POLICY PERSPECTIVE

Coral reef quality and recreation fees in marine protected areas

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Abstract

The recreational use of marine protected areas (MPAs) is a potential source of funding for MPAs in developing countries, for instance given the willingness of international divers to pay considerably higher diving fees than they currently pay. We conducted a global survey of MPAs containing coral reefs to investigate what factors are important in determining the size of fees charged to recreational SCUBA divers. The survey suggests that a negative perception about diving fees by managers is a more important predictor of fee size than the quality of diving, which can help explain the prevalently low size of diving fees. Decentralized fee systems and higher diving fees can help capture some of the surplus willingness to pay for diving in MPAs, but an excessive reliance on tourism for funding MPA management could expose coral reefs to damages.

Introduction

Marine protected areas (MPAs) provide refuge to coral reefs from human exploitation, and recreational SCUBA divers value their abundant fish and their corals undamaged by fishing methods such as bottom trawling and blast fishing (Wielgus *et al.* 2003, 2009). While charging fees for diving may contribute to the funding of MPAs (reviewed in Peters & Hawkins 2009), in MPAs of developing countries diving fees are usually low and their contribution to management is modest (Emerton 2003).

International visitors who dive in MPAs of developing countries are frequently willing to pay diving fees that are substantially higher than what they are required to pay (Arin & Kramer 2002; Green & Donnelly 2003; Depondt & Green 2006; Parsons and Thur 2008; Peters & Hawkins 2009; Wielgus *et al.* 2009). For example, in some places in the Caribbean the median willingness to pay by international visitors is an order of magnitude higher than the diving fees they pay (Green & Donnelly 2003). This suggests that increasing the diving fees of international visitors could make a major contribution to meeting the shortfall in MPA budgets and thus in enhancing MPA effectiveness. So, what constrains fees at their current modest levels? One possibility is variation in the quality or quantity of what divers can expect to see—perhaps low fees are typical of generally less attractive sites. Implementing recreation fees may also be hampered by negative attitudes toward establishing or increasing fees. For example, MPA managers might be concerned that the collection of fees will increase the administrative expenses of their MPAs (Norris & Curtis 1999). In addition, collection systems that are managed by a central authority might not allow raising fees at the local level, or may eliminate incentives for doing so if its allocation of funds to MPAs is not proportional to what each MPA collects (Erdmann *et al.* 2004).

We conducted a global survey of MPAs containing coral reefs to investigate what factors are important in determining the size of diving fees charged to international visitors. We expected that fee size would be related to the condition of coral reef attributes, as perceived by the MPA managers. We also evaluated the perceptions of managers about recreation fees.

Methods

From the 980 MPAs containing coral reefs in Mora *et al.* (2006), we contacted MPAs by e-mail using the addresses of the contact officers (usually the MPA manager) of

Table 1 Pairwise correlation coefficients of ecological variables in marine protected areas. Wrecks were considered an ecological variable because they can provide habitat to fish and corals.

	Coral diversity	Coral cover	Reef-fish diversity	Reef-fish abundance	Large-fish abundance
Coral cover	0.451				
Reef-fish diversity	0.488	0.176			
Reef-fish abundance	0.029	0.714	−0.098		
Large-fish abundance	−0.254	−0.061	−0.124	0.061	
Wrecks and others	0.133	0.296	−0.174	0.153	0.367

63 MPAs, which were provided by UNEP-WCMC (Cambridge, UK). The e-mail messages explained that answers to an attached questionnaire (see Appendix) would be treated anonymously. In previous research, we have observed that MPA officers generally are well informed about the condition of their MPAs, especially about the features that are relevant to tourism. The questionnaire also included questions not related to this study, but which could be useful in future investigations.

The questionnaire included questions on the size and adequacy of the MPAs budget. Although information on international and domestic visitors was collected, only that pertaining to international visitors was analyzed in this study. The questionnaire also elicited the MPA officers' perception of the diving attributes in their MPAs (coral cover and diversity, fish abundance and diversity, the presence of sharks and other large fish, and the presence of other attractions such as ship wrecks, turtles, and sea snakes). Diving attributes were selected on the basis of our diving experience and the expert opinion provided by A. Manica, University of Cambridge. Based on our previous observations, we assumed that most divers considered observing sharks and sea snakes, which are potentially dangerous animals, as a positive experience.

We used subjective measures on the condition of diving attributes (the MPA officers' perceptions) because MPAs usually do not have up-to-date field measurements for these attributes (Gerber *et al.* 2007). As economic agents, people in charge of setting fees for MPAs ("fee setters") are expected to make pricing decisions based in part on how attractive they perceive the MPAs to be. Because of the commonly large differences between diving fees and willingness to pay for diving in MPAs, fee-setters are also expected to use prices as signals about the quality of diving in the MPAs (see Rao, 2005 for a review on using prices as quality signals). To address the subjective nature of the responses about diving attributes, we provided MPA officers only the opportunity to select the category ''high'' (see Appendix). Not selecting this category would imply a broad range of possibilities for reef condition. Therefore, different MPAs for which the category "high" was selected for a particular attribute are likely to be similar in the real (objective) magnitude of this attribute. Because respondents were told that their answers would be treated confidentially, there was no apparent motivation for strategic behavior when providing answers to the questionnaire (i.e., a motivation for providing misleading ratings on diving attributes).

We analyzed the questionnaire responses with information-theoretic methods. First, we reduced the number of predictor variables to conform to the norm that the number of predictors should not exceed 10% of the number of observations (Burnham & Anderson 2002). Reef-fish abundance was highly correlated ($t = 5.586$, $P < 0.001$) to coral cover (Table 1), so it was excluded from the analysis. Coral cover has been widely used as an indicator of general reef condition (e.g., Fisher *et al.* 2008), so we selected this variable and (the uncorrelated) large-fish abundance as representative ecological variables. We selected other MPA characteristics that could affect fee sizes based on support from the literature: the concern that collecting fees is expensive (Norris & Curtis 1999), and a centralized fee system (Erdmann *et al.* 2004). These variables and the concern that fees could reduce the number of international visitors were grouped into a single variable: negative attitudes toward recreation fees.

Our global model therefore had daily fee as the dependent variable, and coral cover, large-fish abundance, and negative attitudes toward recreation fees as independent binary factors. Linear regressions were conducted with the ''glm'' function of the statistical package R, version 2.8.1 (R Development Core Team, Vienna, Austria). We used the identity link function and assumed a Gaussian error distribution. We tested for the validity of linear regression assumptions using the global validation test of Peña & Slate (2006), and found violations to the assumption of normality of the error distribution (Table 2). When we transformed the dependent variable using $\ln(Y+1)$, we found no violations to the regression assumptions. For the global model and its subset of

Table 2 Results of tests on linear-regression assumptions based on the global validation procedure of Peña & Slate (2006), with the dependent variable untransformed and transformed with $\ln(Y + 1)$.

	Parameter and *P*-values	
Assumption tested	Untransformed	Transformed
1. Skewness	$S_1 = 5.466$, $P = 0.019$	$S_1 = 0.622$, $P = 0.430$
2. Kurtosis	$S_2 = 2.151$, $P = 0.143$	$S_2 = 0.299$, $P = 0.584$
3. Linearity	$S_3 = 2.254$, $P = 0.133$	$S_3 = 0.745$, $P = 0.388$
4. Homoscedasticity	$S_4 = 1.010$, $P = 0.315$	$S_4 = 1.508$, $P = 0.219$

models (with transformed dependent variable), we estimated the Akaike information criterion for small samples (AIC_c) and the Akaike weight. We assessed each variable's relative importance by calculating w_+, which is the sum of the Akaike weights for all models containing the variable (Burnham & Anderson 2002).

Results

We obtained replies from 59 MPAs. In only 6 MPAs (10%), the budget was sufficient to cover management costs. From the 59 MPAs, 45 (76%) charged fees for diving. Statistical analysis was conducted only on 32 of these MPAs, which provided information on all of the variables studied in the regression analysis. These MPAs represented all the regions containing coral reefs (Table 3) and were located in countries traditionally considered as ''developing''. Of the 32 MPAs, 3 (9%) stated that their budget was sufficient to cover management costs. The mean (±SD) fee charged to international visitors for diving was US$ 37.70 ± 45.50. Summary statistics on socioeconomic and ecological characteristics of the MPAs are presented in Table 4.

The goodness-of-fit (r^2) of the global model was 0.317 ($F = 4.326$, $P = 0.013$). Our analysis indicated that the model that included negative attitudes towards recreation fees, coral cover, and an intercept was the highest-ranked model among the set of candidate models (Table 5a). Negative attitudes toward recreation fees was the most important variable in explaining differences in fees among MPAs ($w_+ = 0.991$), followed by coral cover ($w_+ = 0.611$), and large-fish abundance ($w_+ = 0.344$). Fee size was positively related to large-fish abundance, and was negatively related to coral cover and negative attitudes (Table 5b).

Table 3 Number of marine protected areas (MPAs), by region, for which the relationship between diving-fee size and MPA characteristics was studied.

Region	Number of MPAs
Western/Central Pacific Ocean	19
Indian Ocean	7
Western Atlantic Ocean	5
Eastern Pacific Ocean	1
Total	32

Table 4 Summary statistics for marine protected area characteristics (see Appendix for details on the variables).

Variable	Mean±SD or%
High coral diversity	78%
High coral cover	78%
High reef-fish diversity	94%
High reef-fish abundance	88%
High large-fish abundance	59%
Presence of wrecks and other attractions	88%
Number of diving sites	14 ± 20
Presence of diving operators	69%
MPA is main destination	41%
Daily per capita Gross Domestic Product	US$ $7,745 \pm 5,187$
Concern of visitor decrease	25%
Centralized fee system	28%
Expensive fee system	13%

Discussion

We studied factors that contribute to the size of diving fees for international visitors in MPAs worldwide. Our results suggest that, from the standpoint of MPA managers, negative attitudes towards MPAs are more important than the perception of diving quality in their MPAs. In fact, a perception of high coral cover was a predictor of low diving fees. This could be explained by the negative correlation ($r = -0.443$, $t = -2.706$, $P < 0.011$) between the perception of high coral cover and the countries' Gross Domestic Product (expressed as US$ at purchasing power parity; obtained from CIA 2009), which is consistent with the observation that many reefs with healthy corals are located in some of the world's poorest countries (Whittingham *et al.* 2003). The definition of an appropriate fee level is likely to be shaped by the general perception of prices in each country (i.e., willingness to pay), which is a function of income. In addition, payments for recreation in lower-income countries are not as widespread as in more developed countries, where people have become accustomed to paying to support the management of protected areas (Harris & Driver 1987). Establishing or raising diving fees may therefore be resisted because it may reduce the number of international visitors. However, there is evidence that the demand for nature-based recreation by international visitors in developing countries is price-inelastic; when fees

Table 5 (a) Results of an information-theoretic assessment of a global model of determinants of diving-fee size in marine protected areas, and its submodels. Models are arranged in order of decreasing Akaike weight (w), and only models with $w > 0.001$ are presented. Δ is the difference between the AIC_c value of the model and the lowest AIC_c value in the set of models. The global model included the variables coral cover (Corc), large-fish abundance (Larf), negative attitudes towards recreation fees (Atti), and a constant (Cons). (b) Parameter statistics based on all models with $w > 0.001$.

a) Model	AICc	Δ	w
1. Corc, Atti, Cons	99.074	0.000	0.402
2. Atti, Cons	100.032	0.958	0.249
3. Global	100.455	1.381	0.202
4. Larf, Atti, Cons	101.212	2.138	0.138
5. Corc, Cons	108.036	8.962	0.005
6. Larf, Cons	109.356	10.282	0.002
7. Corc, Larf, Cons	109.422	10.348	0.002

b)	Coefficient			SE	
Parameter	Min	Max	Mean (SD)	Min	Max
Atti	−1.333	−1.302	−1.318 (0.015)	0.397	0.410
Cons	3.225	4.148	3.471 (0.483)	0.295	0.713
Corc	−0.728	−0.649	−0.688 (0.039)	0.479	0.563
Larf	0.191	0.283	0.236 (0.038)	0.515	0.599

are raised, the percent reduction in visitors will be less than the percent increase in fees, resulting in net financial gains (Lindberg & Aylward 1999). In spite of this, the current economic crisis compels cautiously appraising the amount by which fees are increased. In addition, large increases in fees may imply elevated costs and burdens on personnel in some MPAs because of needs for enhanced security to deal with larger funds, better accounting and data-processing systems, and investments in public relations (Norris & Curtis 1999).

The benefits provided by MPAs to the recovery of overexploited resources has been widely documented (reviewed in MPA 2008), and MPAs are also receiving attention for their potential in helping to alleviate poverty in coastal communities dependent on coral reefs (Leisher *et al.* 2007). For example, the protection of coral reefs by MPAs can enhance economic value of fisheries outside the MPAs, as fish biomass and yield can increase in the vicinity of the MPA boundaries (Williams *et al.* 2009). Unfortunately, many MPAs continue to receive deficient funding from central authorities (Balmford *et al.* 2004; Erdmann *et al.* 2004; Peters & Hawkins 2009). If MPAs are to meet the expectations of helping to protect the world's coral reefs, a decentralized system of user fees will be needed to tap into visitors' willingness to pay for recreation. An excessive reliance on tourism, however, may lead to levels of recreational activities that can imperil the ecosystem. For example, large numbers of damaged coral colonies have been observed in places with high diver densities (e.g., Schleyer & Tomalin 2000; Zakai & Chadwick-Furman 2002). Nonetheless (even if the demand for diving in MPAs can be price-inelastic) large increases in prices can lead to a reduction in the number of dives. Willingness to pay surveys in individual MPAs can help estimate a fee level that will contribute to revenues and avoid an excessive number of dives (see Loomis & Walsh (1997) for examples of applications). To avoid preventing the entrance of lower-income domestic divers, MPAs can adopt a strategy of charging lower fees to domestic visitors (many MPAs already do this); this is a common strategy adopted by protected areas worldwide (Ceballos-Lascuráin 1996). Finally, it is important to keep in mind that the results of this study are based on information obtained from 32 of the approximately 1,000 MPAs that contain coral reefs, and it will be interesting to see how these results compare to those of future studies.

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Appendix

1. What is the name and country of your marine reserve?_____
2. What is the nearest commercial airport to your marine reserve?_____
3. Approximately how much time does it take to travel from the airport to the marine reserve?_____
4. Please indicate how much your marine reserve charges visitors *on average* and on a *daily* basis, for entering the reserve and participating in recreational activities. Please also indicate the approximate number of people participating in each activity *per year*.

	Average payment by a domestic visitor *per day* (in your national currency)		Number of domestic participants *per year*		Average payment by a foreign visitor *per day* (in your national currency)		Number of foreign participants *per year*	
Activity	Adults	Children	Adults	Children	Adults	Children	Adults	Children
SCUBA diving								
Snorkeling								
Sports fishing								
Whale watching								
Use of beaches								
Other activities (please specify below)								

5. Approximately what percentage of the international visitors in your marine reserve come from each of the following regions?

Africa	Asia	Europe	United States and Canada	South America, Central America, and the Caribbean
%	%	%	%	%

6. Is your marine reserve the main travel destination for the international tourists who visit your country? Yes__No__
7. What is the approximate budget (in your local currency) available for managing your marine reserve per year?_____
8. Is this budget sufficient for covering all of the management costs of the reserve? Yes_____No_____
9. If you answered "No" to the previous question, how much more money (in local currency) do you estimate is needed to manage your marine reserve?_____
10. Approximately how many diving sites are there in your marine reserve?_____
11. Please indicate with √ which of the following attractions for divers are present in your marine reserve.

High *diversity* of corals	High live coral cover	High *diversity* of coral-reef fish (surgeonfish, parrotfish, etc.)	High *abundance* of coral-reef fish	Sharks	Other large fish (manta rays, barracudas, etc.)	Whales or dolphins	Other attractions. Please specify below (ship wrecks, turtles, sea snakes, etc.)

12. Are there diving operators in or near your marine reserve? Yes_____No_____

13. What do you believe is the impact of SCUBA divers on the coral reef of your marine reserve? Please indicate with √

Very Low	Low	Moderate	High	Very high

14. What is your opinion on increasing visitor fees in your marine reserve? Please indicate with √ *all* of the statements that you agree with.

It may cause a decrease in domestic tourists visiting the marine reserve.
It may cause a decrease in international tourists visiting the marine reserve.
It would raise more revenue for management activities in the marine reserve.
Collecting fees at the marine reserve is expensive.
Collecting fees would be difficult because it is difficult to control access to the marine reserve.
All or most of the money collected from fees does not remain in the marine reserve.
Please provide any other comments you may have regarding visitor fees in your marine reserve.

Thank you very much for your participation!

