

Understanding characteristics that define the feasibility of conservation actions in a common pool marine resource governance system

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Abstract

Effective conservation requires people to make choices about how they interact with the environment. Social characteristics influence the likelihood of establishing conservation actions with strong compliance (hereafter “feasibility”), but are rarely considered in conservation planning. Our study makes two contributions to understand feasibility. First, we explicitly test the associations between social characteristics and the presence and form of resource management. Second, we compare the ability of different types of data to elucidate feasibility. We use Ostrom’s (2007) thinking on social–ecological systems and literature on resource management in Melanesia to create a context-specific framework to identify social characteristics that influence feasibility for conservation management. We then apply this framework and test for associations between the presence and form of management on one hand and social characteristics on the other, using data collected at different resolutions. We found that conservation feasibility was associated with characteristics of the governance system, users, and the social, economic, and political setting. Villages with different forms of management were more similar to each other socially than to villages without management. Social data collected at the resolution of households accounted for over double the variation in the form and presence of management compared to data at the resolution of villages. Our methods can be adapted to conservation planning initiatives in other socioeconomic settings.

Introduction

Conservation goals are achieved through diverse conservation actions, including spatial management to regulate extractive uses of natural resources. Although it is commonly acknowledged that social characteristics influence the likelihood of establishing long-term conservation actions with strong compliance (hereafter “feasibility”) (Mascia 2003), these characteristics are rarely considered in conservation planning (Cowling *et al.* 2004; Polasky 2008). The spatial prioritization component of systematic conservation planning (hereafter “systematic

assessment”) guides spatial and temporal decisions about conservation actions that achieve conservation goals by considering conservation value and threat cost-effectively (Pressey & Bottrill 2009). To date, social context has mostly been incorporated into systematic assessments as threats or costs (e.g., Ando *et al.* 1998; Margules & Pressey 2000; Wilson *et al.* 2007; Ban & Klein 2009). A more nuanced approach to planning with social characteristics can identify areas where conservation is feasible, potentially reducing misspending on areas where social characteristics (e.g., low willingness) will inhibit effective action (Knight *et al.* 2010). Planning regions would

ideally be assessed, not only according to social characteristics, but also with information on cost, conservation value, and threat, thereby informing a complete picture of conservation opportunities (Knight *et al.* 2010).

Increasingly, attempts are being made to map the feasibility of direct conservation actions across a variety of spatial extents. Globally, a systematic assessment mapped country-specific governance indicators (e.g., political stability; O'Connor *et al.* 2003). At the scale of individual countries, social well being (Stephenson & Mascia 2009) and cultural adaptation to environmental change (Sexton *et al.* 2010) have been mapped. For smaller study regions with defined management units, characteristics such as willingness and capacity to engage in stewardship programs have been mapped (Knight *et al.* 2010; Curran *et al.* 2011; Raymond & Brown 2011). These few studies provide a foundation for further work on mapping social characteristics that make conservation actions feasible. We add to this literature by examining which social characteristics have been suggested to influence conservation feasibility in the Solomon Islands, by using a common framework (Ostrom 2007), widely used around the world (e.g., Cinner *et al.* 2009), to guide our study. The use of a common framework is advantageous because it helps to identify common characteristics associated with forms of management across different social-ecological contexts. With the common framework used here, we seek to improve the robustness of recommendations about factors that shape feasibility and data needed to predict feasibility spatially.

While mapping feasibility is relatively new to conservation planning, a large body of literature within the social sciences has investigated conditions for effective resource governance, a precondition for conservation actions to be feasible. Ostrom (1990) identified eight principles defining robust governance of common-pool resources, including well-defined resource boundaries, and collective-choice arrangements. Agrawal (2001) identified more than 30 social characteristics influencing sustainability of resource use by facilitating self-organization of communities and implementation of actions. This body of work, in tandem with preceding studies on human-environmental interactions (e.g., McCay 1978), gave rise to Ostrom's (2007) social-ecological systems framework. Ostrom's framework has six components: (1) natural resource users (e.g., fishermen), (2) governance system (e.g., property rights), (3) resource system (e.g., coral reef ecosystem), (4) resource units (e.g., fish), (5) related ecosystems, and (6) broader social, economic, and political context. These components of the social-ecological system interact to shape outcomes that help or inhibit effective resource governance. Although social characteristics that influence effective resource governance are

context-specific, wider use of a common framework will build understanding of both common and idiosyncratic characteristics of effective resource governance in different social-ecological systems. Our study is a contribution to this larger picture.

Effective conservation planning depends on ascertaining which social data are most useful for identifying characteristics that explain feasibility of conservation action. In this study, we use Ostrom's (2007) social-ecological systems diagnostic framework to organize social characteristics that influence conservation feasibility in Melanesia, and assess whether these characteristics mirror Ostrom's principles for effective governance (Ostrom 1990). Two research questions underpin our study: (1) what social characteristics are most strongly associated with conservation feasibility? And (2) which types of data most effectively reflect conservation feasibility? The resource system and units of interest in our study system are, respectively, fisheries and fish and invertebrates (e.g., trochus) associated with coral reefs.

Materials and methods

Study region

The Solomon Islands, located within Melanesia, comprises six main islands, mostly surrounded by steeply sloping fringing coral reefs, with globally significant marine biodiversity (Green *et al.* 2006). The Solomon Islands is highly fragmented politically and diverse culturally and linguistically (Tryon & Hackman 1983), with very high dependence on subsistence farming and fishing. While population density is low (about 18 people/km²) compared with Southeast Asia, growth is rapid (2.3% per year). This growth, coupled with expanding domestic and export markets for fish and marine invertebrates and extensive logging, has increased sedimentation, nutrient runoff, and fishing pressure (Albert *et al.* 2008), all of which threaten marine biodiversity (additional information in Supporting Information).

State-supported customary law is the primary institution regulating management of marine resources in the Solomon Islands (Hviding 1998). Conservation actions implemented by villages include different forms of management. For example, permanent closures are areas where resource extraction is prohibited. Temporary closures are areas where harvesting is allowed temporarily (e.g., for feasts). Some villages also implement quotas and restrictions on species and gear. The national government is thought to have insufficient expertise or resources to meet the challenges of management (Lane 2008), underlining the importance of villages or groups of villages in natural resource management.

Table 1 Social characteristics associated with conservation feasibility in the Solomon Islands, based on the literature review. These are subdivided into three components of Ostrom's social–ecological systems framework (Ostrom 2007): (1) the governance system; (2) users; and (3) the social, economic, and political settings.

Component of the social–ecological system	Description	Reference
Governance system	Clearly defined resource use rights help to reduce conflicts over ownership and facilitate management arrangements	Foale & Macintyre (2000) Macintyre & Foale (2007)
	Designing management areas with local communities while incorporating local and/or traditional knowledge and existing management systems helps to align rules and local conditions and engenders support	Govan <i>et al.</i> (2009) Johannes <i>et al.</i> (2000)
	Monitoring of resources and resource users is important for effective governance	Aswani (2005)
	Mechanisms for resolution of conflicts over resource ownership are important because conflicts often arise with economic opportunities for use of resources	Foale & Macintyre (2000)
	Linkages between the different levels of governance (nested enterprises) that integrate local management with legislation promote the sustainability of management	Schoeffel (1997)
	Strong traditional self-governance influences the enforceability of management institutions	Aswani (2005)
Users	Perceived decline in resources motivates some villagers to participate in management	Foale (2001)
	Social capital facilitates the success of alternative livelihood projects to compensate for restrictions on resource use	Foale (2001)
	Strong leadership can motivate villagers in support of management	Aswani & Hamilton (2004) Aswani & Lauer (2006) Foale (2001) Laffoley (2008) Muehlig-Hofmann (2007)
Social, economic, and political settings	Resource dependence of villages and accessibility to markets increase pressure on resources and make the implementation of management more difficult	Van Helden (1998)
	Low-population densities mean that pressure on resources can be low until they are commodified (e.g., beche de mer)	Foale (2008) Otto (1998) Sabetian & Foale (2006)

Defining conservation feasibility

We reviewed the scientific and gray literature (see Supporting Information) on resource governance in Melanesia to identify social characteristics that potentially influence the feasibility of implementing conservation actions (Table 1, column 2). Using the social–ecological systems framework, we identified the extent of alignment between social characteristics identified in the literature and one or more of three components: governance system, users and social, economic and political setting (Table 1). We also noted if the social characteristics identified in previous studies in Melanesia overlapped with Ostrom's (1990) principles for effective governance to examine whether these principles were applicable to our case study. Ostrom's (1990) principles provide detail on the key characteristics thought to influence effective governance, while Ostrom's (2007) framework provides a generic list of characteristics that could

be important in different circumstances. We assumed that the resource system, resource units, and related ecosystems were equivalent for all villages, because most villages for which data were available were coastal with fringing coral reefs.

Social data and data analyses

Our data were collected at two spatial resolutions, representing two different types of data. First, we used data from a national village resource survey conducted by the Solomon Islands' National Statistics Office in 2007–2008 (hereafter "national survey") (details at <http://www.spc.int/prism/country/sb/stats/>). This survey carried out one interview per village. We selected social characteristics from the national survey that matched those identified from the literature review. National data for only five social characteristics (Table 2) were both relevant and complete for most villages ($n = 1,269$).

Table 2 Social characteristics related to conservation feasibility in Ostrom's (2007) social–ecological systems framework applied to the Solomon Islands (Figure 1). Social characteristics are based on the literature review. Data used to describe these characteristics are from the national survey and the household interviews. Question details in Table S1

Social characteristics	Social characteristics from national survey	Social characteristics from household interviews
Clearly defined resource user rights	Existing land-sea ownership conflicts	Exclusivity of resources for subsistence fishing Existence of ownership disputes Exclusivity of resources for commercial fishing
Perceived decline in resources	Perceived status of the fishery Interest in establishing locally managed marine areas	Perceived change in fish size Perceived change in fish abundance Change in distance traveled for subsistence fishing
Social capital	Frequency of village meetings Collective efforts to clean the surrounding environment or rebuild village infrastructure	Frequency of village meetings Degree of trust in village
Resource dependence		Frequency of fishing trips Dependence on fishing for primary income Distance traveled for subsistence and commercial fishing Portion of catch sold Consumption frequency of local fish Consumption frequency protein from other sources (e.g., pork, tinned fish)

Second, we collected new data for individual households ($n = 140$, one interview per household) in 10 villages within the Roviana, Vonavona, and Marovo Lagoons in the Western Province. Closed and open-ended questions focused on the social characteristics identified from the literature review (Table 1). Interviews took between 30 minutes to 1 hour. Villages varied from 10 to 300 households. Between 6% and 90% of households were surveyed per village, with high percentages interviewed in villages with 10–20 households and low percentages in villages with hundreds of households. Villages were selected based on previous knowledge of their management of natural resources and likelihood of permission to carry out research. We sought to interview the head of each household, usually male or, if unavailable, the next in authority. Villages that have implemented management are part of a Resource Management Program established by one of the authors (S Aswani) in 1999, which has helped to set up over 21 permanent and temporary closures that aim to improve livelihoods and conservation (Aswani *et al.* 2007).

We used canonical correspondence analysis (CCA) to examine the relationship between the presence and form of management (including permanent closures, temporary closures, gear restrictions, and species restrictions) and the social characteristics in Table 1 (see Supporting Information for details on CCA). We applied CCA to both the national survey data and the household data. The relevant data from the national survey CCA was limited so all five of the variables selected from the national survey were used for the analysis. For the household survey, we

applied CCAs to different combinations of variables (assumed to be relevant to conservation feasibility from Table 1) until we identified the combination most strongly associated with different forms of management. This gave us a final list of 14 characteristics from the household surveys (Table 2).

Results

Social–ecological systems framework for Melanesia

Our literature review identified 11 social characteristics potentially related to effective management in Melanesia (Table 1). We associated these social characteristics with Ostrom's (2007) governance system, resource users, and social, economic, and political settings (Figure 1). Six of our 11 social characteristics overlapped with six of Ostrom's (1990) principles for effective governance (Table 3). Also in Table 1 are social characteristics that appear to influence conservation feasibility but did not overlap with Ostrom's principles, although they can be related to components of the social–ecological systems framework (Figure 1).

Social characteristics from national survey and household interviews

Village data from the national survey provided an overview of social characteristics across villages in the Solomon Islands. Of the 1,269 villages used in this

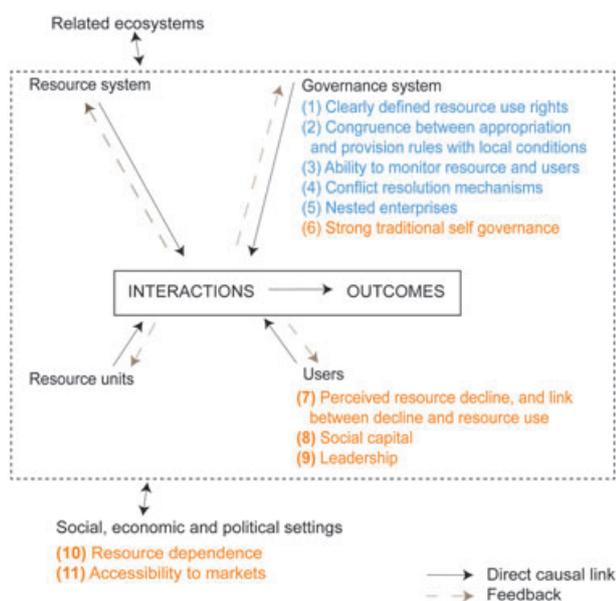


Figure 1 The 11 social characteristics from Table 1 organized within Ostrom's (2007) social-ecological systems framework. Characteristics in blue overlap with Ostrom's (1990) principles for effective governance. Characteristics in orange do not coincide with Ostrom's principles.

study, 31% had implemented some form of management including: temporary closures (24%), species restrictions (13%), quota restrictions (10%), gear restrictions (10%), and permanent closures (5%). Of the villages with management, 49% had multiple forms of management. Of all villages, 23% undertook collective efforts to clean the surrounding environment or rebuild village infrastructure, 5% had ownership disputes, and 39% were considering establishing locally managed marine areas. There was a significant difference in perceived changes in fishery conditions between villages with and without management (Pearson's chi squared test, $P < 0.000$). Those with management identified improved resource conditions more frequently (10% of villages with management, 1% of villages without management). Villages with management had significantly more village meetings than those without management (Pearson's chi squared test, $P < 0.000$).

Household interviews, formulated around the social-ecological systems framework for Melanesia, indicated that the primary income for most households was from gardening (45%) or fishing (21%). Travel distances to subsistence and commercial fishing grounds were positively correlated (Pearson's correlation 0.67, $P < 0.000$), likely reflecting the dual purpose of most fishing grounds. Less than 1% of interviewees sold all their catch from their last fishing trip and only 18% sold more than half.

Interviewees mostly fished close to home: 77% indicated paddling less than 30 minutes to their favorite subsistence fishing ground. Just under half the interviewees perceived a decrease in the number (47%) and size (46%) of fish within their fishing grounds (Figure 2A). Of the 10 villages interviewed, there was a consensus in two villages that no management was implemented. In the other villages interviewee responses were mixed. At least one interviewee indicated temporary closures in eight villages and permanent closures in five villages. In two of the eight villages where management was identified by some interviewees, others claimed no management was present.

Understanding conservation feasibility

For the national survey, social characteristics explained 24% of the variation in the presence and form of management (Monte Carlo test of all canonical axes, $F = 32.5$, $P = 0.002$). Within this 24% of variation, the x -axis captured 83% of the relationship between forms of management and social characteristics, separating the villages into two main groups: those with and without management (Figure 3A). Forms of management from the national survey included temporary and permanent closures and restrictions on species, quotas and gear. Villages associated with management were characterized by higher social capital, having land-sea ownership disputes (including disputes existing before and arising from management), and having incentives for participation in management.

With data from the household interviews, social characteristics accounted for the larger part (59%) of variation in presence and form of management across the 10 surveyed villages (Monte Carlo test of all canonical axes: $F = 5.82$, $P = 0.002$). Within this 59% variation, the x -axis captured 76% of the relationship between presence and form of management and social characteristics. Like the CCA of national survey data, the CCA's x -axis for household interviews separated the villages into two main groups: those with and without management (Figure 3B). Forms of management from household interviews included temporary and permanent closures. Relative to villages without management, villages with management were associated with higher social capital, more perceived change in fish status, higher dependence on local marine resources for commerce, disputes over resource ownership, and higher resource exclusivity. Villages with no management were associated with high use of local marine resources for subsistence, low-resource exclusivity, and higher consumption of nonmarine animal protein.

Table 3 Ostrom's (1990) eight principles for effective governance with literature on social characteristics that does or does not supports the relevance of these principles to conservation feasibility in Melanesia

Ostrom's principle	Description	Supported from previous experience in Melanesia (from literature review)	Supported by this study
(1)	Well defined boundaries	Yes, Aswani (2005) found that clearly defined resource-use rights helped to reduce conflicts, facilitating the implementation of resource management. However, clearly defined resource-use rights are uncommon in the Solomon Islands. Studies elsewhere indicate that conflicts over ownership often emerge only when there is economic opportunity associated with resources (Foale & Macintyre 2000).	Yes, villages with management had more restrictive access rights for commodity fishing.
(2)	Congruence between appropriation and provision rules and local conditions	Yes, it has been suggested that temporary closures that allow for periodic harvest for cultural festivals have greater affinity with cultural traditions (Macintyre & Foale 2007; Foale 2008). Explaining the benefits of resource management with due consideration for local and/or traditional knowledge was critical in the success of conservation projects undertaken in the Marovo, Roviana, and Vonovana parts of New Georgia (Otto 1998; Macintyre & Foale 2007; Foale 2008; Laffoley 2008; Cox <i>et al.</i> 2010). Spiritually significant areas have been targeted for conservation. An example is Tetepare Island where there is some congruence between spiritual and conservation values. However, in Tetepare, the prohibition of resource use by The Friends of Tetepare (FOT) landowner organization was closely followed by internal conflict over resources (Aswani & Hamilton 2004).	Inconclusive, analysis did not show strong differences between social characteristics associated with different management types.
(3)	Collective-choice arrangements	Limited information available. Perhaps, in the context of Melanesia, collective-choice agreements have in some cases been replaced by strong local leadership (Hvding 2011), considered critical for effective management in this region.	Inconclusive, villagers mostly thought they did not play a role in the implementation of management.
(4)	Monitoring	Yes, a lack of support from government for resource management means that communities themselves will be responsible for enforcement of resource-use regulations. Resource use is more easily regulated by communities if the resources to be managed are adjacent to the community (Foale & Manele 2004).	Inconclusive, villagers mostly thought they did not play a role in monitoring and there was limited accountability for those individuals responsible for monitoring.
(5)	Graduated sanctions	Limited information available. Cox <i>et al.</i> (2010) found case studies that suggested graduated sanctions could be replaced by high-social capital because high levels of cooperation would make people less likely to break rules. Previous research in Melanesia (Foale 2001; Aswani 2005) showed that high-social capital was more strongly associated with villages with management than those without.	Yes, villages with management had higher social capital than those without it.
(6)	Conflict-resolution mechanisms	Yes, both the commodification of resources and resource management will often cause conflicts over ownership of resources (Aswani <i>et al.</i> 2007). Effective mechanisms for timely and lasting conflict resolution, whether formal or informal, are largely lacking but badly needed.	Inconclusive, conflict was identified in all villages with management, but there was limited information on mechanisms for conflict resolution.
(7)	Minimal recognition of rights	Yes, the Lands Act and Fisheries Act, including their interpretations in court, support customary marine tenure (Kabui 1997).	Not examined because, according to legislation, recognition of rights is equal across all villages.
(8)	Nested enterprises	Yes, if resource management is recognized within legislation, it is more likely to be sustained (Johannes <i>et al.</i> 2000). However, government attempts at resource management have had limited success, for example, national moratoria on the harvesting of sea cucumbers.	Not examined because degree of nestedness is assumed equal across all villages.

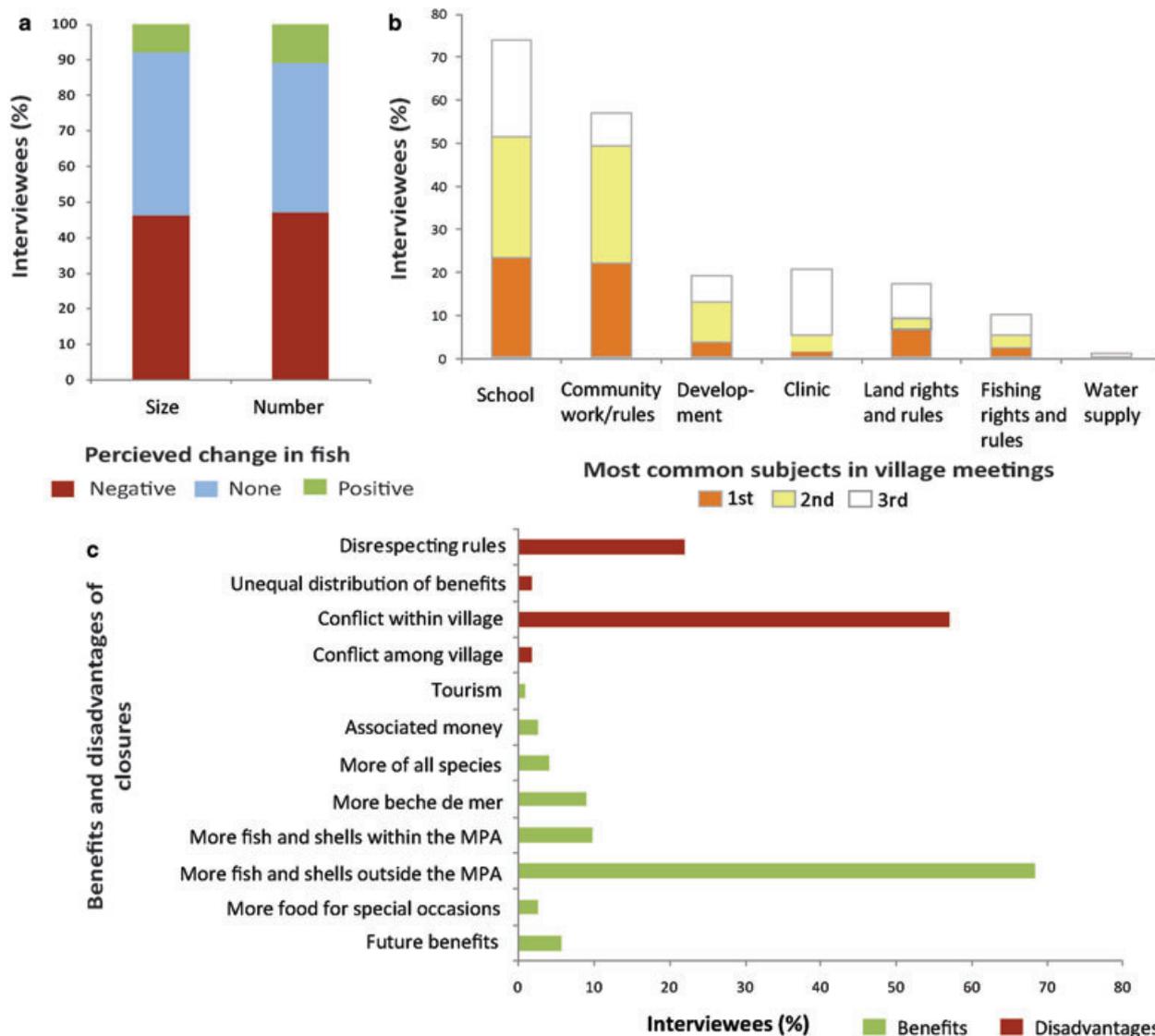


Figure 2 Results from household interviews. (A) Perceived changes in fish size and number. (B) Opinions about the disadvantages (brown) and benefits (green) of closures, all of which are aspects of fishing rights and rules (sixth column in part C). (C) Frequency of the three most common subjects identified by interviewees as the focus of discussion in village meetings.

Views on management and village priorities from household interviews

Interviewees (*n* = 122) identified both advantages and disadvantages of closures (Figure 2B). Most believed there were present benefits (83%) or would be future benefits (6%) from closures, including: more fish and/or invertebrates (inside and/or outside closures) (82%), tourism (1%), and other forms of monetary benefits (2%) such as schools or churches built from proceeds of organized periodic fishing within closures. Negative changes to fishery conditions were thought to be associated with increased fishing pressure (64%) and destruc-

tive fishing gears (22%). Those interviewees who believed there were more and larger fish (10% and 7%, respectively) attributed these changes mainly (>90%) to the presence of closures. At the same time, 50% of interviewees believed that closures had disadvantages, including conflicts associated with lack of compliance and loss of fishing grounds. Some level of conflict was identified in all communities with management but none without management.

Most interviewees did not feel they had much role in establishing closures, with only 38% of villagers stating that the community had participated. Most interviewees

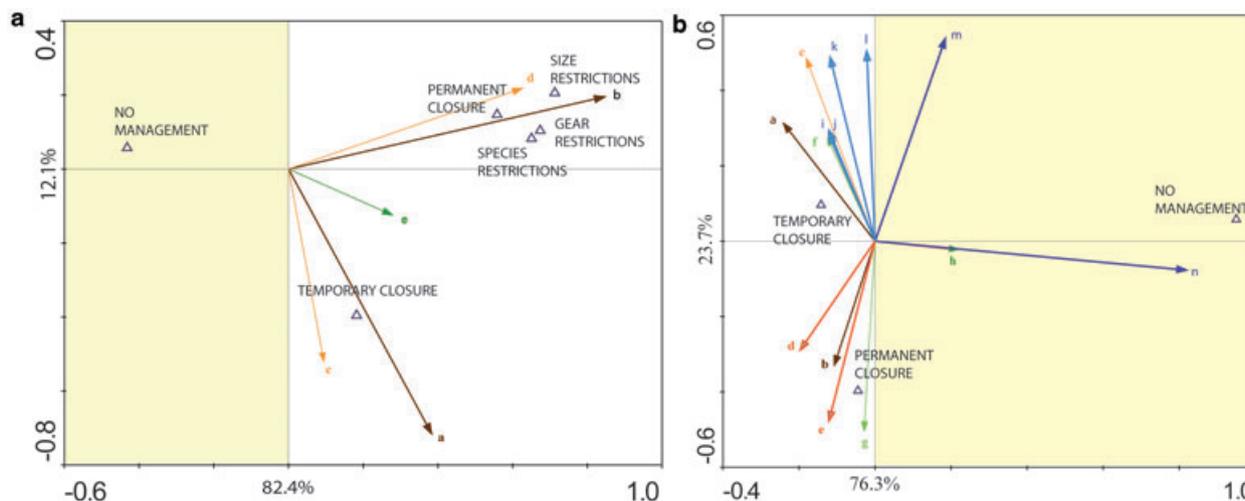


Figure 3 Associations between social characteristics of villages and the presence and form of management of marine resources. (A) Canonical correspondence analysis (CCA) biplot, using data on 1,269 villages from the national survey data. Brown arrows indicate higher social capital and include (i) higher frequency of village meetings and (ii) more group effort. Yellow arrows indicate a perceived decline in fish and include (iii) perceived less fish and (iv) greater interest in establishing management. Green arrows indicate less defined resource use rights by (v) existing land-sea ownership disputes. (B) CCA biplot, using data from 140 household interviews. Brown arrows indicate higher capital, including (i) higher degree of trust in villages and (ii) higher frequency of village meetings. Yellow arrows indicate a perceived decline in fish through (iii) longer distances traveled for subsistence fishing. Orange arrows indicate a perceived increase in (iv) fish size and (v) fish numbers. Light green arrows indicate greater defined user rights though (vi) more exclusivity of resources for subsistence fishing and (vii) existence of ownership disputes. Dark green arrows indicate less defined resource use rights as (viii) more outsiders fish in select fishing ground. Light blue arrows indicate higher resource dependence for commercial purposes as there is an (ix) increased frequency of fishing trips, (x) greater dependence on fishing as a primary source of income, (xi) longer distances traveled for commercial fishing and (xii) greater portions of their catch are sold. Dark blue arrows indicate resource dependence for subsistence purposes interpreted as higher when (xiii) fish caught locally was eaten more frequently and lower when (xiv) other sources of protein were eaten more frequently. The social characteristics hypothesized to facilitate resource management are overlaid as eigenvectors. Smaller angles indicate stronger correlations between forms of resource management (open triangles labeled with capitals) and social characteristics (arrows labeled with letters corresponding to keys below the figures, with individual characteristics in color-coded categories). Social characteristics with longer arrows are more strongly correlated with the ordination axes and therefore more closely associated with the variability found within the data.

identified the Resource Management Committee (66%) and the chief, elders and/or pastors (74%) as having roles in establishing rules. Resource Management Committees, comprised selected individuals (usually elders) in each village, are established when management is implemented and are the points of contact for NGOs and academics working in the region. Most villagers (78%) did not believe they had much role as individuals in enforcing the rules. About 39% thought the chief, elders or pastor had a role in enforcement, and 69% thought enforcement was the role of the Resource Management Committee.

To understand village priorities, we asked interviewees to list and rank the three most frequently discussed issues in village meetings. School, church, and community rules (other than those related to marine management) were the most topical issues (Figure 2C). The topic of “reefs” (which includes their ownership, status, fishing or anything associated with marine resources) was identified as

a frequent issue at only one site (Nusa Hope), and by 7% of the interviewees at that site.

Discussion

Despite consensus on the need to integrate social data on conservation feasibility into planning (Cowling *et al.* 2004; Polasky 2008), few studies have attempted to do so (e.g., Guerrero *et al.* 2010; Knight *et al.* 2010). Our approach used the social–ecological systems framework (Ostrom 2007) and literature on management of natural resources in Melanesia to contextualize this framework. We then explicitly tested the types of social characteristics, which are most strongly associated with feasibility for conservation action, using social data collected at two resolutions: whole villages and individual households. The same approach could be taken to understand conservation feasibility in other regions. The characteristics associated with the feasibility of conservation actions in

the Solomon Islands are likely to be somewhat context specific, so it is important to have a common framework that places our findings in a more general context.

What social characteristics are most strongly associated with areas where conservation actions are feasible?

The social–ecological systems framework (Ostrom 2007) provided a useful guide for organizing characteristics describing conservation feasibility in our study region. Several of the social characteristics found to influence conservation feasibility in our literature review overlapped with Ostrom's principles for robust governance of common-pool resources (Ostrom 1990; Cox *et al.* 2010). Six of those principles were supported by our literature review (Table 3), providing further evidence that some of the principles are widely applicable (e.g., the well defined boundaries principle). The well-defined boundaries principle was also supported by our village and household data. For other principles, including collective-choice agreements and graduated sanctions, we found no supporting evidence from the literature review of positive or negative influence on conservation feasibility in Melanesia (further details in Table 3). However, Cox *et al.* (2010) suggested that graduated sanctions can be replaced by social capital in some areas and our village and household data showed that villages with management had higher social capital. Conflict was found across all villages with management, and villagers did not feel they played a large role in implementing or monitoring management, suggesting that principles of collective-choice arrangements and conflict resolution mechanisms were not well established in these villages.

Some additional user and external characteristics not mentioned by Ostrom (2007) influenced effective resource governance in the Solomon Islands. National survey data indicated a higher perceived resource decline in villages with management than those without (see Aswani & Hamilton 2004; Foale & Manele 2004; Aswani & Lauer 2006; Hviding 2006). Conversely, household interviews associated both more and bigger fish with management, but also recorded fishermen in villages with management traveling longer distances to catch their fish, potentially a sign of resource depletion. These apparently contradictory findings likely result from the time lag of approximately 10 years between establishing management and our surveys. Perhaps the fishery is recovering in waters with management but not yet enough to justify a return to fishing adjacent to villages.

Our data from household interviews indicated that increased dependence on resources for commercial purposes was associated with villages with management,

complementing past literature (e.g., Van Helden 1998; Cinner & McClanahan 2006). Villages exploiting resources for commercial purposes are most likely to overfish (e.g., Otto 1998; Foale 2008). In these villages, resource decline, combined with increased competition for the status derived from income from sales or exchange of commodified marine products, will presumably strengthen the incentive to manage (Otto 1998).

Insights into data on conservation feasibility

Our findings suggest a trade-off between the accuracy with which conservation feasibility can be assessed and the extent of the planning region. In this study, we found national survey data and household interviews explained feasibility to different extents, with household interviews providing a more thorough understanding of feasibility for conservation actions but requiring more time and covering smaller areas. The better performance of household data is likely due to their specific focus on assessing characteristics associated with feasibility, unlike the national survey data, and their ability to capture variation in perceptions and priorities within villages. Consequently, it is critical to identify the data resolution that provides the greatest benefit for decision-making, which probably depends on the goals of the systematic assessment (Stephanson & Mascia 2009).

Predicting conservation feasibility for individual forms of management will require a more detailed understanding of social characteristics related to feasibility than is needed to understand feasibility for generic management. Both our national survey data and household data showed stronger differences between villages with and without management than between villages with different forms of management. Our results contrast with those of Knight *et al.* (2010) who suggested household interviews were suitable to identify feasibility for different forms of management. Differences between communal and private land tenure, and/or marine and terrestrial systems, might explain our contrasting results. When resources are governed communally, as in the Solomon Islands, a more detailed understanding of incentives and disincentives is required to spatially allocate different forms of management effectively.

Because of the costs of obtaining data from direct interviews, approaches to modeling conservation feasibility across regional extents could offer a way forward (Guerrero *et al.* 2010; Mills *et al.* 2012). Guerrero *et al.* (2010) used census data to model willingness to sell among private landholders, an indicator of conservation feasibility in South Africa, and suggested relevance to planning across regions. This study contradicts Guerrero *et al.* (2010) because we found that national census data

for villages explained conservation feasibility poorly. In our study region, predicting conservation feasibility based on household data would be more accurate, and would require extensive time and resources. On the other hand, using inaccurate representations of conservation feasibility in systematic assessments could require more investment afterwards in ground-truthing predictions and correcting mistakes.

A limitation of our data is that they provide only a snapshot in time, and our analyses can only indicate correlation, not causality. Feasibility for conservation actions is not static as depicted here, but rather changes in response to regional and local factors such as changes in market conditions and local leadership. All villages in which we surveyed households had management established for at least 10 years, while the duration of management by villages in the national survey was unknown. This lag makes it difficult to determine whether the characteristics we observed are preconditions for or consequences of management. Additionally, other potential factors that could explain the differences between characteristics associated with villages with and without management should also be investigated. Examples are history and settlement patterns of villages.

Identifying social characteristics related to the feasibility of conservation actions across a planning region is an important step in reducing misspending of conservation funds on areas where effective action is unlikely. We identified social characteristics associated with the presence and form of management that provide some insights into conservation feasibility in Melanesia. However, investing in social data to predict feasibility for conservation actions should always be complementary to involving stakeholders in the planning process and evaluating, after initial spatial assessments, alternative local opportunities for conservation (Game *et al.* 2011).

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Supporting Information

Additional Supporting information may be found in the online version of this article at the publisher's web site:

Table S1. Questions used for the canonical correspondence analysis from the national village resource survey and from the household interviews.

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