Scientific Evaluation in Women’s Participatory Management: Monitoring Marine Invertebrate Refugia in the Solomon Islands

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This paper summarizes the results of a women’s community-based marine protected area that has been successful in sustaining invertebrate biological resources and in promoting strong community support. We outline the project and the associated biological results, describe the processes involved in attaining a committed level of community participation, and review the lessons learned during the project’s implementation. We attribute the project’s preliminary success—improved shellfish biomass, enhanced local environmental awareness, and the reinvigoration of cultural management practices—to the following factors: 1) the high level of participatory involvement and community leadership; 2) the local perception that shell beds have recovered rapidly and the role that scientific evaluation has played in reinforcing this notion; 3) a research program that is cross-fertilizing indigenous and scientific ecological knowledge; 4) the unique marine tenure system that allows for the project’s development and the area’s policing; and 5) the tangible economic incentives created by the development project, which ultimately empowers local women. We hope that the project’s findings can be generalized to other regions of the world with operational sea-tenure regimes and that it can help to make the establishing of community-based marine protected areas (CBMPAs) across the Pacific region more effective.

Key words: women, marine protected areas, scientific evaluation, participatory management, marine invertebrates, Solomon Islands

Marine habitats throughout the insular Pacific are increasingly threatened by human activity. In recent years, marine protected areas (MPAs) have emerged as a popular means of conserving global biological diversity and safeguarding essential ecological processes through the control of human activities that disrupt or damage the marine environment. Marine protected areas can be valuable fisheries-management tools, particularly for multispecies tropical fisheries in which absolute yields are difficult to predict and in which there are multiple users and fishing techniques (Man, Law, and Polunin 1995; Russ 1994; Wantiez, Thollot, and Kulbicki 1997). Experts generally agree that MPAs can enhance spawning stock biomass, allow for larval dispersal and export of adults to adjacent unprotected areas (e.g., Johnson, Funicelli, and Bohnsack 1999; Russ and Alcala 1999), and result in a greater diversity of corals and other benthic organisms (e.g., Hoffmann 2002). Social and marine scientists have also examined the economic and social benefits of MPAs (e.g., Alder 1996), although the performance criteria used to determine successes or failures are still being developed. The concept and application of MPAs continues to evolve, with one recent shift toward testing and refining different participatory and collaborative management approaches to ensure that MPA policies designed to produce the expected biological benefits do not conflict with local social and economic needs and interests (e.g., Alder et al. 2002; Garcia Charton et al. 2000; Roberts and Hawkins 2000).

Co-management policy agreements between local communities and outside agencies presently enjoy the support of social scientists and a number of policy makers (e.g., Jenoft 2000; Orlove and Brush 1996), although authors differ regarding the optimum degree of power sharing between the two groups. Marine scientists, too, have come to realize the importance of including local communities and institutions in designing, establishing, and monitoring marine protected areas and spatiotemporal refugia (e.g., Castilla 1999; Russ and Alcala 1999). Participatory approaches empower local...
communities by recognizing their knowledge and customary rights, thus encouraging them to participate in management. Such approaches also recognize the impossibility of enforcing managerial initiatives if local stakeholders are excluded and their resource stewardship efforts are ignored (Agardy 1997; Sillitoe 1998).

Communities, however, are not always prone to cooperate, and conflicts frequently arise due to: 1) contradictory conservation goals between outside agencies and local stakeholders; 2) divergent political and economic agendas among local participants (e.g., tribal authorities), national participants (e.g., ministry of fisheries), and international participants (e.g., funding agencies); 3) a lack of economic and educational programs to assure the long-term sustainability of any conservation project locally; and 4) internal strife among inclusive members, particularly in socially and culturally heterogeneous communities (e.g., Aswani 2002; Cooke, Polunin, and Mace 2000). Given the proliferation of marine conservation strategies in the developing nations of the insular Pacific, we believe that, when facing these types of problems, it is important to take advantage of the valuable lessons that have been learned during the early stages of the creation of a community-based marine protected area (CBMPA).

The fundamental objective of any participatory scheme is to engage and maintain the long-term commitment and participation of an affected community. The strategies and methodologies employed to establish marine protected areas will be refined as lessons emerge from project implementation studies around the world, and this should result in a higher success rate in terms of improved food security, social equity, and environmental protection.

This paper presents results of a scientific evaluation of a “no-take” and spatiotemporal refugia concerned with the size distribution and abundance of marine invertebrates. The paper then discusses how the local dissemination of these findings is promoting the participation of women in monitoring and enforcement, as well as assisting in the creation of additional management regimes. We also examine the social, institutional, and economic conditions that have contributed to the initial success of a community-based marine protected area. This work is based on a marine conservation and economic development initiative that was established in 1999 in the Roviana Lagoon, Solomon Islands, with the technical and financial assistance of one of the authors (Aswani 2000; Aswani and Weiant 2003). The project’s aim was twofold: 1) to create a spatiotemporal and permanent marine closure to manage marine invertebrates; and 2) to launch a cash enterprise to offset the women’s loss of access to shellfish, which traditionally has been an important source of income. This initiative is part of our larger conservation and development program, which is assisting local communities to establish a network of marine protected areas in the Roviana and Vonavona Lagoons, southwestern New Georgia. The objective is to protect critical habitats and resources in a culturally, economically, and ecologically sensible manner. To date, 16 MPAs have been established and we predict that by the year 2005 over 20 will have been instituted (Aswani and Hamilton 2004a, 2004b).

After a two-year marine and social science evaluation of the program, we attribute the project’s preliminary success in improving shellfish biomass, enhancing local environmental awareness, and reinvigorating cultural management practices to: 1) the high level of participatory involvement and community leadership; 2) the local perception that shell beds have recovered rapidly and the role that scientific evaluation has played in reinforcing this notion; 3) a research program that is cross-fertilizing indigenous and scientific ecological knowledge; 4) the unique marine tenure system that allows for the project’s development and the area’s policing; and 5) the tangible economic incentives created by the development project, which ultimately empowers local women.

We anticipate that it will be possible to generalize this evaluation’s findings to other regions of the world, particularly to those areas in which there are still operational sea-tenure institutions and in which high levels of community participation can be expected. Also, these findings will be useful to development and conservation practitioners who are developing integrated conservation and development projects (ICDPs) in regions sharing similar characteristics with the Solomon Islands (Brown and Wyckoff-Baird 1992; Campbell and Vainio-Mattila 2003). More generally, we show how an applied anthropology that addresses conservation, education, and development is effectively articulated when natural and social science research efforts are integrated. Next, we summarize the regional context, the project, and the scientific results of the shellfish monitoring program. We then discuss each of the factors that have contributed to the project’s initial success and the challenges that lie ahead.

**Roviana Women and Marine Invertebrates**

In the Solomon Islands, women’s utilization of marine resources is a vital source of protein and income for coastal communities (see Figure 1). Women glean for shells, crustaceans, echinoderms, and seaweed, and they engage in hand-line fishing, diving, and mass-harvesting techniques. Yet, despite their significant role in the economies of the South Pacific, women are only rarely included in fisheries development and management decisions because governments, industry, and banks hardly recognize the importance of their contributions (Chapman 1987; Matthews 2002). Solomon Island women are frequently disadvantaged by the introduction of fisheries development and conservation schemes, and until recently scant attention has been given to the management of resources that are vitally important for women locally. Because the harvesting of marine invertebrates is mostly carried out by women, the decline in these resources may have the dual effect of altering their position within the household and the community on the one hand and causing a decline in household levels of food security and income on the other. Any attempt to develop long-term sustainable fisheries in the region will require the participation of women, and
sustainable development will only be achieved if women and other marginalized groups are socially and economically empowered (Bidesi 1994; Overton and Scheyvens 1999). This will necessitate considerable effort, given that in the Solomon Islands, as elsewhere in the region women’s voices continue to go largely unheard with respect to sustainable development, the environment, and the health of their communities (e.g., Griffen 1994).

The Roviana Lagoon (see Figure 2) is protected by a series of raised offshore coral islands that are characterized by rugged, notched limestone with numerous inlets, bays, carbonate-sand beaches, and moats (Stoddart 1969). The inner lagoon encompasses a variety of habitats that include grass beds, mangroves, freshwater swamps, shallow reefs, outer reef-drops, and river estuaries. Roviana women have great knowledge of the fauna with which they interact, including knowledge on the spawning seasonality, feeding habits, and periodicity of many invertebrates. Women glean predominantly in two habitats—estuarine and outer barrier-island intertidal flats. The estuarine bivalves collected include blood cockles (Anadara spp.), mud clams (Polymesoda spp.), oysters (e.g., Crassostrea rhizophorae), Venus shells (Gafrarium tumidum), and mudwhelks (Terebralia palustris). The primary season for collecting these organisms is during the months of May through August (masa rane, day low tide), when diurnal low tides allow women to enter Rhizophora mangrove forests. With the advent of the odu rane (day high tide) tidal season in September, tidal periodicity reverses, and women move into other habitats. The most sought-after invertebrates in the region are the mangrove Anadara granosa, or blood cockle, and the Polymesoda (Geloina) spp., or mud clam, although in Munda and south Vonavona, species that are characteristic of open reef flat, coral rubble, and sand banks are harvested more frequently.

Blood cockles and mud clams are vital resources for coastal communities across the Solomon Islands and in other Indo-Pacific island nations (Fay-Sauni and Robinson 1999). In Roviana, the nutritional, economic, and cultural importance of these two species stems from their historic abundance, large size, and accessibility. From a scientific perspective, little is known about the environmental requirements, biology, population status, and tolerances of these bivalve populations in the Solomon Islands. The causes of localized declines in shellfish abundance, for instance, are unknown, and there is little understanding of the effects of overfishing or modification of water quality due to land-based activities.
The most complete studies of aspects of the biology of *Anadara granosa* are by Broom (1986) and Narashimham (1988), but these studies were limited to the Philippines, Malaysia, Thailand, India, South Korea, and Indonesia and did not include other areas of the insular Pacific. Morton (1984) reviewed the ecology of *Polymesoda* (*Geloina*) in the Indo-Pacific region, but little is known about stocks in the Solomon Islands. In recent years, Roviana women have noticed that *Anadara granosa* (hereinafter referred to by its Roviana name, *riki kosiri* or *riki*) and *Polymesoda* spp. (hereinafter referred to by its Roviana name, *deo*) have been declining in size, abundance, and accessibility due to overharvesting and habitat degradation from logging on the New Georgia mainland. Note that due to the absence of historical quantitative baseline data for the Roviana area, it is impossible to scientifically verify reductions in mean size and abundance of *riki* and *deo*. In such situations, it is vital to draw from women’s daily experience to gain a historical perspective on recent changes and current status of these invertebrates. Drawing upon indigenous ecological knowledge, therefore, becomes crucial in the designing of scientific research and management plans for species such as *riki* and *deo* and, more generally, in building a comprehensive image of marine species that are poorly understood by marine scientists (Aswani and Hamilton 2004a).

### The Resource Management Project

In the late 1990s, the growing perception that marine invertebrate resources were being overexploited encouraged some community leaders to discuss the development and implementation of a resource management program. The Baraulu and Bulelavata communities in eastern Roviana (Figure 2) addressed the issue of resource loss and investigated avenues to curb the overexploitation of marine invertebrates. They decided upon the area and the conservation strategy they thought would meet the needs of the women, the communities, and the marine resources. In July 1999, “The Baraulu/Bulelavata Women’s Sewing Project” (also known as the Baraulu/Bulelavata Women’s Shellfish Project) was established. The main objective was to create a temporal and permanent closure for the protection of key invertebrate resources.
species, while simultaneously providing women with an economic venue to offset the income they would lose by not selling shells collected from the management areas.

Management sites were selected through a combination of locally driven assessments and on the basis of information gained from research on local foraging strategies (e.g., Aswani 1998). The community selected the neighboring areas of Duduli and Rereghana as the project area, which encompasses several square kilometers of mangrove and sea grass habitats (Figure 3). These bays were chosen because of the perceived decrease in shell size and abundance that has resulted from fishing pressure, site preferences, and village proximities. Mangrove ecosystems are well established in the region and are extremely important as nurseries for juvenile fish, as spawning grounds for numerous species, and as major feeding zones for both reef and pelagic species. The most prevalent mangrove species within the closures are Rhizophora, Dolichandrone, and Bruguiera (DOS 1974). The substrate of adjacent waters is fine silt and clay with colonies of Enhalus acoroides and some Thalassia hemprichii sea grasses. Scattered dead and living Porites coral colonies dot these areas.

The community implemented a management regime under which gleaning for shells and collecting crabs are now prohibited for eight months (September–April) and open for four months (May–August). The closures mimic the community’s traditional use of the resources: 1) the shellfish areas within Duduli and Rereghana are typically harvested less during the odu rane season (September–April); and 2) specific shellfish areas within these sites have in the past been closed for extended periods in preparation for special community and religious events, at which times ample supplies of food would be needed (although for much shorter periods). The aim of the program was to establish a less-intrusive regime that allowed women access during times of the year that corresponded to their traditional use and management of resources. The project harnessed local forms of sea tenure, thus
building upon a practice with which the community is already familiar. (Later, we will address the management strategy’s appropriateness in terms of its biological and social objectives and potential effects.) The aim of the closures, therefore, was to enhance the size distribution and abundance of riki and deo and to perform the management by building upon existing indigenous ecological knowledge and traditional practices of sea-tenure governance.

**Monitoring Methods**

The objectives of the monitoring were to evaluate the biological effects of the closure, to increase the women’s level of involvement in the resource management project, and to ensure that the community could conduct the monitoring in subsequent years. Two strategies were followed to conduct the shellfish monitoring: in situ (in the field) and ex situ (household surveys). In situ monitoring was carried out in September 2000 (preclosure), May 2001 (postclosure), August 2001 (preclosure), and May 2002 (postclosure). No baseline data were collected when the closure was put into effect in 1999, and the number of monitored sites fluctuated over time due to financial, logistical, and community constraints. In September 2000, eight sites were sampled (three experiment sites and one control site each for riki and deo). In 2001, the number of sampled sites was increased to 16 (four experiment sites and four control sites each for riki and deo) in an attempt to yield more accurate scientific results. In 2002, however, only 14 of the 16 sites were monitored because of a local management decision—one site, Koqu Piu, was selected for permanent closure, and another site, Koreke, was closed in preparation for a religious festival and thus could no longer be used as a control site (Table 1).

Women were trained to conduct in situ monitoring to assess the early effects of the Duduli and Rereghana closure. A rotating team of 6 to 10 Roviana women, and on occasion men and school children, conducted the in situ monitoring. At each site, the range of suitable shellfish habitat was monitored, with the starting point selected at random. Transects for riki were run every 20 feet in the water at the mangrove-estuarine interface, and samples were collected every 10 feet using a one-quarter square-meter quadrant. Women customarily collect riki by wading into the water and digging their feet and hands into the muddy substrate (Figure 4), and this method

<table>
<thead>
<tr>
<th>Areas Monitored Within Closed Area (Experiment Sites)</th>
<th>Areas Monitored within Open Area (Control Sites)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Riki</td>
<td>Riki</td>
</tr>
<tr>
<td>Koqu Piu</td>
<td>Koqu Piu</td>
</tr>
<tr>
<td>Divulani</td>
<td>Divulani</td>
</tr>
<tr>
<td>Koqu Kanada</td>
<td>Koqu Kanada</td>
</tr>
<tr>
<td>Duduli</td>
<td>Duduli</td>
</tr>
<tr>
<td>Deo</td>
<td>Deo</td>
</tr>
<tr>
<td>Miho Rereke</td>
<td>Miho Rereke</td>
</tr>
<tr>
<td>Kopo I</td>
<td>Kopo I</td>
</tr>
<tr>
<td>Kopo II</td>
<td>Kopo II</td>
</tr>
<tr>
<td>Koreke</td>
<td>Koreke</td>
</tr>
</tbody>
</table>

Table 1. Major Experiment and Control Sites Monitored

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**Figure 4. Baraulu and Bulelavata Women Monitoring Riki**

Photo by Pam Weiant.

**Figure 5. Baraulu and Bulelavata Women Monitoring Deo**

Photo by Pam Weiant.

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was used to collect the shells during sampling. Transects for deo were laid every 40 feet, and samples were taken every 20 feet using a one square-meter quadrant. Women collect deo on land in the mangrove forests adjacent to the lagoon water. The deo is gleaned by spotting the shell in the mud, and it is removed by digging. This method was used to sample deo (Figure 5). All shells were counted and sorted by size class. Size was measured using a standard based both on the size range of shells harvested in the lagoon and on other research regarding size correlation to reproductive maturity and fecundity (e.g., Broom 1986) (see Table 2). The total number of shells and their per-site number per square-meter quadrant were tallied and entered on Excel spreadsheets (see Table 3).

Ex situ monitoring of household harvest yields was conducted at a time when Duduli and Rereghana were open to harvest. In May 2001, five women were trained to instruct all village households on how to record catch data on a standardized form. The following data were recorded: harvest sites, number of shells gathered (sorted by species and size), number of gleaners per trip, and number of hours spent foraging. The data were entered on Excel spreadsheets, and the average household catch per trip was calculated. The goals were to quantify daily household harvest, to document variation in catches during the open season, and to better understand the fishing behavior of the women (i.e., location choice, time duration of each trip, and the trip’s purpose). Simultaneously, specialized indigenous ecological knowledge regarding the ecology of riki and deo was documented.

### Monitoring Results

We compared shellfish abundance by time (preclosure 2000 through postclosure 2002) and treatment (experiment and control) using the statistical package JUMP. Post-test comparisons were performed using Tukey’s honestly significant difference (HSD) test, which compares all possible pairs of means to predict where the significant differences occur. Two significant results were that: 1) there was a statistical

| Table 2. Size Classes for Deo and Riki (in centimeters) |
|----------------------------------|---|---|---|---|
| Size classes  | 1  | 2  | 3  | 4  |
| Riki  | 0-2.9 | 3.0-4.4 | 4.5-5.9 | ≥6.0 |
| Deo  | 0-5.9 | 6.0-7.9 | 8.0-9.9 | ≥10.0 |

### Table 3. Shellfish Density by Species and Treatment (Mean Number per Meter-Squared Quadrant)

<table>
<thead>
<tr>
<th>Shell Type</th>
<th>Site Name</th>
<th>Treatment</th>
<th>Preclosure 2000¹</th>
<th>Postclosure 2001</th>
<th>Preclosure 2001²</th>
<th>Postclosure 2002</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deo</td>
<td>Bulelavata</td>
<td>Control</td>
<td>2.2</td>
<td>3.5</td>
<td>1.7</td>
<td>2.2</td>
</tr>
<tr>
<td>Deo</td>
<td>Naroe</td>
<td>Control</td>
<td>——</td>
<td>2.4</td>
<td>2.2</td>
<td>1.4</td>
</tr>
<tr>
<td>Deo</td>
<td>Toku</td>
<td>Control</td>
<td>——</td>
<td>2.5</td>
<td>1.9</td>
<td>2.0</td>
</tr>
<tr>
<td>Deo</td>
<td>Koreke</td>
<td>Control</td>
<td>——</td>
<td>2.2</td>
<td>——</td>
<td>——</td>
</tr>
<tr>
<td>Deo</td>
<td>Koqu Piu</td>
<td>Experiment</td>
<td>1.7</td>
<td>2.3</td>
<td>——</td>
<td>——</td>
</tr>
<tr>
<td>Deo</td>
<td>Divulani</td>
<td>Experiment</td>
<td>0.6</td>
<td>2.8</td>
<td>3.7</td>
<td>3.6</td>
</tr>
<tr>
<td>Deo</td>
<td>Kanada</td>
<td>Experiment</td>
<td>2.0</td>
<td>2.4</td>
<td>1.6</td>
<td>2.1</td>
</tr>
<tr>
<td>Deo</td>
<td>Duduli</td>
<td>Experiment</td>
<td>——</td>
<td>2.5</td>
<td>——</td>
<td>——</td>
</tr>
<tr>
<td>Riki</td>
<td>Koreke</td>
<td>Control</td>
<td>——</td>
<td>3.2</td>
<td>——</td>
<td>——</td>
</tr>
<tr>
<td>Riki</td>
<td>Kopo I</td>
<td>Control</td>
<td>——</td>
<td>4.6</td>
<td>7.2</td>
<td>7.6</td>
</tr>
<tr>
<td>Riki</td>
<td>Kopo II</td>
<td>Control</td>
<td>——</td>
<td>5.1</td>
<td>17</td>
<td>6</td>
</tr>
<tr>
<td>Riki</td>
<td>Rereke</td>
<td>Control</td>
<td>1.7</td>
<td>1.7</td>
<td>1.3</td>
<td>1.2</td>
</tr>
<tr>
<td>Riki</td>
<td>Koqu Piu</td>
<td>Experiment</td>
<td>2.4</td>
<td>15.5</td>
<td>——</td>
<td>18.8</td>
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<tr>
<td>Riki</td>
<td>Kanada</td>
<td>Experiment</td>
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<td>25.8</td>
<td>8.4</td>
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<tr>
<td>Riki</td>
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<td>Experiment</td>
<td>4.7</td>
<td>15.3</td>
<td>5.6</td>
<td>9.2</td>
</tr>
<tr>
<td>Riki</td>
<td>Duduli</td>
<td>Experiment</td>
<td>——</td>
<td>6.9</td>
<td>3.8</td>
<td>10.8</td>
</tr>
</tbody>
</table>

¹Because of time and financial constraints, the first monitoring season included only four sites for both riki and deo, consisting of one in the control area and three in the experiment area. The sample size was increased in the 2001 monitoring season to more fully assess the effects of the closure.

²During the preclosure 2001, Koreke was not monitored (nor in the following postclosure 2002) because the area had been closed to prepare for a religious event and thus could no longer be considered a control site. Prior to the open 2001 season, Koqu Piu was permanently closed. Since the area was not harvested during the open 2001 season, it was not monitored during the preclosure 2001. The postclosure 2002 data reflect one year of no harvest.
difference in the abundance of riki and deo in the experiment sites over time, with no statistical difference at the control sites; and 2) there was a statistical difference in the abundance of riki and deo between treatments, most notably during postclosure 2002 for both species and postclosure 2001 for riki. There was, nonetheless, a less significant difference between experiment and control sites prior to the 2002 open season for deo.

First, the effect of time on the abundance and size distribution of riki was analyzed. The mean sum of riki per quadrant was compared over the four time periods by treatment, and this revealed, using a value of \( p = 0.05 \), a statistical difference in the experiment sites (\( p = 0.03 \)) but not in the control sites. The Tukey HSD test suggested that the statistical difference occurred between time period A, or preclosure 2000, and B, or postclosure 2001 (Figure 6). When we compared the mean sum of riki between time period A (preclosure 2000) and D (postclosure 2002) there was also a significant difference in the experiment sites (\( p = 0.01 \)) but not in the control sites. To further assess the effect of treatment on the abundance of riki, the mean sums of shells at control and experiment sites at time D were compared, revealing a significant difference (\( p = 0.04 \)). Using a two-way ANOVA, the mean sums of riki at control and experiment sites over the four time periods were compared and predicted to be statistically significant (\( p = 0.05 \)) (Figure 6). Differences were particularly significant between the experiment and control sites during time period B (postclosure 2001) as shown by the Tukey HSD test. Finally, we measured trends in size class over time. A statistical difference occurred in the abundance of each size class over the time period for the experiment sites, with class 2 in postclosure 2002 being significantly different from preclosure 2000 (Figure 7). Meanwhile, there was no predicted change in size class over the time periods for control sites.

Next, we examined the effect of time on the abundance and size distribution of deo. The mean sums of deo were compared over the four time periods by treatment and showed (using value of \( p = 0.05 \)) a statistical difference in the experiment sites (\( p = 0.03 \)) but not in the control sites between time periods A and D. To assess the effect of the treatment, the mean sums of deo at the control and experiment sites at time D were compared, and no statistical difference was predicted (\( p > 0.05 \)). A two-way ANOVA showed that the mean sums of deo at control and experiment sites over the four time periods were not statistically significant (\( p > 0.05 \)) (see Figure 8).
Finally, stage classes were compared by time (A vs. D), and the analysis showed small differences in the mean number of shells in each stage class for both the control sites and the experiment sites (Figures 9 and 10).

Results from the ex situ monitoring revealed that the mean numbers of riki and deo harvested per household in one fishing event during the first month of the open period were similar, with slightly more shells harvested in 2001 (Table 4). In both years, size class 2 contributed most significantly to the catch, followed by size class 3. In 2002, the contribution to total catch from size classes 1 and 4 increased, which suggested time to grow to the next size class (with the largest size class being the most fecund) (Broom 1986). There was a decrease in number of riki and deo harvested over the duration of the “open” 2001 season. Because of the reclosing of Duduli and Rereghana during what is usually the open season in 2002, trends in catch size could not be independently evaluated.

In summary, the increase in abundance of shellfish stocks was a significant finding. We are aware, nonetheless, that these findings are preliminary and that they could contain some inaccuracies resulting from potential biases in the field data collection process (e.g., due to weather or the experience levels of data collectors), from the areas selected for sampling, from the time frame of the study (only three years to date), and from the possible inadequacy of the monitoring technique. The results, at any rate, have been valuable in getting the community to value their project.

Women’s Participation in Monitoring

We were aware of the trade-off between community involvement and scientific rigor in the monitoring. Indeed, assessing the early biological effects of the Duduli and Re-reghana closure on the abundance and size distribution of riki and deo is important for determining the project’s biological success. Yet, equally or more significant is whether or not the participatory monitoring and its preliminary results have increased women’s support for the project. Great effort was directed toward increasing the level of participation and involvement of the community, especially by the women and women’s leaders.
children, through training participants on monitoring methods, encouraging local participation in the monitoring, and discussing the meaning of the monitoring results. A number of workshops were conducted between 2000 and 2003 to discuss these issues.

The monitoring protocol allowed women to participate in the field monitoring, the household harvest recording, the expert workshops, and the field logistics. Village women who were physically able to gather shellfish (which excluded women with small children, those pregnant or nursing, and the elderly) were divided into four groups of approximately 30 women (of a total population of around 500 Baraulu residents). Each group was assigned to one day each week on which a minimum of six and a maximum of ten women were asked to volunteer for the monitoring and two women were asked to prepare lunch for the team. A leader and an alternate leader were nominated within each group to organize and oversee the monitoring procedure. We attempted to coordinate the monitoring effort with the women’s other domestic and community duties. For instance, we did not monitor on Fridays (women’s local market day), Saturdays (fishing day), or Sundays (church day). Given the size of each group, the women could select a week to monitor that best fitted their household and community commitments. To bolster enthusiasm, various foodstuffs were provided to women during the monitoring, and a meal was shared upon return to the village. The women repeatedly voiced satisfaction with their participation in the monitoring, and they also seemed to enjoy the camaraderie. As is common in so many areas of the Pacific, their enthusiasm was given its most public voice during village feasts.

Generally, the women were aware initially of the declining shellfish stock and recognized, to some degree, the potential impact the project would have on their community. A small number of women were unconvinced, however. But after the first two years of the closure, the willingness of the women to become engaged in the project was enhanced by: 1) their direct involvement in the monitoring; 2) the circulation of scientific results showing the closure’s benefits; and 3) the broadened perception that the shellfish were once again easier to find after the area was reopened. Nonetheless, we ran into a number of obstacles and had to modify our management strategy. Despite the long field seasons and the women’s dedication, our team was often limited by the short amount of time available for monitoring. Solomon Islanders have multiple social obligations, which sometimes preclude their full participation in a particular activity. For instance, the group leaders often had difficulty assembling their groups, which delayed departure and prevented completion of the monitoring planned for that day. This of course increased the number of days required to complete the job. Such relatively minor setbacks in the monitoring schedule were compounded by other delays caused by heavy rains and community obligations (in particular, a death in the village means all work is suspended for four to five days). We also found that community involvement and enthusiasm wanes and waxes over time, with a significant slowing of momentum following unplanned pauses in the monitoring schedule.

Local conceptions of time and commitment to a project also may vary widely. Therefore, a project leader must be cognizant of these types of logistical problems when designing a project that entails a high level of community involvement and must structure deadlines appropriately. In our case, the project leader had been working in the region for over a decade, and so the community had confidence that the project was not a “fly-by-night” operation. Also, the graduate student leading the monitoring component of the project spent two full field seasons working with the community to ensure that the women were sufficiently trained in the monitoring protocol. In the future, the members of the community are expected to monitor the shellfish beds on their own, although the project leader will continue to assist them if needed. We realize that most projects must operate under time and financial constraints, and the value of time, particularly, should not be trivialized because long-term projects are more likely to assure a community’s commitment and to succeed.

### Monitoring Results and Environmental Education

The marine protected areas and their resulting biological outcomes are tangible means of demonstrating the significance of resource management. In essence, “seeing is believing” and no workshop or educational campaign can ever be as effective as people witnessing actual management results, whether real or perceived. The Baraulu and Bulelavata women’s active participation is now having a positive impact on management decisions and is encouraging the adoption of more sustainable harvesting practices. Increasing cooperation has been prompted by the perception that shell beds are recovering and by the evaluation’s positive results which reinforce this view. The monitoring findings were disseminated locally through several workshops held during 2001, 2002, and 2003, following the preliminary analysis of our data.

In fact, we have no measure of changes in environmental awareness among the Baraulu and Bulelavata people. Nonetheless, we argue that their current willingness to accept restrictions rarely implemented in other marine conservation projects is based on increased responsiveness to environmental concerns. Local communities often opt for closing fishing areas that are less productive or to which access is more difficult. The Baraulu and Bulelavata women, by contrast, have chosen to close an area that is of primary importance for shellfish collection. Moreover, the women have decided to permanently close a key area for harvesting riki within the Duduli and Rereghana closure as a result of the preliminary positive assessment of the closure. This spot, called Koqu Piu, is commonly referred to by the community as the riki “hospital” because it is locally considered to be a source population. In September 2002, this permanent no-take zone was extended to cover a larger area (Zone 1 in Figure 11).
Solomon Islands high school and university students are being included in this program and a wider ongoing marine conservation initiative in the region to promote our capacity-building effort. Several high school students from the Biulah High School and Goldie College in Roviana, for instance, were recruited to participate in research and monitoring activities in 2004. Basic principles of rapid ecological assessment techniques, shell monitoring, and GIS were taught for capacity-building purposes and to engender a vision of sustainable resource use among students. To ensure the long-term ability of local people to sustain their projects, we are currently searching for local candidates to conduct graduate marine science and anthropological studies at the University of California, Santa Barbara. Numerous authors (e.g., Howe 2001; Garcia Montero 2002; Pattengill-Semmens and Semmens 2003) have noted the importance of environmental education and technical capacity building in enhancing local, regional, national, and international strategies for marine resource management.

**Marine Science and Indigenous Ecological Knowledge**

Roviana women possess ecological knowledge that can add to fisheries science. The use of this knowledge in combination with marine science is a preventive and cost-effective way to enhance biodiversity conservation, to protect particular species, and to improve stock abundance (Christie and White 1997; Johannes 1998). It is true that indigenous ecological knowledge does not initially develop for the purpose of conserving marine resources, but rather to increase fishing success locally (Aswani 1998). And the scientific method cannot always validate useful, empirically valid, or culturally significant indigenous ecological knowledge (Brouwer 1998).
Nonetheless, several aspects of local knowledge regarding riki and deo were identified as relevant for designing our research and monitoring protocol. Specifically, this knowledge has: 1) facilitated the selection of experiment and control sites based on women’s knowledge of the distribution and abundance of marine invertebrates across various localities; 2) helped in the design of the reserves; and 3) assisted in the interpretation of the monitoring results.

We have found that employing scientific methods to validate indigenous ecological knowledge is locally reinforcing. Because scientific research results frequently confirm local observations, the Baraulu and Bulelavata women who assisted in selecting the sites and in designing the management strategy view the monitoring results as a validation of their knowledge. We are currently emphasizing the importance of this achievement in our ongoing regional education campaign, the goal of which is to encourage local inhabitants to establish a network of marine protected areas across south New Georgia (see Aswani and Hamilton 2004b).

In summary, then, we do not suggest that Western forms of knowledge or practice are superior in any measure, but, rather, we seek to find effective ways to work in partnership with local communities and to cross-fertilize indigenous ecological knowledge, anthropology, and marine science for the successful management of marine resources.

**Sea-Tenure as a Resource Management Context**

In the Solomon Islands, jurisdictional powers to regulate access, use, and distribution of resources generally are rooted in traditional law, which consists of an amalgam of practices from pre-European contact as well as foreign practices and ideologies. Rights of inclusiveness are differentiated according to various sociocultural rules based on birth, marriage, residence, and the direct transfer of rights by traditional authorities. Entitlements to sea space, where still recognized, do not merely entail ownership of resources but also imply a shared sociocultural identity and require self-governance by those who hold them. The national and provincial governments recognize, in principle, traditional sea tenure, and both property composed primarily of natural resources and property governed as part of management systems are subject to de facto local controls, which are based on local norms and values. The government plays a nominal role in dictating policy because it cannot monitor local fisheries or enforce fisheries regulations. These conditions suggest, as has been pointed out by a number of researchers (e.g., Johannes 2002; Virdin 2000), that co-management schemes involving government and nongovernmental organizations and local peoples will fail unless policy makers first recognize the existence of sea tenure.

Recognition of sea tenure’s existence, however, is not enough. Anthropological research that identifies inclusive stakeholders and existing forms of sea tenure is essential to drafting any form of management policies. Researchers and policy makers must: 1) identify the responses of those in charge of sea-tenure governance when confronted with population growth, fishery commercialization, and political contest over natural resources; and 2) determine which institutional arrangements are more adaptable to co-management regimes, since institutional differences among existing sea-tenure regimes are not only conceptual but also have real social and environmental consequences (Aswani 2002; cf. Foale and Manele 2003). In Roviana, people have similar conceptions of their entitlement rights to sea space, yet there are marked differences in operational rules of management among regional villages. These differences are the result of people’s historical and spatial patterns of settlement across the landscape and adjoining seascapes and the attendant impact of these patterns on property relations (Aswani 1999). Different settlement processes have dictated whether entitlement holders to an indigenous sea estate live in an area adjoining or away from that estate. The geographical location of stakeholders, therefore, determines whether traditional leaders are more—or less—capable of managing their resources.

It is critical to identify the most viable local institutional framework covering shellfish habitat on which to base conservation initiatives because it is meaningless to implement a management regime in an area, no matter how rich in marine biodiversity or in need of management, if outsiders cannot be excluded and participating members cannot enforce resource use and access rules. In Roviana, ethnographic studies (Aswani 1997, 1999, 2002) have revealed that sea-tenure regimes can be differentiated broadly into two conceptual regimes. In the territorial-enclosed entitlement regime, found in the Saikile and Kalikoqu chieftain districts (Figure 2), most entitlement holders are spatially nucleated and reside adjacent to their territorial waters. The results are that territorial boundaries are circumscribed and control of access and use of waters is under a centralized control exercised by local authorities and is based on sea entitlements that are recognized regionally.

In the mosaic-entitlement regime, found in the independent Munda-area hamlets of Nusa Roviana, Dunde, Kekehe, Lodu Maho, and partly in Kindu (Figure 2), a large proportion of entitlement holders are geographically dispersed and live away from their holdings. Stakeholders who have moved have often intermarried with other tribal groups (e.g., Kalikoqu and Saikile or eastern Solomon Islanders). Variations of entitlement holders results in: 1) territorial boundaries that are porous; 2) decentralized control exercised by competing local authorities who cannot regulate access to resources; and 3) the contesting of sea-tenure entitlements by regional groups. To establish a co-management regime, therefore, it is imperative that we study and understand the Roviana concepts of sea tenure. Otherwise, it will be impossible to predict the ability of local people to institute and enforce regulatory mechanisms that the system proposes to put into place.

The Baraulu and Bulelavata villages and their adjoining waters lie in an area between the Kalikoqu and Saikile chieftain districts. In Baraulu, half of the village pledges its
alliance to the chief of Saikile and the other half to the chief of Kalikoqu (most inhabitants have rights to both districts). While both chiefs nominally vie for control of this area, formal jurisdiction over adjacent waters falls under the control of the Kalikoqu polity. Territorial waters are administered by Baraulu and Bulelavata elders. Dissention over the control of this area does not result in interloping by neighbors because the majority of stakeholders reside in Baraulu and members of neighboring villages have no interest in fishing there. In other areas of south New Georgia, territorial disputes between groups do result in continued interloping and concomitant resource degradation. In the case of Baraulu and Bulelavata, sea tenure falls under the territorially enclosed entitlement regime. Note that this system is not fault proof and that minor disputes over resource ownership among villagers can emerge. The advantage is that minor disagreements can be solved endogenously and do not require negotiation with neighboring groups.

In this situation, the project’s conservation strategy integrates an adaptable sea tenure regime with a resource management and development plan. Despite a tangential association during the early planning of the project, an expatriate consultant hired by World Wildlife Fund-Solomon Islands criticized the closure schedule and argued that the project was subsidizing women with a financial incentive (i.e., a sewing project) for continuing a practice that they have traditionally done for centuries (i.e., the periodic closing of shellfish beds) (Foale 2001). In fact, Foale’s criticism is based on a single two-day field trip to the area during the project’s initial stages.

We do not perceive the project’s harnessing of local forms of sea tenure and management to be a weakness, but rather a tremendous strength and the very foundation of the management regime. The plan builds upon a practice with which the community members are familiar, and because of that they are better able to grasp its biological value and understand the use restrictions it requires. The strategy is also practical in that it fits the geographical seascape. For example, policing restrictions on catch and shell size is a problem because of the extent of the lagoon area, but spotting poachers entering and exiting the closures is not difficult. The project also reinvigorates a management strategy that had previously been implemented on an ad-hoc basis. Because this is a community-driven project, we believe that this strategy will result in the long-term management of the area with long-lasting positive conservation results.

This outcome is being realized already. The community has established Koqu Piu as a permanent closure and recently extended this area to cover neighboring waters (Figure 11). This extension has been driven locally and catalyzed by the scientific findings, which revealed that after 18 months of being closed the abundance of riki at Koqu Piu had increased significantly. While the adjacent mangrove is also closed to deo gleaning, the area is not considered prime deo habitat. Thus, the community is considering whether it should establish a permanently closed area for deo as well. While ideally they would select no-take areas that encompass source and sink populations, no scientific evidence is available to indicate where these areas are, or even to test the local wisdom regarding where they are. Nonetheless, deo and riki possibly have short-lived larval cycles and are likely to recruit within short distances of their source population, thus facilitating recovery of localized stocks (Foale and Manele 2003). In making management decisions, therefore, the community is relying on a preventive management strategy that integrates local knowledge and the insights gained from our research. The initial success has paved the way for the establishment of more strict conservation measures (i.e., no-take areas). The lesson being learned is that fishery scientists will rarely achieve ecological sustainability and the protection of marine biodiversity unless they seriously consider local forms of sea tenure and their adaptability to introduced management regimes (Aswani and Hamilton 2004a).

The Development Project

It is unrealistic to expect a community-based conservation project to succeed with only short-term expert guidance and financial support. Solomon Islanders have developmental aspirations that cannot be ignored and are increasingly demanding outboard motors, corrugated roofing, iron water tanks, and chainsaws, all of which require considerable cash that is obtained from the exploitation of natural resources such as timber and fisheries. Evidence from other areas of the Pacific (e.g., Kiribati) shows that despite women’s first-hand knowledge that the stocks of, say, Anadara granosa are decreasing, the desire to earn cash and provide food for the household far outweighs the inclination to conserve resources (Fay-Sauni and Robinson 1999). We recognize the need for incentives to allow for the recovery of marine resources in other sectors in which women can be encouraged to engage. This fits the common international goal of providing coastal communities in developing nations with alternative sustainable livelihoods (e.g., ecotourism, mariculture) to halt the deterioration of coastal resources. This approach is generally known as “integrated conservation and development projects” (ICDPs) and contrasts with a more orthodox method to conservation, which is to erect exclusory barriers around areas of biological significance without providing local communities with economic alternatives or full participation in management decisions (Brown and Wyckoff-Baird 1992).

In 1999, the Baraulu and Bulelavata women received financial assistance to establish the management initiative and the women’s sewing project. The principal aim was to assist women by substituting the sewing project’s cash profits for the income that they had lost by not selling shells. Another goal of the project was to provide women with a measure of financial independence and some disposable income that might be used to support local enterprises such as the construction of a permanent facility for women’s activities and the sending of local women to nursing and vocational schools in Honiara. To date, the development project has had
mixed results. A myriad of problems arose during the initial stages of the project, ranging from disputes among women to a boycott by some men who felt disfranchised. Further, there have been signs among the Baraulu and Bulelavata women of a dependency on capital assets and growing tensions and disorganization (Aswani 2000).

Between 1999 and 2001, women met intermittently to produce garnets for school children and for church services. Although cash dividends were generated, they were squandered due to financial mismanagement and conflict between senior women. This conflict can only be understood in the context of historical contingencies that stretch back for several generations, ranging from intraclan conflict during the settlement of the village in the early 20th century to more recent interclan quarrels resulting from logging royalty disbursements during the 1980s and 1990s. Such conflicts continue to permeate the daily lives of women. Throughout the project, for instance, a small number of women have been trying to undermine aspects of the development project (e.g., keeping the sewing machines) to demonstrate that they possess more authoritative land and sea rights than other women and are, thus, capable of exercising more control over the project’s resources. In addition, a number of problems regarding the “ownership” of the area earmarked for management emerged among some Baraulu men following the creation of the project. These men felt their ancestral rights to Duduli and Rereghana were more binding than those of their village kin and consequently that they had to be remunerated for allowing the project to proceed. The majority saw this as absurd, given that the project was designed to benefit all stakeholders, including the women of the quarreling men. Given the sea-tenure context, we have been able to work with the community to solve this problem endogenously and to get the commitment of all stakeholders to participate without expecting direct financial compensation. Note that a majority of women remained interested in making their project work during these uncertain periods.

A change of attitude among skeptics occurred after the church’s intervention in 2002 and again in 2003. The head of the Christian Fellowship Church (“the Spiritual Authority”) encouraged all CFC women to establish cash enterprises, such as sewing projects, to boost their role in the community and the church. This action has given the project tremendous legitimacy and quelled opposition by those men who resisted the closures and a minority of women who had explained their lack of participation on the grounds that the church had not recognized the initiative.

This change has also been encouraged by our larger initiative that seeks to create a network of marine protected areas in the region and that provides infrastructural assistant to various communities; for example, we are currently building a clinic in Baraulu. The results include: 1) a women’s clubhouse is being built in Baraulu and another is being built in Bulelavata, with our financial assistance and the contribution of free labor and materials by the communities; 2) the women have begun to reorganize so that they can invest more time in the project; 3) all disputes concerning control over the project assets (e.g., sewing machines) and natural resources have ceased; and 4) the women have expanded the scope of their development project (e.g., baking buns). The development project is still in its infancy, and it is unrealistic to expect immediate success without a long-term capacity-building strategy, given that the women have other household and community obligations to fulfill.

Indeed, from the outset we were aware of the potential risk of launching a community-based marine protected area under a program that uses economic incentives to foster environmental conservation. But it is naïve to assume that indigenous peoples—or any group, for that matter—will prima facie accept a resource management program on the basis of a local or introduced conservationist ethic. Surely, local people understand, and are concerned for, the ongoing preservation of their marine resources. Yet, they also have economic aspirations that outweigh any serious attempts to implement environmental regulations.

Not surprisingly, participants in our program were more interested initially in the economic incentive than in resource conservation. But members of the community who were truly concerned about the health of the marine resources believed, as we did, that if the closures had quick noticeable biological results, people would see the value of the long-term closures versus the short-term closures traditionally imposed, and that they would understand the benefits for the community, thus lessening their focus on the economic incentives. It is in this context that the results of the scientific monitoring become critical. Scientific results have been a catalyst for reinforcing the local perception that shell beds have been recovering as a result of the management regime. Through the women’s participation in monitoring and environmental education workshops, the focus of the project has shifted from the potential benefits of introduced cash enterprises to the inherent value of managing local resources more comprehensively. Today, Baraulu and Bulelavata women are realizing that their project has the potential of protecting their natural resources while they are empowered by their own community cash-generating enterprise. In summary, we believe that people’s witnessing of tangible management results and continued participation in environmental education are essential if we are to move beyond the economic dependency created by financial incentives as a central component of conservation projects

Discussion

An important question is how suitable the management strategy is in terms of its biological and social objectives and potential effects. In fact, three years of closure with two years of monitoring data are not sufficient time to obtain the rigorous scientific results necessary to determine the actual biological impact of the marine closures on the two invertebrates. More needs to be done because the conservational effectiveness of the Duduli and Rereghana “seasonal” closures are hindered for three reasons. First, a complete, multiyear
closure of Duduli and Rereghana would be the ideal strategy. Shellfish are considered a metapopulation, and the permanent closure would better protect the “sink” and “source” populations of riki and deo. During this time, field surveys could be conducted to identify and to prevent disruption of the “source” population zones (Quinn et al. 1993). The problem is that community-based marine conservation efforts must meet the needs of the local community to be ratified and followed. In the case of the Duduli and Rereghana closures, the marine resources yielded by the area are still too important to household livelihoods to make a permanent closure of the whole area a current possibility. The community, nonetheless, has taken steps in the direction of a full closure. Women agreed to indefinitely close Koqu Piu, a bay locally considered to be a primary “source” population for riki, in 2001, and the area was expanded to cover the neighboring bay of Koqu Veke in 2002 (Zone 1 in Figure 11). This spot remains closed, and the monitoring results from 2002 revealed that the year-long closure yielded significant increases in the number of riki. In addition, the Baraulu community has established a permanent no-take MPA in their neighboring shallow inner-lagoon reefs (Figure 3, see Aswani and Hamilton 2004a, 2004b).

Second, from the start of the project, local people have recognized that there has been a trade-off between the temporal closure versus other management strategies, such as no-take zones and size and catch restrictions. The advantage of the temporal closure is that the design formalizes an aspect of traditional fishing practices, and, thus, the women already understand the strategy, the guidelines, and the restrictions. During the open harvest season, however, there are no limits on the take, and this resulted in a free-for-all use of the resources in these favored sites (Figures 12 and 13). The lack of harvest restrictions may hinder the long-term effectiveness of the closure by potentially offsetting any increase in shellfish abundance that occurs when the area is closed. If we compare time period B (monitoring that occurred after the eight months of closure) and time period C (monitoring that occurred after the four months of harvest) in Figures 6 and 8, we see that there was a decline in shellfish abundance. The effect of open access during the open season has been recognized by the women, and we are discussing the possibility of setting other restrictions (e.g., size and/or bag limits), and particularly the idea of restricting the harvests of shells in size classes 2 and 3. We realize that there are trade-offs between stage classes harvested. For example, stages 3 and 4 are more fecund, and there is a need to have a certain proportion of stage 1 and stage 2 shells to make it to the next growth stages during the closure. Although people prefer the taste of the smaller shells, women want the larger shells for selling in the market. Thus, they are more amenable to restricting the harvest of...
smaller shells. Without sound scientific information to go on, we have established a preventive management strategy that seeks to sustain shellfish populations within the parameters of traditional values and subsistence needs.

The final problem has been poaching. During the closed period of 2002 a small group of women poached in some areas where deo are found. The preference for poaching deo rather than riki is linked directly to the market—deo is easier to poach (women can stay dry and can hide from passing boats within the mangroves), and the shells are larger, which means that fewer are needed to fill a palm basket to sell at the market. Expert workshops and group consultations have been arranged to discuss possible solutions, such as how to increase adherence to the fishing restrictions and prevent poaching. In 2002 and 2003, rules were set by the Baraulu Resource Management Committee (RMC) that detail the repercussions of failing to adhere to the seasonal closure guidelines. The Baraulu and Bulelavata men have also agreed: 1) to mediate any internal disputes; 2) to support their spouses in the monitoring (by taking over household activities while women are monitoring or participating in sewing); and 3) to watch for women who do not adhere to the community restrictions. Long-term legislative enforcement of management initiatives to manage riki, deo, and other species will be achieved through the Western Province “Customary Land Resource Management Orders” statute. We have begun the formal process of codifying this and other management initiatives that are being implemented to protect significant habitats and species.

Conclusion

The current trend in marine protected areas is to ensure community involvement during all critical phases of the reserve design process—planning, establishment, and enforcement (e.g., Salm, Clark, and Siirila 2000; Bunce et al. 2000). Few case studies, however, have demonstrated how to achieve this goal, and even fewer have acknowledged the obstacles that may hinder success. This study shows how the results of the scientific evaluation of the Duduli and Rereghana closure have reinforced women’s concern for monitoring and enforcing their community-based marine protected area and assisted in the expansion of their management regime. The most immediate gains for women have been: 1) women have been made participants in community decisions regarding resource management; 2) their understanding of the value of the scientific monitoring has grown significantly since the project’s inception; and 3) they have been empowered financially by the cash enterprise. These initial successes have been afforded by strong community support, the educational role of the monitoring protocol and its results, the integration of different forms of knowledge, an adaptable marine tenure system, and the economic incentive provided by the project. The following lessons have been learned from this experience:

1. Early identification of biological success not only aides in securing local community involvement but also indicates the trend in how the target species are responding to the management prescription. No baseline data were used to design the management strategy, but the monitoring results showed the value of a preventive management strategy that relies heavily on local knowledge. This experience should be useful to conservation biologists and fisheries managers who are working in dataless contexts.

2. While the strategy negotiated with the women of Baraulu and Bulelavata has increased the level of participation and dedication to the project, the community still seeks financial assistance to motivate and manage the monitoring, as well as direction in modifying the management strategy. It is unrealistic to expect a project to succeed with only short-term expert guidance and financial support. However, continued environmental education is vital if we are to move beyond the capital dependency created by financial incentives as a key component of conservation projects.

3. Many projects are criticized for their dependence on outside assistance; however, outside help is important for two reasons. First, communities may have good intentions to establish a conservation project but may lack the finances and expertise to do so. Such a project can be expensive, and it is naive to think that a community can necessarily support it. Second, the Solomon Islands national and provincial governments have had little interest in assisting rural communities in managing their marine resources. In this situation, it is up to local communities to manage their activities. Without sound scientific information to go on, we have established a preventive management strategy that seeks to sustain shellfish populations within the parameters of traditional values and subsistence needs.
resources. However, the long-term implications of this project are already visible, as other nearby communities are now seeking to launch similar conservation efforts in their tenured seas. Without these small-scale CBMPAs, there would be no effective marine-protection strategies in this region.

4. The ultimate long-term success of the project depends upon a positive feedback loop between the scientific community and the local community members involved in the project. In the Roviana case, positive scientific findings definitely facilitated and secured community support for the project.

5. Children must also be involved in the conservation strategy (e.g., Ruddle and Chesterfield 1977). In our project, children were able to accompany the women during monitoring and assist in the ex situ counting of the household harvests (they are often most enthusiastic about sorting and counting the shells). Through conversations with the researchers, children learn about the purpose of the project, about how their marine resource fits into the larger global picture of marine conservation, and about the value of their resources.

6. Outside project leaders and funding agencies have to be prepared to accept the fact that local interest in marine resource management may wax and wane over time, particularly in places like Melanesia. For instance, local peoples may have different conceptions of a marine protected area’s time horizon, and stakeholders' commitment to protecting a site indefinitely may vary widely. In addition, development projects should be expected to perform on an intermittent basis, as Melanesians have multiple family and community obligations that often preclude their full-time commitment to a project. This managerial uncertainty and discontinuous engagement of people should be factored into the design and evaluation of a project's success or failure.

In general, we are optimistic that the current project will attain its goal of better resource management, primarily because the closure is in a sea-tenure regime where boundaries are well defined, where there are no poaching pressures from neighboring groups, where there is a capacity to monitor and enforce rules, and where the closures have been established through the participatory decisions of all stakeholders. A number of environmental and socioeconomic challenges, however, will need to be addressed before the future of this conservation and development project is assured. For example, we believe that it is very important to assess the early effects of the Duduli and Rereghana closure on the abundance of riki and deo to determine whether the project is a success from a biological perspective. Also, the results from the monitoring need to be widely disseminated to increase community support for the project and to provide the community with the information to formulate additional management policies. In summary, a project’s long-term environmental and social success depends on a continued incentive that hinges upon a positive information exchange between strongly committed community members and a scientific research program that disseminates its results through environmental education.

Notes

1 Note that the development project was never presented to the community as a trade-off for the MPA. Rather, both initiatives were offered as integral components of a larger community improvement program.

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