONITORING

EBM monitoring programs should be explicitly linked to management targets and threats and cover a range of biological and socioeconomic indicators across all ecosystem types within the management area. A suite of indicators should be identified to measure ecosystem function, service provision and management effectiveness. Monitoring should take place throughout the management cycle, and integrated into adaptive management. Target and limit reference points should be identified: target is the desired state, limit is the undesired state. If an ecosystem reaches the limit then it demands adaptive management.[158] Monitoring programs should be designed so that their scope and nature is consistent with available resources and technical capacity. In the Western Pacific context, community-based monitoring may play a useful role, but caution should be exercised when using data collected by non-specialists (see text box).

RESEARCH PRIORITIES

Ongoing scientific research can play a role in improving the effectiveness of management interventions, by generating knowledge about social and biological systems and building understanding of ecosystem processes. In the Western Pacific, limited availability of funding for biological research demands that practitioners focus on applied research that is closely aligned with local, national and regional management priorities. In particular, research that identifies robust and broadly applicable 'rules of thumb' for ecosystem management are particularly valuable.

EXAMPLE | BUILDING MONITORING CAPACITY IN LOCAL COMMUNITIES

In recent years, an increasing number of conservation initiatives in the Western Pacific have engaged local communities in biological monitoring. In particular, community-based monitoring is a key feature of the locally managed marine area (LMMA) model.

Community-based monitoring is a low cost method for obtaining site specific information for adaptive management, and community involvement increases local ownership and trust in research results. However, many practitioners have reservations about the quality and reliability of data collected by community members. In particular, concerns have been raised about the use of community monitoring data to measure the effect of management measures. Community monitoring can play a valuable role in ecosystem management, but it is important to be realistic about its limitations. It is particularly important to ensure that monitoring efforts are guided by clear and robust experimental design, with adequate training in sampling methods.

Certain monitoring techniques, including the underwater visual census (UVC) method, have inherent biases that are difficult to control in a community monitoring context. Priority should be given to monitoring methods that provide robust, relevant data for local fisheries management. Catch per unit effort (CPUE) monitoring is relatively simple and reliable, and provides information that is intuitively relevant to resource users. Analysis of landed catches (e.g. size distribution, trophic level) can also provide useful information about ecosystem health.[159]

[158] Kaufman L, Karrer LB, Peterson CH (2009) Monitoring and evaluation. In: McLeod K and Leslie H (eds) Ecosystem-Based Management for the Oceans. Island Press: Washington DC, pp. 115-128.

[159] Seidel H (2009) Evaluating the role of science in Community Based Adaptive Management of coastal resources in Fiji. MSc. Thesis, University of Bremen, Germany. <www.sprep.org/att/irc/ecopies/countries/fiji/88.pdf>, accessed 30 September 2009.

STEP 10 | ESTABLISH REVIEW AND ADAPTATION PROCESSES

ADAPTIVE MANAGEMENT

Effective EBM demands an adaptive approach to management. Adaptive management is 'the integration of design, management, and monitoring to systematically test assumptions in order to adapt and learn'.[160]

To implement an adaptive management approach, it is necessary to examine the key values and threats in the management area, develop a set of assumptions about what is occurring and what actions might be used to maintain and restore these values. These actions are then implemented, and their results carefully monitored to develop an understanding of which actions work and which do not, and why.

If your management actions do not achieve their desired results, it may be because your assumptions were wrong, the management actions were poorly executed, the conditions in the management area have changed, the monitoring was faulty – or a combination of these problems. The management actions should be modified to reflect information obtained through monitoring (**Figure 5.5**).[161]

Systematically documenting the management process and results enables the conservation community to benefit from your experiences. Other conservation practitioners are keen to learn from your successes and failures, so that they can design and manage more effective management interventions

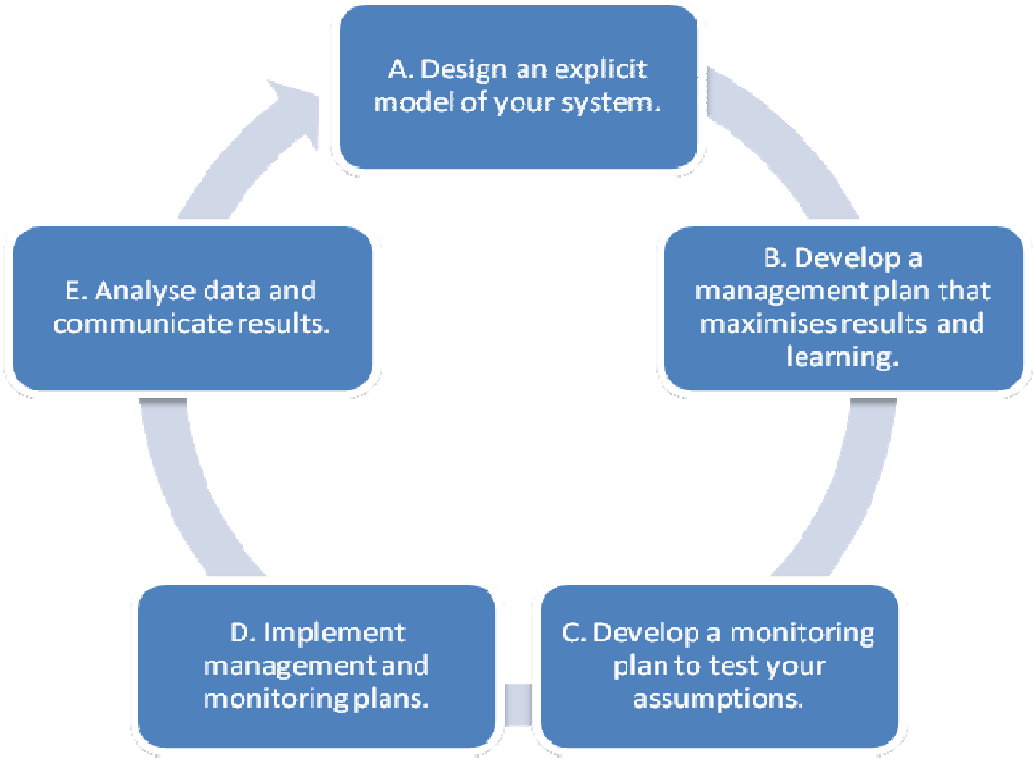


Figure 5.5. The adaptive management cycle.[162]

[160] Salafsky N, Margoluis R, Redford K (2001). Adaptive Management: A Tool for Conservation Practitioners. Biodiversity Support Program, Washington DC. Also available online: www.fosonline.org/resources/Publications/AdapManHTML/adman_1.html

[161] Ibid.

[162] Margoluis R, Salafsky N (1998) Measures of Success: Designing, Managing, and Monitoring Conservation and Development Projects. Island Press, Washington, D.C..

REVIEW AND AMENDMENT PROCESSES

To allow for adaptation of management measures, it is important to establish an agreed process for amending management rules and actions.

The process for amending a management plan should balance simplicity and flexibility with transparency and due process. The process should provide an opportunity for affected stakeholders to comment on the proposed amendment and set minimum standards for notifying stakeholders of approved changes.

Ordinarily, amendments will need to be authorised by the individual or institution that created the original rule. For example, in Fiji, only the Minister for Forests may modify the boundaries of a declared nature reserve. In the case of community rules, the amendment process should respect traditional protocols.

It may be necessary to take special measures to ensure consistency and integration across different management systems – for example, if community based management decisions have been reflected in government licensing decisions, the community will need to liaise with the relevant government agency to ensure that any changes to community management rules are adequately reflected in government issued licences.

In Kubulau, the EBM management plan sets outs procedures for amending management rules and actions. The process for amending the plan is modelled closely on traditional decision-making processes and authority structures, with additional consultation and notification requirements aimed at ensuring affected stakeholders understand and respect proposed changes to the plan.

In Macuata, WWF facilitated a participatory process to reconfigure the province's protected areas network (see text box). The process resulted in a larger network, covering a more diverse range of ecosystem types.

EXAMPLE | RECONFIGURATION OF THE MACUATA PROTECTED AREA NETWORK

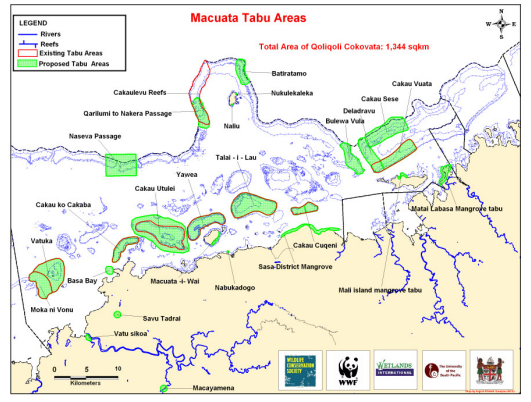


Figure 5.6. Existing and proposed *tabu* areas, Macuata.

In 2008, WWF facilitated a participatory process aimed at reconfiguring and expanding the network of protected areas in Macuata (Fiji). The reconfiguration process was informed by extensive marine and freshwater research, as well as socio-economic surveys. The key stages in the process were:

1. *Planning meeting:* Qoliqoli Management Committee (QMC) met with EBM partners to plan consultation process.

2. *Provincial meeting:* representatives from all 37 villages met to hear research results and map new protected areas.

3. *Village meetings:* village leaders organised 37 village meetings to discuss protected areas and provide feedback.

4. *Public meeting:* WWF and QMC organised an open public meeting to seek feedback on proposed protected areas.

5. *Provincial meeting:* village representatives met to consider community feedback and formulate recommendations.

6. *Final endorsement:* QMC made its final decision, informed by recommendations from provincial meeting.

6. USING EBM TOOLS IN THE WESTERN PACIFIC

Throughout this guide, the importance of integrating scientific and local information into ecosystem-based management planning processes has been stressed. Many EBM tools have been recently developed to synthesize data and support management decisions, ranging from prioritizing areas for land management to evaluating potential for larval connectivity to determining which stakeholders are the most influential for implementing management actions.

While many tools have been successfully applied towards improved ecosystem management,[163] it is critical to recognize that the outputs of the tools are only as good as the input data, which may be very deficient in the Western Pacific. Secondly, because a large number of these tools were designed for well-resourced, developed countries, their applications in the tropical Western Pacific may be limited by low technical capacity to operate the models and, in some cases, a general mistrust of computer-generated models.

At the individual community-level, spatial planning tools are typically not needed as the number of potential management decisions (including options for setting aside protected areas) is likely to be small and can be easily assessed against socioeconomic constraints. However, planning maps may still have high value as communications tools, particularly overlays of biological information and traditional ecological knowledge on readily available platforms such as Google Earth.[164] Furthermore, visualisation tools, such as conceptual modelling diagrams,[165] may help facilitate understanding of complex ecological and oceanographic processes. However, it is recognized that visuals in many current applications are designed specifically for temperate, developed systems and may require further modification to make them applicable in the tropical Western Pacific.

WHAT ARE EBM TOOLS?

The Ecosystem-Based Management Tools Network (www.ebmtools.org) provides the following definition of EBM Tools:

"EBM tools are software or other highly documented methods that can help implement EBM by:

- Providing models of ecosystems or key ecosystem processes;
- Generating scenarios illustrating the consequences of difference management decisions on natural resources and the economy; and
- Facilitating stakeholder involvement in planning processes.

EBM tools include: data collection and management tools; data processing tools; conceptual modelling tools; modelling and analysis tools (such as watershed models, marine ecosystem models, dispersal models, habitat models, socioeconomic models, and model development tools); scenario visualisation tools; decision support tools (such as coastal zone management tools, fisheries management tools, conservation and restoration site selection tools, land use planning tools, and hazard assessment and resilience planning tools; project management tools; stakeholder communication and engagement tools; and monitoring and assessment tools."[166]

[163] Pattison D, dosReis D, Smillie H (2004) An inventory of GIS-based decision-support tools for MPAs. National Oceanic and Atmospheric Administration, National Marine Protected Areas Center, Silver Spring, MD, 20 pp.

[164] Report on the 2009 Pacific Ecosystem-Based Management (EBM) Workshop, 10-11 August 2009, Suva, Fiji.

[165] E.g. Integration and Application Network symbols library, <ian.umces.edu/symbols>, accessed 17 December 2009

[166] Ecosystem-Based Management Tools Network. <www.ebmtools.org/>, accessed 17 December 2009

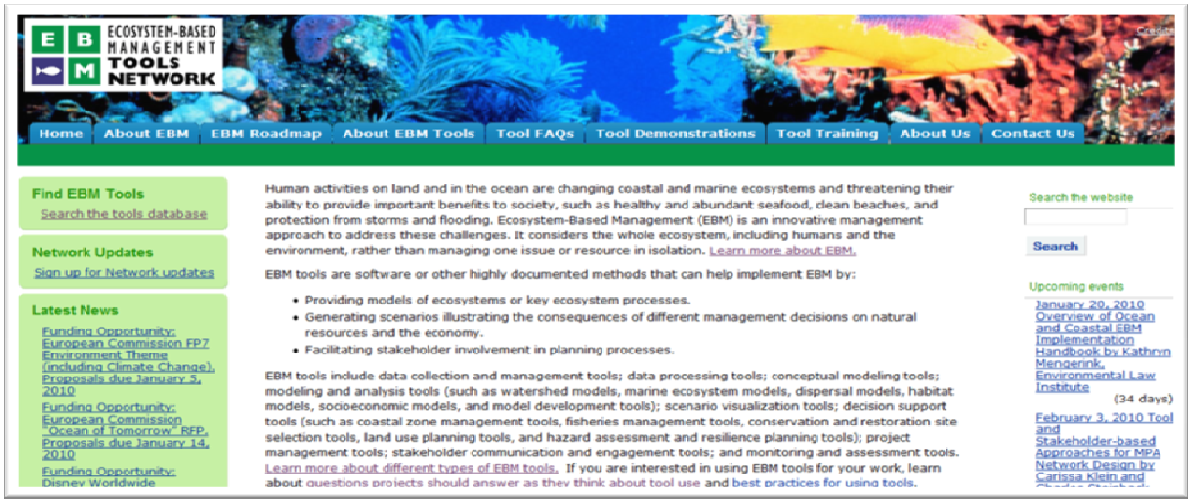


Figure 6.1. The EBM Tools website provides access to a wide range of useful EBM tools (www.ebmtools.org).

Across larger planning scales (e.g. provincial, national, regional), EBM tools and models may have more applicability if they are able to answer specific questions that are relevant to those who will be implementing management decisions on the ground. In addition, given the general lack of data, local and scientific experts need to work closely with the modellers in order to arrive at realistic outputs.

There is some consensus that top-down conservation planning can work in the tropical Western Pacific, but only if it is combined with successful bottom-up, community-based implementation. In the Kimbe Bay example discussed in Chapter 4 (In Focus: Designing Protected Areas), The Nature Conservancy used outputs from Marxan modelling as a "blueprint to focus conservation efforts in the bay".[167] Within each area of interest highlighted as a priority for inclusion within a resilient MPA network, TNC is working through a process to build community-based planning initiatives that include:

- community engagement to introduce the concept of the MPA network;
- community visioning to set goals and delineate boundaries of their locally managed marine areas (LMMAs);
- participatory conservation planning to identify values relevant to each community; and
- development and endorsement of LMMA plans by communities and agreements to achieve the conservation visions.

The successful use of EBM tools in the Western Pacific, therefore, may ultimately rely on how well the outputs complement local objectives. Where communities or site managers are willing and able to implement the resulting management recommendations, biodiversity conservation and protection of natural resources will be enhanced. However, conservation planners should be aware that there may be very valid socioeconomic and/or governance constraints that prevent communities or site managers from initiating management in some areas that EBM tools models prioritize for protection.

[167] Green A, Lokani P, Sheppard S, Almany J, et al. (2007) Scientific design of a resilient network of marine protected areas. TNC Pacific Island Countries Report No 2/07, Brisbane, Australia, 45 pp.

7. SCALING UP ECOSYSTEM BASED MANAGEMENT

The case studies presented in this guide range in scale from a small rural district to a broad seascape, and illustrate the value of EBM as a flexible and effective approach to site-based conservation. However, EBM is not exclusively about site-based conservation: EBM principles may usefully be applied at broader scales, and integrated into national and sub-national policies and programmes.

In the Western Pacific, conservation practitioners can play an important role in 'scaling up' EBM by:

- communicating the principles, methods and results of EBM in the field;
- promoting integration of government policy and decision-making processes;
- promoting policy and law reform that reflects EBM principles; and
- collaborating with government agencies on program design and fundraising.

COMMUNICATING RESULTS

Site-based conservation provides important lessons for broader policy processes. By clearly and actively communicating the results of EBM practice to government, conservation practitioners can demonstrate the benefits of an integrated approach to environmental and natural resource management.

Effective communication with government requires an understanding of the policy priorities of each relevant agency, and may involve assessing and presenting the benefits of EBM in socio-economic terms.

In Bird's Head (Indonesia), economic analysis of the costs of unregulated over-exploitation of anchovy persuaded the fisheries department to take immediate action to regulate the fishery, thus protecting an important food source for both humans and piscivorous fishes such as tuna.

PROMOTING INSTITUTIONAL INTEGRATION

Government agencies in the Western Pacific typically operate within significant financial and human resource constraints, and there are often limited internal and external structures for cross-sectoral engagement. Consequently, government agencies tend to adopt a fragmented approach to management of natural resources and the environment. In many cases, this fragmentation leads to poor ecosystem management outcomes.

Through their work in the field, conservation practitioners can model cross-sectoral approaches to ecosystem management, and identify practical opportunities for improved institutional integration at the government level. In Fiji, conservation practitioners have played an active role in the establishment of a national Protected Areas Committee, a cross-sectoral forum that brings together a range of government agencies, academics and NGOs (see text box below).

PROMOTING POLICY AND LAW REFORM

Conservation practitioners can play an important role in promoting the adoption of policies and laws that reflect contemporary conservation science and practice. To effectively influence government policy, practitioners need to present persuasive evidence of the benefits of EBM to officials with influence and decision-making power.

In the Western Pacific, it is particularly important to establish personal contact with government decision-makers. By fostering close working relationships with government officials, conservation practitioners improve their ability to inform and influence government policies and programmes.

Proposals for policy and law reform should be aligned to existing government priorities – for example, priorities identified in the National Biodiversity Strategy and Action Plan (NBSAP).

Photo Credit: Stacy Jupiter

EXAMPLE | NATIONAL GAP ANALYSIS IN FIJI

As signatories to the *Convention on Biological Diversity*, most Western Pacific nations have committed to completing a national-scale ecological gap assessment to expand upon the amount of land and sea area under protection within their territories. In order to complete such an analysis and determine the minimum size requirements for protected areas, data are needed on: how species or ecosystems are distributed; the ecological processes that maintain these biodiversity patterns; and the threats to biodiversity.

In Fiji, a cross-disciplinary, multi-stakeholder Protected Area Committee (PAC) has been established to provide technical advice to the National Environment Council. The PAC is composed of representatives from government, non-government and private sector. Its tasks for completion of the ecological gap analysis include:

- Identify key biodiversity values and set quantitative, time-bound targets for biodiversity protection;
- Evaluate and map the occurrence and status of critical biodiversity in a spatial database;
- Analyse and map the occurrence and status of existing protected areas;
- Compare maps of biodiversity with maps of existing protected areas to identify gaps against targets for protection;
- Develop a complete list of priority sites for protection;
- Identify four sites to extend existing protected areas or create new protected areas and organize wide participatory discussions in each area;
- Provide capacity building and assistance to local communities at each site; and
- Share lessons learned in a policy summary which can be used for development of future protected areas.

8. KEY LESSONS LEARNT

Ecosystem-based management practitioners working in the tropical Western Pacific have noted that their experience of EBM practice has shared certain common features, and that these experiences differ from EBM practice in other regions of the world.

The tropical Western Pacific is characterised by high levels of reliance on coastal marine resources, limited government management capacity and strong traditions of community-based natural resource management.

High levels of natural resource dependence demand an approach to EBM that recognises the economic, social and cultural importance of continued resource use, while working to ensure that the use of those resources is sustainable over time.

Traditional belief systems in the region emphasise the strong relationship between people, land and sea, but the effectiveness of government interventions in natural resource management issues is often undermined by fragmentation of responsibilities within and between government agencies.

COMMUNITY-BASED MANAGEMENT

In the tropical Western Pacific, community-based management has emerged as the most widely accepted approach to natural resource management and biodiversity conservation. In practice, site-based conservation in the region often reflects a hybrid approach, in which active community involvement and control is combined with varying degrees of external support and influence.

Regardless of the manner in which they are initiated, it is essential that ecosystem management processes respect the needs, interests, rights and aspirations of local resource owning communities, and contribute to local conservation and development goals, not just national and international targets.

Direct involvement of local communities in management planning ensures that local knowledge, needs and priorities are incorporated in management decisions in ways that increase community ownership of the management process.

In the Western Pacific, effective EBM often requires an understanding of social and cultural connectivity. Kinship ties, historical relationships and cultural obligations play an important role in decisions about use and management of natural resources in the region, and may present opportunities for integrated management of ecosystems.

Management planning processes that respect and reinforce the roles of traditional leaders, while providing opportunities for broad community engagement, strengthen long-term prospects for successful community-based resource governance.

ADAPTIVE MANAGEMENT

In the Western Pacific, limited availability of data and the complexity of key ecosystems require an iterative and adaptive approach to ecosystem management. However, limited financial, human and technical resources in the region makes sophisticated large-scale adaptive management largely unrealistic.

Community-based adaptive management that combines traditional and local knowledge, scientifically sound monitoring methods and responsive decision-making processes provides a strong foundation for improving the management of ecosystems over time and responding to new challenges, including the impacts of climate change.

CLIMATE CHANGE ADAPTATION

Ecosystem-based adaptation provides a cost effective strategy for reducing vulnerability to climate change impacts and increasing resilience, while maintaining ecosystem services and sustainable livelihoods in the face of climate change.

Ecosystem-based adaptation and community-based natural resource management are mutually supportive. Strong traditions of local governance, communal resource tenure and traditional and local ecological knowledge present fertile conditions for community-based adaptation in the Western Pacific.

Examples of ecosystem-based adaption measures that can be implemented at the community level include: managing fishing pressure to maintain coral reef resilience; protecting and restoring mangroves; and, protecting and restoring water catchment areas. All of hese measures, however, should be applied to maintain ecosystem function regardless of whether or not adaptation to climate change is a specified goal.

LOCAL AND TRADITIONAL KNOWLEDGE

The region is endowed with a rich heritage of local knowledge and traditional resource management practices, informed by generations of intimate association with terrestrial and marine ecosystems. EBM presents opportunities for integrating local knowledge with existing and emerging scientific knowledge about ecosystem functions and processes.

BUILDING PARTNERSHIPS

Effective EBM requires identification of the full range of stakeholders and strategic decisions about engaging stakeholders in the process of change. Collaborative partnerships greatly enhance management effectiveness, by bringing together organisations with diverse expertise, roles and resources. The establishment of partnerships promotes coordination and integration of management activities, improves efficiency and promotes shared solutions to ecological challenges.

IDENTIFYING ECOSYSTEM VALUES

Effective EBM requires an understanding of the species, habitats and ecosystem processes in the management area. Biological surveys and local ecological knowledge are both useful tools for identifying conservation values and threats.

Integration of economic, social and cultural values into management processes is a central tenet of EBM. By understanding the values that people place on an ecosystem, EBM practitioners are better able to understand the drivers of change in the ecosystem, and constraints on management responses.

INSTITUTIONS AND DECISION-MAKING

Conservation practitioners must have a clear understanding of the context in which they operate and identify opportunities to link their work with existing policies, programmes, institutions and decision-making processes.

Customary resource tenure is a key factor in natural resource management in the Western Pacific. In many cases, effective conservation practice requires an understanding of both legal and traditional resource rights and decision-making processes. In practice, traditional governance systems remain the primary mechanism for regulating the use of terrestrial and marine resources in many contemporary Pacific island communities.

Gaining a clear understanding of decision-making processes can greatly enhance the effectiveness of EBM initiatives. Local staff provide vital insights into traditional authority structures and community decision-making processes. Socio-cultural research may also provide useful information about formal and informal decision-making processes.

Due to its cross-sectoral nature, EBM may require the involvement of a number of existing institutions, or the establishment of new institutions or coordination mechanisms. In the Western Pacific, interactions between traditional institutions and government are particularly important – in many rural communities, traditional leaders exercise greater influence than government agencies. In this context, engaging traditional leaders in planning and decision-making is an essential element of effective EBM practice.

MANAGEMENT PLANNING

Effective EBM requires the identification of goals and conservation targets that reflect the interconnected nature of ecosystems and their multiple natural, social, cultural and economic values.

Engaging resource owners and users, experts and management agencies in collaborative planning processes provides opportunities for identifying management goals and targets that integrate stakeholder concerns and priorities with scientific and traditional ecological knowledge.

USING SCIENCE EFFECTIVELY

Scientific principles, knowledge and research methods are powerful tools for management planning, and have a central role to play in the identification of management targets, threats and responses.

To increase the likelihood of implementation of recommendations of scientific studies, science needs to address the highest priority management questions, including social and economic issues. Research should be applied, not theoretical, and research findings must be clearly communicated to decision-makers.

Scientific research is most useful when: studies are based on sound principles and are well-designed; the results reflect a consensus of expert opinions; research outcomes can be easily interpreted and turned into targets that can be monitored; and management strategies based on the findings can be applied generally throughout an entire region, taking into account local context.

Science is best understood and most likely to be applied when the local managers and scientists are able to participate in data collection and experiential learning.

PROTECTED AREA DESIGN

The establishment and management of protected area networks is an important strategy for maintaining ecosystem integrity.

To increase their effectiveness, and enhance resilience to climate change, protected areas should be large, representative and connected. Particular emphasis should be placed on maintaining ecological processes that promote resilience to disturbance.

However, in the tropical Western Pacific, socioeconomic and governance constraints will often play a larger role than ecological considerations in determining the ultimate size, shape and placement of protected areas.

MPA effectiveness in much of the Western Pacific depends upon making the networks socially acceptable within a customary marine tenure framework. Successful management implementation will also require that the users perceive equitable distribution of biological and social costs and benefits of closures from protected areas.

Protected areas should be embedded within a broader ecosystem management regime that provides protection outside of reserves.

MANAGEMENT IMPLEMENTATION

Effective EBM requires careful attention to implementation of management rules and actions. Responsibilities and timeframes for implementation should be clearly identified, with mechanisms for periodically reviewing progress on implementation.

Management rules are unlikely to be effective without active efforts to promote compliance, including awareness raising, monitoring, surveillance and enforcement. Management activities can be resource intensive, and consideration should be given to appropriate sustainable financing models.

EDUCATION AND COMMUNICATION

Education and communication programs play a vital role in ecosystem-based management. In particular, well-planned education and communication programs: raise awareness of ecosystem values, threats and contributing factors; encourage behavioural or policy change; and, build capacity to effectively implement management responses.

In the Western Pacific, key messages are often best communicated during informal gatherings. Newsletters and fact sheets (in the local language) focused on key messages are effective within communities. Verbal communication is important to reinforce messages delivered in printed material.

Effective communication is often undermined by a failure to allocate adequate time and money allocated to communication activities in project proposals and work plans.

MONITORING AND ADAPTIVE MANAGEMENT

To measure the effectiveness of ecosystem-based management, it is necessary to establish a plan for ongoing monitoring of key indicators. EBM monitoring programs should be explicitly linked to management targets and threats and cover a range of biological and socioeconomic indicators across all ecosystem types within the management area. In the Western Pacific context, community-based monitoring may play a useful role, but caution should be exercised when using data collected by non-specialists.

Effective EBM demands an adaptive approach to management. To allow for adaptation of management measures, it is important to establish an agreed process for amending management rules and actions. In the Western Pacific, adaptive management may require special measures to harmonise traditional and formal management systems.

USE OF EBM TOOLS

Many EBM tools were designed for use in developed countries. Consequently, their applications in the Western Pacific may be limited by lack of technical capacity, data deficiencies and, in some cases, mistrust of computer-generated models.

The successful use of EBM tools in the Western Pacific may ultimately rely on how well the outputs complement local objectives. Where communities or site managers are willing and able to implement the resulting management recommendations, biodiversity conservation and protection of natural resources will be enhanced.

However, conservation planners should be aware that there may be valid socioeconomic and/or governance constraints that prevent communities or site managers from initiating management in some areas that EBM tools models prioritize for protection.

SCALING UP

EBM is not exclusively about site-based conservation: EBM principles may usefully be applied at broader scales, and integrated into national and sub-national policies and programmes. In the Western Pacific, conservation practitioners can play an important role in 'scaling up' EBM by:

- communicating the principles, methods and results of EBM in the field;
- promoting integration of government policy and decision-making processes;
- promoting policy and law reform that reflects EBM principles; and
- collaborating with government agencies on program design and fundraising.

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