Design of Realistic Hybrid Marine Resource Management Programs in Oceania

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Design of Realistic Hybrid Marine Resource Management Programs in Oceania[1]

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Abstract: This review article synthesizes the authors' several decades of multidisciplinary natural and social science and applied marine resource management experience in the Asia-Pacific region to examine the strengthening of coastal and marine resource management and conservation using alliances between local communities and external institutions. The objective is to assist the design of resource management and conservation programs that enhance the capacity of coastal communities in Oceania to confront both diminishing marine resources and the effects of climate change by providing guidelines for protecting marine biodiversity and vulnerable ecosystem functions. This article describes a management framework that hybridizes local beliefs and institutions expressed in customary management (CM) with such modern management concepts as marine protected areas (MPAs) and ecosystem-based management (EBM). Hybrid management accommodates the social, political, economic, and cultural contexts of Oceanic communities and, compared with recent or conventional management approaches, can therefore better address fundamental local concerns such as coastal degradation, climate change, sea level rise, weak governance, corruption, limited resources and staff to manage and monitor marine resources, and increasing poverty. Research on the hybridization of management systems demonstrates opportunities to establish context-appropriate EBM and/or other managerial arrangements that include terrestrial and adjacent coastal-marine ecosystems. Formal and informal CM systems are widespread in Oceania and in some parts of Southeast Asia, and if appropriate strategies are employed rapid progress toward hybrid CM-EBM could be enabled.

The complex social and ecological processes that characterize human-environmental interactions are difficult to identify (Liu et al. 2007, Levin and Lubchenco 2008, Cinner et al. 2009, Gelcich et al. 2010). This is particularly so for coastal ecosystems experiencing environmental degradation and transformations, such as accelerated sedimentation from terrestrial activities and rising sea levels, thought to be related to climate change. In

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response there have been calls (e.g., Hughes et al. 2005, McClanahan et al. 2008) to implement comprehensive management using tools that include fishing regulations and quotas, marine protected areas (MPAs), and ecosystem-based management (EBM). A variety of interventions, like social safety nets, evacuation from vulnerable sites, and diversification within fisheries, could also enhance adaptive capacity, ameliorate social and economic sensitivity, and reduce exposure to climate change (Cinner et al. 2012).

Although interventions at all scales are required, cautious and realistic expectations should guide implementation of local programs, given an intensifying ecological degradation throughout the insular Pacific. Lacking a cultural idiom to translate outside management objectives into local contexts and goals, international, central government, or nongovernmental organization (NGO)-sponsored management initiatives such as "no-take" and large marine reserves and ecosystem-based-management (EBM) could be viewed with suspicion by provincial governments. Further, they might be flouted at the local level, especially when human health or social and economic issues are perceived as having higher priority. Consequently, local hybrid management systems that combine various forms of management with local governance institutions, political processes, and social and economic concerns compose a basic part of any foundation for social change and sustainable resource use (Christie et al. 2007, Ban et al. 2011, Aswani et al. 2012).

In this contribution we examine the strengthening of coastal and marine resource management and conservation in Oceania, based on alliances among international institutions, local communities, NGOs, and regional and national governmental authorities. We build on our combined decades of multidisciplinary natural and social science research and applied marine resource management experience and publications in the Asia-Pacific region, particularly on Cinner and Aswani (2007), Ruddle and Hickey (2008), Ruddle and Satria (2010), and Aswani et al. (2012). To achieve this, we review and synthesize the intersecting topics of customary management (CM) and EBM within the context of coastal-marine conservation and the protection of marine biodiversity and ecological functions of vulnerable ecosystems. We focus on the two key issues of design considerations for marine protected areas (MPAs) and a research agenda for examining issues related to climate change in Oceania. Emphasis is placed on location-specific social and ecological processes, recognizing the interconnectivity within and between ecological systems, and integrating cultural, economic, political, and social processes (Communication Partnership for Science and the Sea [COMPASS] 2005). The general objective is to consider guidelines for designing local hybrid management systems that enhance the social and ecological capacity of coastal communities to adapt to widespread resource overexploitation and the presumed effects of global climate change, because our experience shows that there are more benefits than limitations in scaling down when designing resource management and conservation plans (Mills et al. 2010, Aswani 2011). However, in so doing it is not our intention to dismiss the important role of regional or international initiatives (Lowry et al. 2009, Ban et al. 2011).

CUSTOMARY MANAGEMENT AS THE FOUNDATION

In a Pacific island context the foundation for developing hybrid preventive and adaptive management plans begins with understanding and building on CM systems (Johannes 1978, Cinner and Aswani 2007, Ruddle and Hickey 2008). Although particularly applicable to Melanesia, in most Pacific islands and some parts of Southeast Asia societies either retain or historically have had some form of CM that is remembered and therefore could be revived, adapted, or hybridized to perform modern management and conservation tasks. However, this will require local resolve and capacity to protect the environment from political corruption and concomitant capital resource extraction (e.g., Lawson 1996, Johannes 2003, Ruddle and Hickey 2008), as well as sustained governance, financial and educational support from government and

nongovernment agencies and organizations, and, in particular, training to understand hybrid Local Ecological Knowledge [LEK]-Western science models.

Research is increasingly showing that schemes pairing and integrating government or NGO-sponsored resource management plans with local needs and concerns are largely successful at meeting social and ecological objectives. At minimum in the insular Pacific this will require an understanding of CM systems and integration of aspects of that system with any management scheme. Commonly, CM is an indigenous system that mediates between people and the environment to regulate the use, access, and transfer of natural resources. It is informed by LEK and embedded in indigenous land and sea tenure systems (Cinner and Aswani 2007). CM systems across the Pacific are not static and are informed by diverse and changing social, cultural, and political processes.

From the late 1970s and early 1980s preexisting (usually termed "traditional," "customary," or "de facto" [Ruddle and Satria 2010]) management that predated "conventional" or "modern" fisheries management became an important research topic among social scientists, as demonstrated by Cordell (1977), Johannes (1977, 1978, 1981, 1982), Ruddle and Akimichi (1984), and Ruddle and Johannes (1985, 1990). Over the last 30 years, preexisting rights have become important for modern fisheries management (e.g., Ruddle 1998*a*, Fa'asili and Kelokolo 1999, Johannes 2002, Veitayaki et al. 2005) and now provide an underlying framework in Samoa (Fa'asili and Kelokolo 1999), Solomon Islands (Aswani and Hamilton 2004), and Vanuatu (Johannes 1998*a*, Johannes and Hickey 2004), among other places (see Cinner and Aswani 2007). Preexisting rights have been used to design and exercise the rights of management and exclusion for use in present-day fisheries because it has been recognized that the underlying characteristics of nearshore fisheries in Oceania are vastly different from those for which the conventional approaches of Western science were developed. Further, the various approaches of Western fisheries science have not been successful in managing nearshore fisheries in Oceania, whereas the underlying knowledge and principles of preexisting systems provide proven alternative approaches to management, because they are preadapted to the characteristics of nearshore fisheries and cultural contexts in Oceania (Ruddle 1994*a*, Ruddle and Hickey 2008, Ruddle and Satria 2010).

However, working with CM systems is challenging, and a number of conceptual hurdles must be overcome before hybridization can be pursued. In particular, the fundamental components of preexisting CM systems must be recognized and defined. Ruttley (1987) and others (e.g., Ruddle 1994*a*, Cinner et al. 2012) observed that it is essential to understand that there exists great cultural variety in CM systems. This makes generalizations extremely difficult and often untenable. It is a complex issue because CM systems cannot be described in normative, immutable terms. Rather, they are dynamic and continuously adapting to both external as well as internal and local experiences and pressures, many of which are not related directly to the fisheries sector (Ruddle 1994*b*). Finally, although tempting in an era of "resurgent irrationalism" (Davis and Ruddle 2009:892), participants in local management systems cannot be assumed a priori as being inherently benign resource conservationists and socially equitable actors (Ruddle 1994*b*, 1998*a*). To uncritically accept that they are is naïve, although politically correct.

As noted by Ruddle (1989, 1998*a*, Ruddle and Hickey 2008), it is fundamental to understand that, unlike science-based fisheries management, CM systems are focused on resolving "gear externalities" (i.e., conflict between different types of fishing gear) and "allocation problems." These management issues are defined in terms of geographical areas and controlled access, are self-monitored by the local fishers, and are enforced by local moral and political authority. Both the problems of gear externalities and assignment are overcome in CM at the first level by control of a fishing area, as a "property," and defining exactly, by "rights," who has access to that area. At the second level "rules of operational behavior" then specify assignments of time

and place within that space and group having access. The first level is sustained by rights of exclusion, or limited access, which maintain the private area of a community of local fishers against outsiders. The second level, intragroup operational rules, is sustained by local authority with the power to invoke sanctions on offenders.

Beyond the basic design principles of authority, rights, rules, monitoring and enforcement, and sanctions (Ruddle and Satria 2010) demonstrate some fundamental issues not usually examined in studies of CM systems (see also Ruddle 1994*a*, 1996). The first is that they function to manage fishing communities, not just fisheries ecosystems, and that CM exists to ensure community harmony and continuity, which commonly emphasizes the importance of ancestors, identity, and place (e.g., as described in Indonesia by Satria and Adhuri [2010], Batanes Province of the Philippines by Mangahas [2010], and Vietnam by Ruddle [1998*b*], Nguyen and Ruddle [2010], and Ruddle and Tuong [2009]).

On the other hand, it should not be forgotten that regional and global markets have a direct impact on CM systems by introducing incentives for individual profit at the expense of local social and economic equity, and thus often, but not always, undermining systems from within (Ruddle 1994*b*, Aswani 2002, Cinner et al. 2005, Cinner et al. 2009). A number of different processes can affect the ability of communities to enforce their CM systems, including population growth, leadership, settlement patterns, price fluctuations, and new commercial value for species previously without economic value, and these processes can either weaken or strengthen property rights, depending on context (Ruddle 1994*b*, Cinner and Aswani 2007). That means that CM systems, as other common property systems (Ostrom et al. 2007), are dynamic, historically conditioned, and deeply embedded in larger political, economic, and social realms. They have long been stressed by external factors that have radically changed systems and sometimes have led to their abandonment (Ruddle 1994*b*). That is not a new phenomenon, although it has become more intense with global cultural homogenization and foreign "assistance" strategies based on neoliberal principles (Davis and Ruddle 2012). Thus present-day variants of preexisting systems exist under environmental, social, economic, political, and demographic circumstances that often differ greatly from those of even the recent past. Nevertheless, there has been enough detailed documentation of CM systems at some stages of their history that they can provide valued information on their underlying principles (Ruddle 1994*a*). This establishes the foundation on which alternative and more appropriate non-Western systems can be designed to suit modern management conditions (Ruddle and Hickey 2008, Ruddle and Satria 2010). However, in some circumstances devolution or hybridization might not be an optimal solution (Ban et al. 2011), particularly near urban centers where CM systems have been irredeemably overwhelmed by economic development, population growth, in-migration, and urban sprawl (Ruddle 1994*b*). In sum, "policy and program decisions about the present-day and future usefulness of local management systems must be based on a clearheaded and realistic evaluation of the moral authority, motives, interests, and cultural conceptions that underpin and drive them" (Ruddle 1994*b*:2).

INTEGRATING CM AND EBM FOR RESOURCE MANAGEMENT

Although CM in Oceania and elsewhere is context-dependent and vulnerable to endogenous and exogenous transformations, in principle it can both sustain biological resources and be successfully adapted to modern fisheries management. For instance, interdisciplinary research has analyzed the effect of changing demographic, economic, and social factors on CM (Aswani 2002, Cinner et al. 2005), as well as the relationship between changing CM or semi-CM (hybrid or nascent) systems and the status of small-scale fisheries (Cinner et al. 2006, Turner et al. 2007), food security and health (Aswani and Furusawa 2007), and the introduction of diverse fishery management regimes (McClanahan and Cinner 2008, Aswani and Sabe-

tian 2010). Results suggest that functional CM practices display many of the core principles of EBM (as per McLeod et al. 2005). That is, the operators of CM throughout coastal areas themselves can enact resource access and use restrictions, gear restrictions, minimum size and catch limits, protection of breeding aggregations, and establish temporal or permanent marine closures. All these are core management practices in EBM plans. Despite the many different meanings ascribed to EBM, "it is important to note that the concept of ecosystem-based management is grounded in the idea that ultimately we are managing people's influences on ecosystems, not ecosystems themselves" (McLeod and Leslie 2009:5). This affords important social and ecological contexts for cross-fertilization, because "[w]hen considering long-term ecosystem-management goals, it is necessary to understand local social and ecological knowledge systems—which have evolved unique ecological, cultural, and social connections to origin of place. Such knowledge systems, whether developed through CM or through adoption of ICM principles, offer examples in which non-local management goals can be commensurate with local knowledge and needs" (Aswani et al. 2012:2).

COMMONALITIES BETWEEN CM AND EBM

Although EBM originated in the scientific "command and control" (Holling and Meffe 1996) of resources whereas CM is integral to an indigenous life shaped during protracted historical adaptation to local environments, their conceptual and operational principles exhibit several parallels that could permit synergistic interactions. There are three important commonalities. First is that Oceanic peoples commonly understand their territorial domains as being integrated, with terrestrial and marine spheres perceived as forming a continuum. Pacific island examples include the Hawaiian *ahupua'a* system (Kaneshiro et al. 2005), the Fijian *vanua* (Veitayaki et al. 2005), and the Roviana (Solomon Islands) *pepeso* (Aswani 1997). The term "*pepeso*" (lit. "ground") signifies an integrated domain comprising the four major zones of mainland, lagoon, outer barrier islands plus associated seaward intertidal habitats, and the open sea. Each domain is subdivided into named zones that represent resource use areas, geomorphological features that either facilitate or obstruct walking or navigating, cultural and historical markers that define land- and seascapes, areas where important biological events such as spawning aggregations occur, and zones that include various terrestrial and marine habitats. This Pacific islander conceptualization of the environment and governable property corresponds largely with the core EBM principle of interconnectivity between and within terrestrial and marine domains. Thus this important parallel could facilitate a synergy between these two models of environmental management.

A second important commonality is that many Pacific islanders own their territories communally and use various strategies, such as temporal and spatial closures, to control access to and use of resources. Throughout the region membership rights are allocated according to various social and cultural rules. These include birth (primary rights), marriage and residence (secondary rights), and the direct transfer of rights by local authorities (usufruct rights). However, the process of implementing resource use and access rights depends on kinship and social and cultural systems, which vary through Polynesia, Micronesia, and Melanesia (Ruddle 1994*a*, 1996). The key point is that territorial rights allow inclusive members to institute spatial, temporal, gear, effort, species, and catch restrictions. These strategies also lie at the core of EBM and general fisheries management. Local strategies can protect vulnerable species and habitats (i.e., biodiversity and ecosystem function), and areas vital during susceptible life cycle stages, like spawning and nursery grounds. Land and sea tenure systems, which are embedded in CM, potentially can protect ecosystem structure and function, and are specific to given localities. Theoretically this enables inclusive members to restrict deleterious human activities. However, this has not occurred in most places, owing to the introduction of capital extraction sustained by local and national corruption.

A third commonality is that beyond excludability and extractability controls CM members are generally considered to possess a holistic view of an environment. This is embedded in indigenous political, economic, social, and cultural systems and contrasts markedly with the more compartmentalized approach of Western science (e.g., Satria 2007, Satria and Adhuri 2010). Key to EBM is the integration of ecological, social, economic, and institutional perspectives, recognizing their strong interdependencies (Communication Partnership for Science and the Sea [COMPASS] 2005). This objective is shared by the indigenous social and ecological systems.

Initial efforts to hybridize local institutions with EBM should be guided by fundamental principles that go beyond the specific characteristics of individual systems (Cinner and Aswani 2007:211–212). First among them is that CM strategies are heterogeneous and context-dependent, thus interventions will be appropriate only under specific social, economic, political, and cultural conditions. A hybrid CM–EBM institution must match the various spatial scales at which resources are owned, used, and governed under CM systems with the scale of ecologically relevant processes. It should harness both scientific knowledge and LEK methods for detecting and reacting to changes in social and ecological systems. By implication the adaptive nature of hybrid management systems entails a legal capacity to enact and enforce decentralized management, through either CM institutions or village bylaws, and that joint management arrangements like CM and EBM are integrated at provincial and national levels. In this regard hybrid management strategies should embrace the utilitarian nature and goals of CM institutions. Finally, it should always be remembered that hybrid management has limits, such that it may not be appropriate everywhere. It will be limited in both what it can address and its ability to withstand social, economic, and political stresses and shocks.

Any form of environmental management in Oceania must accommodate local livelihood needs, governance, social dictates, economic conditions, and cultural idioms to become successfully integrated with local systems of management, preexisting or otherwise, that have evolved locally and become tailored to particular regional contexts. However, a hybrid CM–EBM system does not require full devolution of governance to local communities. Rather it can entail arrangements to allow representation of local resource management concerns in regional and national policies. A cost-effective way to implement a context-specific EBM and govern coastal resources can be the strengthening of existing CM systems and, within the broader context of national fisheries policies, provision of legal support for participants' rights to communally own and govern resources (Aswani et al. 2012, Cinner et al. 2012). In these ways the institutional and management mismatches between scales inherent in a Western approach, which entail costly and wasteful interagency collaboration, can be overcome.

MARINE PROTECTED AREA DESIGN IN OCEANIA

Many coastal communities in the Asia-Pacific region are experimenting independently with small temporal closures to deal with increasing marine resource scarcity (Ruddle and Satria 2010). These community-managed closures often permit periodic harvesting of resources either at set periods or to satisfy specific community needs (Bartlett et al. 2010, Daw et al. 2011). In general, MPAs form the core of hybridized CM–EBM systems. Notwithstanding various scientific and practical caveats, they can protect the functioning of marine ecosystems as well as enhance spawning stock biomass (by allowing for larval dispersal and the export of adults to adjacent nonprotected areas), maintain species diversity, preserve habitat, and sustain critical functional groups (Halpern 2003, Hughes et al. 2005, Mumby et al. 2006). However, the most appropriate form of MPA for inhabited areas of Oceania remains to be ascertained.

It has been argued that effective MPAs should cover up to thousands of kilometers, depending on environmental conditions (Man et al. 1995, Walters 2000). Others advocate

"no-take" reserves versus periodic closures, arguing that less-restrictive MPAs cannot protect biodiversity, key functional groups, and other longitudinal ecological processes, particularly under changing climatic conditions (McClanahan et al. 2008). However, Pacific islanders prefer smaller and temporal (i.e., nonpermanent closure) MPAs that mitigate negative economic impact of restrictions imposed by management. As a result state-sponsored plans focusing on protection of biodiversity and ecosystem functions through large "no-take" reserves (Worm et al. 2006) are likely to be ignored, owing to overriding concerns for human welfare, despite their clear importance for sustaining and fostering ecological services (Aswani et al. 2012).

Thus any hybrid CM–EBM initiative focusing mainly on MPAs should allow for community-managed marine closures to be periodic, either entirely or in part, and allow resources to be harvested either during set times or according to local cultural, political, or economic requirements. Although scientific understanding of these complex characteristics is limited, cases from Solomon Islands (Aswani et al. 2007), Vanuatu (Bartlett et al. 2010), Papua New Guinea (McClanahan et al. 2006), and eastern Indonesia (Evans et al. 1997) indicate that under certain social conditions (Daw et al. 2011) community-managed temporal MPAs can succeed biologically. That is because spatiotemporal closures are socially more acceptable than permanent reserves, being attuned closely to local concepts regarding governance as well as to cultural, economic, and social factors. Although suboptimal biological results may not be the most scientifically desirable outcome, temporal closure is better than unimpeded open access, because even within a CM system inclusive harvesters quickly overexploit resources in response to new markets for local products. Nevertheless, many questions remain regarding the biological and social effects of permanent and periodic closures in Oceania.

Regardless of type, all MPAs should aim to protect the prime habitats of a range of species, the spawning aggregations of vulnerable fish species, and habitats and species with important ecosystem functions. With outside assistance provided by NGOs, universities, or similar institutions, CM participants should strive to establish and strengthen MPAs with the support of local institutions (Cinner et al. 2012). The strategy employed in each location requires careful consideration and should build on past experiences, because wheels are constantly and wastefully being reinvented by each new batch of consultants, academic researchers, or advocates. Based on accurate, multidisciplinary data and evidence-based design, strategies should instead emphasize expansion of MPAs and a refinement of their location and spacing, thereby enabling adaptation to climate and environmental change, as well as to facilitate the adaptation of rules to local context and customs. As part of such a strategy MPA networks should ensure careful integration of validated LEK and CM institutions. Also crucial for improving the effectiveness of management is flexible monitoring. It should be introduced to measure social, economic, governance, and ecological changes resulting from the introduction of an MPA. That would involve local, regional, and national resource management committees to monitor and enforce compliance with MPA regulations and to develop revenue streams based on user fees, tourism, local fund-raising, and other economic activities to support its management financially.

An example of such a strategy is the more than 30 Solomon Island MPAs (Figure 1), designed by Aswani and his team and based on various multidisciplinary and participatory research approaches. These approaches to support this management outcome included ethnographic regional studies of customary sea tenure to assess the feasibility of implementing fisheries management in Solomon Islands, among other factors (Aswani 2002). Some approaches incorporated into a geographic information system (GIS) database the visual assessments of local aerial photo interpreters, who identified benthic habitats, resident taxa, and spatiotemporal events of biological significance (Aswani and Lauer 2006*a*). Fishing time series data (1994–2004) were incorporated into the GIS database to examine spatial

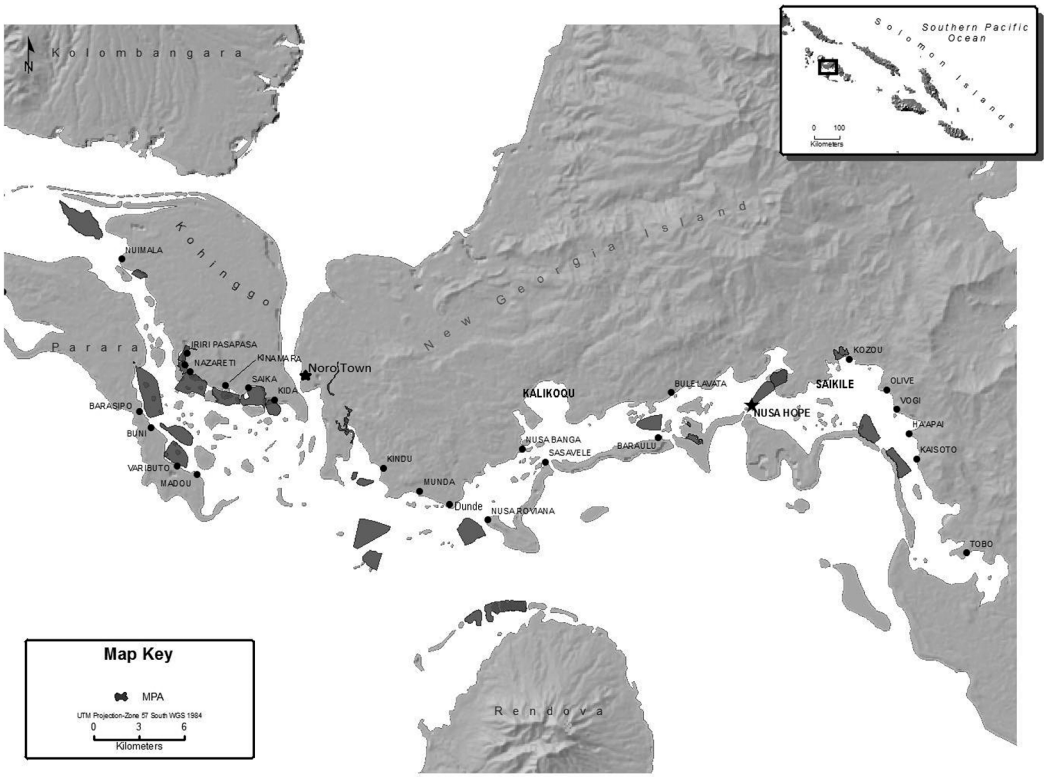

FIGURE 1. The MPA network in Roviana and Vonavona Lagoons, Solomon Islands.

and temporal patterns of fishing effort and yields (Aswani and Lauer [2006*b*]; see also the full method description in Aswani [2010]). In other approaches LEK was coupled with ecological surveys to study aspects of the life cycles of vulnerable species (Aswani and Hamilton 2004, Hamilton et al. 2005).

Pacific island countries have already evolving systems of MPAs at the national and/or local levels, and conservation practitioners could take advantage of the experiences they provide. In addition, a variety of strategies have been used to sustain MPAs, the most challenging aspect for researchers and conservation practitioners (Table 1).

To achieve comprehensive biodiversity conservation practitioners need to design adaptive and precautionary management strategies that evaluate the compatibility of LEK with marine science and the institutional reliability of sea-tenure institutions before their incorporation into plans to protect tropical habitats and species. Not only do practitioners need to select sites rich in biodiversity based on local and scientific assessments, but they also should include sites with minimal public contest over natural resources. Occasionally that may require selecting governable sites of little ecological significance, because exemplification of good governance can encourage later expansion into more ecologically significant areas as nearby communities gradually comprehend the value of resource management and conservation.

Harnessing local forms of sea tenure and knowledge is both an important step toward creating hybrid CM–EBM systems of management and an effective strategy when governments cannot effectively monitor and enforce regulations designed to limit resource

TABLE 1

Nine Strategies Employed in Solomon Islands for Sustainment of MPAs

1. Locating new MPAs	Establish where enforcement is most feasible, to provide realistic and viable examples
2. Restrictions	Work with local authorities to establish context-specific fisheries restrictions, especially to prohibit gear detrimental to particular functional groups (e.g., parrotfish)
3. New institutional infrastructure	Assist local, provincial, and national authorities to establish this at the local/village level (e.g., create resource management committees or involve local churches in conservation)
4. Hybrid governance initiatives	Work with governmental partners to establish hybrid governance
5. Environmental education and awareness	Foster this through community workshops and local field schools
6. Facilitate participatory development	Especially stabilize implementation in sites where resource management is contentious
7. Marine and social science research	Conduct to obtain baseline social and ecological data as well as to make social and ecological impact assessments
8. Train local rangers	For monitoring and management
9. Develop a regional protocol	For researching local governance (e.g., sea tenure regimes) and local perceptions (e.g., LEK) to facilitate the design and implementation of CM–EBM hybrid systems throughout Oceania

use, as has been the case throughout Oceania (Johannes 1998*b*). In this region, conservation practitioners have a rare opportunity to manage and conserve critical ecosystems in a culturally, politically, economically, and environmentally sound fashion. However, this requires innovative approaches such as those described in Table 2. In addition there are new challenges, particularly in parts of Oceania already confronting climatic and environmental change. Such a dynamic context demands research and adaptation planning that go beyond current approaches and result in MPAs within the framework of hybrid CM–EBM systems.

RESPONDING AND ADAPTING TO CLIMATE CHANGE

Global changes from a warming climate are expected to increase the vulnerability of many western Pacific coral reefs to local stress (e.g., Hughes et al. 2003, Hughes et al. 2005, Richmond et al. 2007). Communities throughout the Pacific islands are already experiencing the impact of local climate change. They are particularly susceptible to the specific changes caused by climate vulnerability, especially temperature fluctuations, altered weather patterns, precipitation cycles and hydrological

TABLE 2

The "SESAME" Principles

1. *S*implicity	A management system should be simple and easily understood by policy makers and resource users.
2. *E*xperimental	Given that there are no absolutes in management, conservation practitioners should be curious about local histories, customs, social-ecological interactions, and management options.
3. *S*trategic	Hybrid management programs should build on early successes in management and conservation.
4. *A*ppropriate	Standardized approaches to management will fail unless fitted to local context.
5. *M*ultidisciplinary	Hybrid approaches must include and balance social and natural science approaches.
6. *E*valuate	Practitioners to gauge what works and feed this information back into management.

Source: Adapted from Aswani et al. (2012) (principles formulated by Patrick Christie).

regimes, increases in soil and water salinity or acidity, erosion, and coral bleaching. Changes include increasing levels of climatic unpredictability (Barnett 2001) and therefore associated risks to the primary productivity and the very survival of coastal communities. Primary stress in western Pacific coral reefs also originates from local fishing activities, urbanization, and sedimentation of terrestrial origin caused by agriculture, logging, and mining (Ruddle 2011). The combination of more-extreme climate change and chronic forms of routine stress could act synergistically to accelerate the deterioration of coral reefs (Langdon et al. 2003). Fast-acting environmental disruptions, such as tsunamis, are likely to accelerate these processes and to have rapid and profound effects on the livelihood of communities, as was demonstrated in April 2007 in western Solomon Islands. Many coastal communities also experience disproportionate levels of poverty, exposure to pollutants, or abusive external appropriation of resources. Climate change exacerbates the negative impacts of these marginalizing characteristics (Crate and Nuttall 2009). There are many possible social and ecological responses, including migration; intensification of agriculture, fishing, and forestry; new trading strategies; and institutional transformation (Adger 2003, Cooper 2010, McClanahan and Cinner 2012).

A first step in designing adaptation is to conduct social and ecological research on local climate change, because that provides a measure of local perception of its effects (Roncoli et al. 2009). An advantage is that a local perspective allows researchers realistically to gauge local social and ecological effects of an otherwise elusive global phenomenon. Such local analyses are essential because responsible climate-change research must combine local, regional, and international geographical scales, and different levels of analysis. Climate-change events therefore raise critical questions regarding the social and ecological conditions that make some communities resistant and able to adapt when faced with rapid and protracted change. It is fundamental to distinguish and comprehend the ecological, social, economic, and health consequences of ongoing changes on human and natural systems provoked by climate change. Similarly, the responses of coastal populations to ecological and social disturbances caused, such as higher tides resulting from climate change, need to be elucidated. In a like manner, social drivers such as cultural norms, property regimes, economic welfare, and regulatory enforcement, together with ecological factors like high levels of biodiversity and changed abundance of key species, and community structures that enable communities to become more or less resistant to environmental disruption must be understood, as must CM systems that increase the ecological and social adaptability of coastal communities.

To explore those issues Aswani and colleagues recently conducted a multidisciplinary program that integrated LEK and scientific knowledge to assess the vulnerability of western Solomon Islands communities to the impact of climate change on food and other essential resources. The program measured the social and ecological effects of climate change and both rapid and protracted environmental disruption, and assessed the responses of a gradient of social, economic, and local governance systems throughout the region. The research permitted determination of the levels of impact of climate change–related phenomenon on household food security, well-being, health, and local ecosystems. More important, it enabled understanding of the social and ecological drivers or conditions (e.g., customary governance versus none) that may lead some communities to be more adaptable than others when faced with environmental change. The results of this program can assist Pacific island researchers to analyze local responses to change and the associated asymmetries between less or more adaptable communities. That would help fine-tune resource management plans, such as MPA networks throughout the region within the context of CM–EBM hybrid management.

As environmental uncertainty increases it is fundamental to protect the functions of vulnerable ecosystems using hybrids of CM and modern management systems. Researchers

can work toward increasing the adaptability of coastal communities by using MPAs and terrestrial reserve networks as tools for safeguarding ecological adaptability. They can also document local understandings of climate change and possible adaptive measures, and match this information with existing scientific data, where in existence. These are basic to enabling a better understanding of climate change and its relationships to resource management and use that increase social and ecological flexibility and adaptability to local environmental unpredictability, like experimenting with new crops. Such research also underpins development of the capacity of social groups such as those for youth, women, and church congregations to assess climate change and thereby better manage coastal resources. Already ongoing in many parts of the Pacific (e.g., Lefale 2010), these steps could serve coastal communities throughout Oceania to design management strategies for coping effectively with rapid local ecological transformations.

CONCLUSIONS

Guidelines have been presented for designing hybrid local management systems to increase the social and ecological adaptability of coastal communities in Oceania that face accelerating marine resource degradation and the local effects of global climate change. The strategies outlined are by no means exhaustive; many authors have examined ways in which various managerial arrangements can lead to sustainable artisanal and small-scale commercial fisheries (e.g., Ruddle 1998*a*, Johannes 2002, Cinner et al. 2012, Kittinger et al. 2009). However, the guidelines presented here provide an initial step in establishing hybrid management between local communities and outside agencies. The promotion of hybrid CM–EBM systems is not based on romantic notions that CM is unfailingly conducive to marine resource conservation but rather on a pragmatic approach to establishing workable management solutions. Although CM governance also includes watershed areas, its success at watershed-based management and controlling concomitant impacts on adjacent coastal ecosystems throughout Oceania is barely documented. In part the lack of success can be attributed to such modern capital investment pressures as logging, industrial agricultural plantations, and mining activities, which illustrate that CM is not always effective at regulating environmental exploitation (Ruddle 2011). In contrast, an excellent CM-based example has been provided from Lombok Island, Indonesia (Satria 2007, Satria and Adhuri 2010), in which the forest, farmland, and marine resource sections of a longitudinal profile have their own traditional management authority that shares a strong commitment to the integrated management of resources, resulting in a functional interdependence of their roles. Notwithstanding those caveats, integrated CM–EBM hybrid management designs can be more successful than top-down management plans of central governments.

It is important to recognize, however, that the outcomes of human behavior and ideas are conditional and dynamic, and that such a recognition is the soundest foundation on which to build a hybrid managerial partnership among governments, scientists, conservation practitioners, and indigenous peoples. Practitioners need to identify the forms of governance and management at various spatial and temporal scales that yield positive institutional results for environmental sustainability, social equity, and institutional endurance for both CM and EBM. Although CM–EBM hybridized programs are no panacea for marine management, they provide opportunities for managing marine resources cost-effectively and equitably, building on the best aspects of existing management systems. Ultimately, there is no local alternative to CM that, with legislative support, can foster environmental sustainability while upholding the Indigenous Rights of peoples of Oceania and elsewhere.

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