

**Human Dimensions of Coral Reef Management in the Centre of  
Biodiversity: A case study from Karimunjawa National Park, Indonesia**

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## **Abstract**

Marine protected areas (MPAs) are one of the most widely utilized strategies for coral reef conservation. However, throughout Southeast Asia many MPAs are not reaching their full conservation potential because they fail to adequately address the socioeconomic needs and concerns of local stakeholders. This paper examines how local socioeconomic factors influence the ways in which people use and perceive coral reef resources in the communities near Karimunjawa MPA- one of only seven MPAs in biologically diverse Indonesia. We used regression analysis to examine how a variety of socioeconomic factors (including dependence on marine resources, wealth, age, migration, fishing experience, and whether respondents were multi-generational fishers) were related to respondents' awareness of resource restrictions, perceived compliance with restrictions, perceptions of resource condition, and perceived impacts on resources. We found that respondents who were living inside the park and younger were significantly more aware of MPA regulations. Compliance was perceived to be significantly lower by those fishers who were older and wealthier, and perceived to be higher by those who were more experienced. The current condition of fisheries was perceived to be better by multi-generational fishers, but not by those with greater fishing experience. The current condition of the reef was perceived by migrants, active decision-makers, and older respondents to be significantly better, though migrants predicted the condition of the reef in the next 5 years to be significantly worse. Understanding these relationships can provide much-needed insights into how managers can make strategies such as education and awareness most efficacious.

## **Introduction**

The Southeast Asia region harbours 32.3% of all coral reefs, has 75% of the coral diversity and greater than 33% of the coral reef fish diversity (Wilkinson 2004). Coral reef ecosystems in Indonesia contain the most diverse suite of coral reef species globally (Hughes et al. 2002). However, these diverse and globally important reefs are also among the most threatened. Pressures such as high global economic value of reef resources, high human population densities, poverty, and the prevalence of destructive and unsustainable fishing practices make Southeast Asian reefs the most highly exploited in the world (Edinger et al. 1998; Pet et al. 2001).

Marine protected areas (MPAs) have been advocated and used as a marine conservation tool throughout southeast Asia (Kelleher *et al.* 1995; Crawford 2004). Effective MPAs can provide a range of ecological (Alcala & Russ 1990; Fairweather 1991; Jennings *et al.* 1996; Crowder *et al.* 2000), social and economic benefits (Christie *et al.* 2003). There are only seven areas designated as marine national parks in Indonesia. Given the high biodiversity of Indonesia's reefs and the global overexploitation of tropical marine ecosystems, especially in Indonesia, each of these parks potentially represent valuable examples of threatened marine ecosystems in the Indo-Pacific region.

However, few MPAs in the region are effectively managed (Ming & Wilkinson 1994; Burke *et al.* 2002; Burke & Maidens 2004) and MPA failure rates as high as 90% have been documented in some southeast Asian countries (White *et al.* 2002). MPA failure has been attributed to a number of factors, most of which are social, political and economic in nature, rather than biological (Pomeroy 1995; Christie 2004). These factors include: poor MPA design (Kenchington and Bleakley 1994; Allison *et al.* 1998; Agardy *et al.* 2003);

poorly designed enforcement programs (Woodley and Scary 2003); perceived illegitimacy of the implementing authorities (Sutinen and Kuperan 1999); inequity regarding the distribution of benefits (Christie *et al.* 2003); poor awareness and lack of community ownership (White *et al.* 2002); stakeholder conflict (Carter 2003); and lack of financial or organizational resources (Gladstone 2000; Emerton and Tessema 2001).

Recent literature has focused on understanding how local socioeconomic factors may influence stakeholder perceptions about the management of fisheries and other natural resources (Nazarea *et al.* 1998; Cinner & Pollnac 2004; Gadd 2005; McClanahan *et al.* 2005). Studies have found that livelihood activities and perceptions about the environment are largely influenced by local socio-economic conditions, and that this relationship may have important implications for factors such as reserve design, management, and conflict resolution (Pollnac 1997; Milon 2000; Fu *et al.* 2004). Case studies have also focused on the impacts of protected areas (Trakolis 2001), coastal management (Mehta and Heinen 2001; Ochiewo 2004) and ecotourism (Walpole and Goodwin 2001; Dobrzynski 2002) on local perceptions, attitudes and awareness regarding resource management. However, these relationships have not been thoroughly explored in regards to marine resource use surrounding MPAs. In light of such ill-defined relationships and their apparent importance to improved compliance and effectiveness of marine reserves, there is a need to better understand the ways in which perceptions and attitudes towards management and the marine environment are influenced by socio-economic factors.

Karimunjawa Marine National Park (KNP), located off the northern coast of central Java, supports diverse assemblages of coral and fish species (~400) and is one of only few

examples of coral reefs in the Java Sea region of Indonesia. However, KNP also experiences high levels of fishing pressure and widespread destructive fishing practices (Campbell and Pardede 2006). In a recent evaluation of reef conservation sites in the Indo-Pacific, McClanahan et al (2006) found that KNP was ineffective at maintaining higher levels of fish biomass, coral cover, fish and coral diversity, and other ecological conditions inside the park compared to outside the park. Because of KNP's national and global importance, it is the first marine national park in Indonesia in a government process that aims to re-evaluate management and re-design zoning regulation boundaries of all marine national parks based on rigorous biological and socioeconomic assessments and an extensive consultative approach. In this study, we used KNP as a case study to explore relationships between socioeconomic factors and attitudes towards the marine environment and park management. The main goals of this study were to: (1) describe the prevailing demographic and resource use patterns around KNP; (2) characterize awareness of fishing restrictions, perceptions of compliance with restrictions and perceptions of resource condition; (3) determine which socio-economic factors affect perceptions of coral reef ecosystem condition; and (4) determine which socioeconomic factors are most closely correlated to increased awareness of MPA regulations and perceived compliance with those restrictions.

## **Methods**

### **Study Site**

The Karimunjawa Island group is composed of 27 coral islands (Fig. 1), covers 111,625 ha, and lies 120 km north of Semarang, in Central Java. All of the islands and

surrounding waters have been given the designation of a Marine Nature Reserve (IUCN Management Category 1, Strict Nature Reserve and II, National Park) and are State owned. Only seven of the islands are inhabited.

### **Data collection**

Between January-March of 2003, we conducted 134 household surveys from four communities within and adjacent to KNP: Karimunjawa (n= 45), Parang (n=20), Kemujan (n=20) (all inside the Park), and Genting (n=48) (outside the Park) (Fig. 1). Maps of the communities were created and households were systematically sampled using methods described in Henry (1990). The surveys targeted the head of the household; however, in some situations, more than one respondent may have provided information about the household. For example, in some situations where a female headed the household, her son may have answered fishing specific questions if he was most knowledgeable about the household's fishing activities.

### **Indicators**

Data were collected on 27 socioeconomic and resource use indicators. For respondents who reported having migrated into the study area, the number of years since migrating and reasons for migrating (whether for fishing, other work, health, family and friends or other reasons) were recorded. The presence of select material possessions was recorded as an indicator of wealth (Pollnac & Crawford 2000; Cinner & Pollnac 2004). Thirteen assets considered the most indicative of wealth were used to create a wealth index assessed on a scale of 0-12 (where 0= the respondent possessed none of the assets and 12= the respondent possessed all 12 of the assets). The internal consistency of the index was measured using Cronbach's alpha ( $\alpha = 0.69$ ).

To explore aspects of social groupings and interactions, we examined ethnicity, religion, and the degree of participation in local decision-making (Crawford *et al.* 1998). Based on initial meetings with key informants, we developed an ordinal scale for participation in decision-making. Respondents were considered active in decision-making if they voiced their opinion at community meetings or other forums (value of 2), passive if they attended but did not voice their opinion (value of 1), and inactive if they did not attend community meetings (value of 0). We determined dependence on the fishery and other household occupations by asking household respondents to list the occupations their household engaged in, then asking respondents to rank these occupations from most important to least important (Pollnac & Crawford 2000). Socio-economic characteristics of fishers, such as age, gender, education, wealth, location of residence, and length of residence, were compared to characteristics of non-fishers.

Awareness of fishing restrictions was evaluated by asking fishers open-ended questions regarding places or time periods where they were not allowed to fish, whether there were certain gears they were not allowed to use, or whether there were particular species they were not allowed to catch. Respondents who indicated awareness of any regulations were asked to elaborate and describe the restriction and then were asked whether they believed this restriction was implemented by a non-governmental organization, by the community, or by the government. Perceived compliance with each category of fishing restrictions was evaluated by asking respondents how many people they believed still engaged in the restricted activity. Response choices included “none”, “few”, or “most”. This response was then placed on a scale of 1-3, with 3 being the highest perceived

compliance (no one still engaged in the activity), and 1 being low compliance (most people still engaged in the activity).

Perceived condition of coral reefs and condition of fisheries was evaluated on a 10 point Likert scale (Likert 1932) for three time periods (5 years in the past, the present, and 5 years into the future). To discern whether respondents perceived a relative increase or decrease in resource abundance, two trend scores were developed for each resource (i.e., two for fisheries and two for coral reefs, totalling four trend scores). The trend score for the future was calculated as follows:

$$T_f = L_1 - L_2$$

Where  $T_f$  is the trend score for the future;  $L_1$  is the Likert scale response for five years in the future; and  $L_2$  is the Likert scale response for the present. This resulted in a positive trend score if respondents felt the resources were improving (i.e., if the future score was higher than the present score) and a negative trend score if the respondent indicated the resources were declining. The trend score for the past was calculated as follows:

$$T_p = L_2 - L_3$$

Where  $T_p$  is the trend score for the past;  $L_3$  is the Likert scale response for the present; and  $L_2$  is the Likert scale response for five years in the past.

Respondents were then asked open-ended questions regarding what factors they believed may be impacting the condition of the reef and the condition of the fisheries. These responses were then organized into 13 categories of impacts, such as the weather or over-fishing, depending on content.

Marine resource use was assessed using a range of indicators. Fishing gear types were categorized as either purse seine, inshore hand line, gill net, spear gun, poison, explosive, hand spear, or pelagic line. Dependence on the various fishing gear types was assessed on a five-point ordinal scale (where 0= not dependent and 4= most dependent).

### **Analyses**

Linear regression was used to test the effects of independent variables [age, location of residence (i.e. inside or outside the park), gender, years of formal education, whether or not the respondent had migrated to the area, whether the respondent's father was a fisher, rank of dependence on fishing, rank of dependence on salaried employment, level of involvement in community decision-making, and wealth] on the dependent variables (awareness of fishing restrictions, perceived degree of compliance with fishing restrictions, perceived past present and future condition of the reef, and perceived past, present and future condition of fish resources). For purposes of the linear regression, awareness of fishing restrictions was assessed on a 7-point scale [where 0= awareness of zero restrictions and 7= awareness of all seven restriction types (i.e., spatial, seasonal, gear, explosive, poison, net, and species restriction)]. Awareness of traditional or community-established fishing restrictions was considered equal to nationally-established restrictions (provincial and district laws also apply). If respondents did not answer a question or provided inconsistent answers, their responses were not included in the model.

Linear regression models were constructed by elimination of variables with significance values  $p < 0.10$ . We used the Statistical Package for the Social Sciences (SPSS) to run

backward stepwise regressions. Multi-collinearity was not evident for any relationships (tolerance > 0.75) (Hamilton 1992).

## **Results**

### **Socio-Economic Conditions at Karimunjawa National Park**

Respondents had a mean of 5 years of formal education, with 81% having 6 years of education or less. More than half the respondents had migrated from other areas of Indonesia; the average length of time migrants had lived in Karimunjawa was 24 years (range <1 year to 70 years). Most of those who reported migrating did so to be closer to family (34%) or to find work (23%). Respondents comprised five main ethnic groups: Javanese (89%), Bugis (7%), Madura (2%), Bajao (1%), and Mandar (1%). All of the households surveyed were Islamic.

Fishing was the most common occupation in and around KNP, ranked as the primary occupation by more than 50% of the households and a secondary occupation by an additional 20% of households (Fig.2). Informal employment, agriculture and gleaning were the next most important occupations, respectively. Gleaning accounted for 6.5% of those employed however no respondents ranked this occupation as primary. While primary dependence was almost equal for marine-based occupations (fishing and gleaning) as compared to agriculture-based occupations (cash crop and subsistence), more households were highly dependent (primary and secondary) upon marine-based occupations (75.4%) than upon agriculture-based occupations (52.2%).

Indicators of wealth point towards a relatively low standard of living (Table 1). Those owning a title to their home comprised 77% of the survey population, and 74% of households had electricity. However, only 2% of households had piped water and only 11% had a flush toilet. Cronbach's alpha indicated that the material style of life variable developed from these indicators had an acceptable level of reliability ( $\alpha = 0.68$ ) (Nunnally 1978).

### **Differences between fishers and non-fishers**

Fishers and non-fishers differed significantly on four variables. Fishers were less likely to be migrants (48%) than non-fishers (65%) (chi-square=4.1, df=1, p=0.04). Fishers were more likely to have a father who fished (55%) than were non-fishers (23%) (chi-square=14.4, df=1, p=0.0002). Fishers also had a greater wealth index score (mean<sub>fishers</sub>=3.3; mean<sub>non-fishers</sub>=2.5; Z=2.3; df=1; p=0.02) and greater awareness of regulations (mean<sub>fishers</sub>=2.3; mean<sub>non-fishers</sub>=0.93; Z=6.2; df=1; p<0.0001) than non-fishers. There was no significant difference between fishers and non-fishers on education, location of residence (i.e., inside or outside the park), or level of participation in decision-making.

### **Resource Use Variables**

Resource use variables were assessed by household (Table 2). Approximately 13% of fish landed was used for subsistence purposes with the remainder sold in the market. The mean level of fishing experience was about 19 years (range of <1 year to 50 years). Those whose father had also fished comprised 40% of the population. Five fishing trips per household per week was the average, amounting to 690 total fishing trips per week for all households.

Respondents were asked how many times each week they used various gears and whether each gear was the primary fishing gear used (Fig. 3). Results indicate that inshore hand line fishing is the most utilized fishing technique (although this technique was only ranked fourth in terms of dependence). Pelagic line was ranked second for frequency of use and for dependence. Although purse seine nets comprised a low proportion of the total fishing effort, more than 60% of fishers ranked them as their primary gear. No household claimed to use explosives, poisons or weirs as fishing techniques. Though many households were loyal to only one gear type (25%), there were more households involved in the use of 2 or 3 different gear types (62%) and even some involved in the use of 4 or more gear types (13%).

### **Perceptions and Knowledge of Restrictions**

Karimunjawa National Park (KNP) was mentioned only once out of 18 open-ended responses on spatial restrictions (Table 3). However, the closed area referred to most by respondents was Menyawakan Island (10 times), which is an island 10km to the west of Karimunjawa inside a tourism zone of the park where fishing is prohibited. The most commonly mentioned seasonal restriction was a traditional prohibition of fishing on Friday, which is enforced by the community. The most commonly mentioned species restriction mentioned was on napoleon wrasse, with 26 respondents showing high awareness of restrictions related to the federal prohibition on catching Napoleon Wrasse (*Cheilinus undulatus ruppel*). Restrictions on the use of poisons for fishing were mentioned by more respondents than any other type of restriction. Sixteen respondents believed that both the government and the community were partly responsible for this

restriction, indicating the importance of both community and government enforcement pressures.

Perceived compliance varied significantly by restriction type (Fig.4). Net restrictions had the lowest perceived compliance, whereas poison, species, and explosives restrictions had the highest perceived compliance.

Poison, explosives, nets and gillnets were the most frequently mentioned factors affecting the condition of the fishery (Fig. 5). Poisons and explosives were most frequently mentioned factors affecting reefs (Figure 5). Gill-netting, supernatural forces and over-fishing were perceived to impact fisheries condition to a greater degree than reef condition. Land-based activities were mentioned little for reefs and not at all for fishing conditions. Weather was considered an important impact on both fishing condition and reef condition.

On average, respondents perceived a large decline in fisheries condition and a small decline in reef condition over the previous five years; respondents did not expect any major changes in the condition of reefs or fisheries over the next 5 years (Fig. 6).

### **Influence of Socio-Economic Factors on Perceptions and Knowledge**

Linear regression models were used to test the influence of independent, socio-economic variables on dependent, perception and awareness-based variables. Awareness of restrictions was positively influenced by residing inside the Park and negatively influenced by age (Table 4). Perceived compliance with regulations was lower for

wealthier and older respondents and greater for those with greater fishing experience (Table 4).

Perceived current condition of fisheries was influenced by intergenerational fishing and the number of years fishing. Those whose father fished tended to believe fisheries were in better condition whereas those with more fishing experience tended to believe that fisheries were in poorer condition. The perceived trend in fisheries condition over the previous 5 years was influenced by wealth, decision-making and location. Wealthier respondents tended to perceive a greater decline in the condition of fisheries over the last 5 years. Those involved in more active decision-making perceived an improvement in the condition of fisheries. Respondents living inside the park tended to perceive an improvement in the condition of fisheries over the previous 5 years (Table 4). No variables were found to influence expectations of future fisheries condition.

Perception of current reef condition was positively influenced by having migrated into the area, being active in decision-making, and greater age. Perception of future reef condition was negatively influenced by a greater dependence on fishing and migration to the area, but positively influenced by the number of years fishing.

## **Discussion**

Recent studies have highlighted the importance of understanding local perceptions of resource users (Ormsby & Kaplin 2005), and have explored how variability in perceptions about natural resources or the institutions that govern them are related to specific socioeconomic factors (Walpole *et al.* 2001; Cinner & Pollnac 2004). Consistent with these studies, we found that perceptions of natural resources and awareness of

resource management regulations varied predictably among park residents based on their socioeconomic characteristics. Our study of Karimunjawa National Park highlighted four areas of concern to park management: 1) the importance and prevalence of fishing activities on coral reef areas; 2) the distinct socioeconomic characteristics of fishers in comparison to the general population; 3) a poor understanding of the impacts and influence of anthropogenic activities on marine ecosystems; and 4) the generally low awareness of the park and other fishing regulations.

### **Fishing Activities in KNP**

At Karimunjawa, fishing effort is concentrated on the reef rather than on pelagic areas, and fisheries are largely market-based. In terms of total fishing effort, reef-based hand lines and pelagic hand lines are the predominant gear used. However, *muro ami* purse seine fishing on reef areas was also prevalent and, though used less frequently, many fishers ranked it as their primary gear type. Whereas hand line and pelagic line fishing are lower impact fishing practices, the use of purse seines can place considerable pressure on the reef ecosystem (McClanahan 2004). Awareness-raising programs may need to focus on improving local understanding of the impacts of purse seine fishing and of the federal restrictions against small mesh sizes.

### **Socioeconomic Characteristics of Fishers**

Migration can be an important factor in coastal population growth and marine resource use in Indonesia, and is responsible for at least a quarter of the total population growth in the past decade in some areas (Kramer *et al.* 2000). Consistent with this, we found that more than half of the respondents in and around KNP had migrated from other parts of Indonesia. Although access to fishing was not a primary reason for people to immigrate

to the area, this recent influx of people to the KNP area has likely placed additional strain on marine ecosystems through associated coastal development and demand for marine resources. Moreover, migrants were found to have different perceptions of coral reef condition, suggesting that population growth due to migration could potentially affect the level of community support for coral reef management.

### **Perceptions of Marine Resources**

Many respondents recognized the impacts of destructive fishing practices, such as poison fishing, blast fishing and gill netting. However, the low proportion of respondents mentioning the impacts of land-based activities or economic, social and political systems points toward a lack of understanding about more complex and abstract issues that may affect marine ecosystems. Approximately 13% of respondents were not able to cite a single factor that may impact the condition of fisheries; 16% could not cite a factor impacting reef condition. If local people do not perceive particular impacts to exist (e.g., shrimp farming, untreated sewage and agriculture), then they are not likely to see a reason to cease or minimize involvement in these harmful activities. Improving public awareness, especially in regards to the dependence of the local economy upon the health of its natural systems, may improve conservation, and requires a broadening of environmental education programs (Holl *et al.* 1995).

Regression models showed that current fishing condition was perceived to be higher by those whose father fished. Greater fishing experience, however, was correlated with a lower perceived condition of fisheries. These results indicate that whereas many fishermen remain optimistic about the future of their occupation, those with an enhanced context within which to base an assessment perceived poorer fisheries condition. These

results highlight the importance of understanding how fishers develop dynamic fishing tactics and strategies as an adaptive response to changes in perceived resource abundance, environmental conditions and market constraints (Salas and Gaertner 2004).

Wealthier individuals perceived declines in fisheries condition over the past 5 years. Because this group is more likely to be benefiting from increased pressures on fisheries and may experience lower catches with greater effort when over-fishing does occur, they are more likely to perceive declines in fisheries condition over time. Fishing gears have become more modern and technologically advanced in recent years, and prices have increased substantially as well over the past 5 years. Fishers therefore associate greater wealth with improved fisheries condition and are more aware of fish catch as a result. Wealth has also been found by a number of studies to correlate to concern for the conservation values of the marine ecosystem (Newmark *et al.* 1993; Mehta & Kellert 1998; Gillingham & Lee 1999). In contrast, those living inside KNP perceived the condition of fisheries to have improved over the past 5 years.

Individuals with a greater dependence on fishing were more likely to expect the condition of the reef to decline in the next 5 years. Individuals most dependent upon fishing have more invested in the future condition of the reef, and therefore, have more reason to be concerned about future conditions. Greater experience was correlated with a perception of improving reef condition into the future, indicating that more experienced fishers are optimistic about the future of the reef. This apparent optimism and predicted improvement of reef conditions into the future may not have a positive impact on conservation if these fishers do not perceive a problem. However, the desire to see improvements in reef condition into the future may bolster support of any reef protection

measures. Interactions with the community indicated strong support for reef protection measures. However, perceived incursions from ‘outsiders’ and lack of effective enforcement have made locals cynical about both reef protection measures and the commitment of the government to implement protection policies.

### **Knowledge of Restrictions**

Limited awareness about the existence of the park and other fisheries regulations among fishers in and around KNP is a problem confronting the effectiveness of the park. For example, long-standing regulations such as the *Ministerial Decree No. 123 of 1975 on Minimum Mesh Size of Purse Seine Used to Catch Small Pelagic Fish* was not described in any form by any respondents despite the fact that purse seines were ranked as the most important and the third most frequently used gear. On the other hand, fishers were largely aware of federal restrictions on poison fishing. Respondents showed the greatest awareness of poison fishing restrictions and perceived the highest compliance with this restriction. Poison fishing was the least frequently utilized fishing method and was the most frequently cited factor impacting the condition of fisheries and reefs. The high awareness about the impacts of poison fishing may be the result of internationally funded education programs on the consequences of poison fishing (World Bank 2003).

To effectively improve awareness about the park and other regulations, it is important to understand whether particular groups of stakeholders hold varying levels of awareness about fisheries regulations. We found that greater awareness of fishing restrictions and marine management was negatively related to the fishers’ age, but positively related to whether they lived inside the park. Many studies have found education level to be associated with higher levels of awareness about management restrictions (Trakolis 2001,

Mehta & Heinen 2001), however this relationship was not apparent in our study. Age and residence inside the park may have been more important than education in this study because of the consistently low level of education among the large majority of the population.

Assessing perceived compliance may elucidate social norms and pressures as well as views on particular restriction types. Wealth and greater age were both correlated with a lower perceived compliance in these communities. Wealthier individuals and those with more time spent in the community are more likely to establish and enforce traditional or district level regulations and may therefore be more familiar with non-compliance of those regulations. Wealthier individuals, such as those that own the muro-ami nets, may also be differentially benefiting from non-compliance and therefore perceive compliance and the social pressure to comply to be lower. The finding that those with greater wealth within the community perceive high non-compliance indicates not only the potential for improved compliance, but also the importance of involving this particular socio-economic group in the process.

## **Conclusion**

When local participation in the management, operation and planning of a MPA is limited, it is likely that a lack of appreciation and ignorance of the value of the park will develop (Fauzi 2002). The findings of this study suggest a need for improvement in the awareness of local people to re-establish the importance of preserving the reefs of KNP. Awareness campaigns about federal legislation for restrictions on cyanide use have proven effective, providing an example of the manner in which spatial closures, established at the federal level, could become legitimized at the local level in the same way. Because awareness of

locally-established spatial and temporal closures was greater, management should also seek to legitimize these closures in federal legislation.

The findings of this study provide insights into the ways in which socio-economic factors may impact levels of awareness, perceptions of compliance with restrictions, and perceived resource condition. This case study adds to the growing body of similar case studies providing evidence to the usefulness and applicability of the information gained through socioeconomic, perception, and awareness-based assessments. Information gained from these surveys and from interactions with the community has already proven effective in assisting with rezoning of Karimunjawa National Park, and the results provide important baseline information against which the effectiveness of new management regulations can be evaluated. Results of this study also contribute to the growing body of evidence that an understanding of the socio-economic factors that influence use of the marine environment and incorporation of this understanding into management is vital for successful marine parks (Christie et al. 2003, McClanahan et al. in press). Like other case studies of the relationship between socio-economic conditions and use and management of marine resources (Cinner & Pollnac 2004, Crawford et al. 2004, Crawford et al. 1998), the generalizability of the results of this study to other areas in Indonesia or elsewhere is questionable. Future research needs to move beyond the case study approach applied here (and elsewhere) if we are to fully understand the importance and influence of socio-economic factors in marine park success, and how these factors vary within and across communities and regions. However, there remains much work to do in exploring the social and psychological dimensions of marine ecosystem management, including refining the social assessment process, integrating knowledge from a variety of social and biological science disciplines, and exploring these issues

from a larger scale. Viewed from a holistic perspective, this work will lead towards improved assessments of socio-economic and perception-based indicators for the improved efficacy of marine protected areas as a marine conservation strategy.

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Table 1 *Indicators of Wealth*

<b>Indicator</b>	<b>Ownership</b>
Land Title	77.0%
Electricity	73.9%
Gas or electric stove	46.3%
TV	30.6%
Vehicle	21.6%
Generator	18.7%
Water tank	15.7%
Video player	15.7%
Flush Toilet	11.2%
Refrigerator	2.2%
Piped water	2.2%
Satellite	1.5%

Table 2 *Characteristics of Resource Use Patterns*

<b>Characteristic</b>	<b>Value</b>
Total Fishing Trips Per Week	690.7
Average Fishing Trips/ Household/ Week	5.2± 4.6*
Percent of Trips to Reef	60.8%
Fish Sold in Market	86.6%
Households Involved in Fishing	74.6%
Average Years Fishing	19.4±13.1*%
Fisher and Father Fished	53.3%

\*Standard deviation

Table 3 *Percent of Survey Population Aware of Restriction Types and Implementing Body*

Restriction	Total Awareness (%) <sup>a</sup>	Implementing body				Common Answers
		Government	NGO	Community	Unknown	
Spatial	13.4	6.7	0.0	3.7	3.0	Menyawa Kan Island, Burung Island, Geleang Island
Seasonal	5.2	1.5	0.0	3.0	0.7	August (Navy Island), Islamic New Year
Species	34.3	29.9	0.0	3.7	0.0	Turtles, Ornamental fish, Giant clams
Nets	35.8	25.4	0.7	17.2	0.0	n/a
Poison	59.0	56.7	0.0	14.2	0.0	n/a
Explosives	29.9	29.1	0.7	9.7	0.0	n/a
Other Gear	2.2	1.5	0.0	0.7	0.0	Compressor, Electricity

a Percent of respondents that mentioned the specific restriction. More than one response could be chosen for the implementing body, therefore values in the Government, NGO, Community, and Unknown columns do not necessarily equal the Total column.

Table 4 Regression Model of Socio-Economic and Dependent Variables

Variables	B	Std. Error	F	P	R <sup>2</sup> Adjusted	Intercept	N
<b>Awareness*</b>							
Live inside park	0.54	0.25	4.79	<0.03			
Age	-0.01	0.01	5.30	<0.02	0.102	64.52	73
<b>Compliance*</b>							
Wealth	-0.07	0.03	4.40	<0.04			
Years Fishing	0.02	0.01	3.68	<0.06			
Age	-0.02	0.01	5.28	0.03	0.068	64.85	73
<b>Fish Condition: Current</b>							
Father Fished	0.68	0.35	3.81	<0.05			
Years Fishing	-0.00	0.01	5.63	<0.02	0.051	1059.58	95
<b>Fish Condition: Past Trend</b>							
Live inside park	1.46	0.54	7.30	<0.01			
Wealth	-0.36	0.13	8.23	<0.01			
Decision-making	0.58	0.33	2.98	<0.09	0.083	226.68	100
<b>Fish Condition: Future Trend</b>							
Age	-0.47	0.32	1.65	<0.20	0.009	20.37	70
<b>Reef Condition: Current</b>							
Migrant	0.98	0.47	4.38	<0.04			
Decision-Making	0.61	0.33	3.38	<0.07			
Age	0.01	0.02	3.20	<0.08	0.138	83.54	73
<b>Reef Condition: Future Trend</b>							
Dependence on Fishing	-0.93	0.32	8.27	<0.01			
Years Fishing	0.01	0.18	5.05	<0.03			
Migrant	-0.83	0.45	3.34	<0.07	0.138	28.40	59
<b>Fishing Trips Per Week</b>							
Years Fisher	0.11	0.03	15.47	<0.00			
Dependence on Fishing	1.32	0.45	8.72	<0.01			
Age	-0.01	0.03	10.72	<0.00	0.215	442.37	134

\* Fishers only included

## Figures Legend

Fig. 1 *Map of Karimunjawa Island Chain and Karimunjawa National Park (dotted outline)*

Fig. 2 *Distribution of Primary and Secondary Household Occupations*

Fig. 3 *Percent of Households Ranking Gear as Primary Compared to Percent of Total Fishing Trips per Week with Gear Type*

Fig. 4 *Perceived Compliance with Restrictions* In response to whether ‘none’, ‘few’ or ‘most’ people break rules of restriction types, ‘none’ is taken to mean ‘high’ compliance and ‘most’ is taken to mean ‘low’ compliance.

Fig. 5 *Percent of Respondents Perceiving Impacts on Fisheries and Reef Condition*

Fig. 6 *Average Rank of Reef and Fish Condition Over Time With Standard Error Bars*











