The non-extractive economic value of spiny lobster, *Panulirus argus*, in the Turks and Caicos Islands

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Summary

Increases in spiny lobster size and abundance have been observed within some marine protected areas (MPAs). To date, the potential economic benefits of these changes have been assumed to derive from the effects of emigration of adult lobster to adjacent fishing grounds and/or increased larval export to downstream nurseries that sustain fisheries. According to economic theory, these effects may provide consumptive (extractive) economic value to the fishery but are only part of the total economic value. Non-extractive economic value resulting from viewing wildlife may also have an important impact on the overall economic viability of some MPAs. This research examined scuba diver preferences in the Turks and Caicos Islands using a paired comparison conjoint survey and assessed the influence that spiny lobster (*Panulirus argus*) presence had on market share for dive charter packages of varying environmental quality and price. Market simulations showed significant increases in market share for dives where spiny lobsters were present, implying, for the first time, that spiny lobsters have non-extractive economic value. This non-extractive value of spiny lobster may have an important impact on the economic viability of some MPAs, especially those in regions like the Turks and Caicos Islands that are highly dependent on marine-oriented nature tourism.

Keywords: spiny lobster, *Panulirus argus,* scuba divers, marine protected areas, conjoint analysis

Introduction

Spiny lobster, *Panulirus argus*, are a commercially important species in many parts of the Caribbean, but stocks have long been depleted by fishing (Ehrhardt 1994; Hunt 1994). In some parts of the Caribbean there has been an increase in the harvest of under-size immature lobsters to supply export demand and the burgeoning tourist industry (King 1997). The management of lobster stocks in the region is complicated for a number of reasons. Given the complex life history of the animal (Lipcius & Cobb 1994), it is difficult to link spatial and temporal patterns of adult abundance to settlement, and post-settlement abundance to the production of adults (Lipcius *et al.* 1997). Local stocks of lobster are likely to be dependent on 'upstream' sources of larval production (Lyons 1981) due to diverse and variable surface current patterns within the Caribbean (Roberts 1997*a*). Even after settlement, variability in habitat quality, ontogenetic migration, and differential postlarval and juvenile mortality (Lipcius *et al.* 1997) make it difficult to predict the number of adults that will recruit to the fishery three to four years in the future.

To complicate matters, the Greater Caribbean basin contains a large number of small island nations and is socially and institutionally complex (Chakalall *et al.* 1998). Many of the national fisheries departments have very limited research and management capacity, poor enforcement records and/or limited access to information (Ehrhardt 1994; Christy 1997). The combination of institutional and ecological complexity makes regional management a challenging proposition. Effective management at regional scale is necessary because of the importance of matching ecological and institutional scale in successful renewable resource management regimes (Ostrom 1990).

Marine protected areas (MPAs) have been advocated as a general fisheries management tool that is ecologically useful and can simplify local and regional fishery management (Plan Development Team 1990; Roberts & Polunin 1993; Roberts 1997*b*; Bohnsack 1998; Murray *et al.* 1999). MPAs may help conserve essential habitat, increase recruitment to 'downstream' nursery grounds and adult 'spillover' to adjacent commercial fishing grounds, increase or maintain levels of biodiversity, maintain ecosystem resilience and provide non-extractive recreational, research and educational opportunities. MPAs are seen as a means to provide a number of valuable services simultaneously (Costanza *et al.* 1998) and, as such, should be viewed as an important component of any tropical coastal management strategy.

Lobster size and abundance increase within MPAs for some spiny lobster stocks (Davis 1977; Childress 1997; Lipcius *et al.* 1997). Evidence for spillover of adult lobster to adjacent commercial fishing grounds is, however, limited (MacDiarmid & Breen 1993; Childress 1997; Kelly *et al.* 2000). Due to the complex life history of spiny lobster, it has proven more difficult to provide empirical support for the positive effects of MPAs on downstream recruitment

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(Childress 1997), although the model of Stockhausen *et al.* (2000) does support the hypothesis that MPAs can serve this role.

Many scientists and fishery managers assume that fisheries enhancement provides the primary tangible economic benefits resulting from MPAs. As Dayton *et al.* (2000, p. 268) note, 'everybody agrees that, with adequate protection, reserves will enhance non-migratory stocks within their own borders, but this enhancement increases only the aesthetic values of the reserves. To add economic incentive, one must be able to show that reserves improve fishing outside their boundaries'. In some areas where tourism, scientific research or education is important, non-extractive use values may also have a substantial impact on the economic viability of MPAs. Concentrating only on direct consumptive use value and neglecting non-extractive and broader non-market values may lead to the underestimation of the benefits of conservation and policies biased against marine conservation.

In many tropical regions, where the use of MPAs hold particular promise, *de facto* open access fishing regimes are widespread (Christy 1997). Under open access conditions, all of the producer surplus or economic rent may be dissipated when fishers engage in intense competition (Gordon 1954), leaving fishers (and society) economically no better off, even though more fish are harvested. If the depletion of a fishery imposed external costs on other members of society, as it would when the depleted species was valued for tourism, society would be worse off. Non-extractive uses of marine species, on the other hand, do not usually impose high costs on other sectors of society. Environmental quality has quasi-public-good characteristics because non-extractive 'consumption' by one person often does not diminish the experience of another, at least to the point where congestion sets in (Davis & Tisdell 1996). Evidence suggests that degradation of the marine dive tourism experience due to overcrowding may decrease well-being before there is appreciable physical damage to the marine environment (e.g. Schleyer & Tomalin 2000). Divers and snorkellers can cause damage to reefs (Rouphael & Inglis 1997; Plathong *et al.* 2000), but the effects are often localized and certainly not of the same magnitude as those that result from uncontrolled fishing.

While some of the benefits of MPAs may be difficult to quantify (e.g. increased ecological resilience or existence value), the demonstration of direct and immediate economic benefits could add substantial legitimacy to arguments for using MPAs for fisheries management and conservation. Tangible economic benefits are particularly important for many of the developing island nations of the Caribbean that have limited financial resources and may not be able to justify environmental protection over the longer term given short-term development priorities. In the Turks and Caicos Islands (TCI), for instance, commercial fishing and marine-oriented tourism are both important to the local economy. Rapid growth of the tourism industry has made it the largest industry in the TCI. According to TCI Tourism Board figures, tourist arrivals increased to over 120 000 in 1999, an increase of 53% from 1995 levels. Marine nature-based tourism plays a very important role in the TCI, with over 10 000 dives recorded in two national marine parks during the three-month period October to December 1999 (Homer 2000*a*). In addition, up to 100 snorkellers per day use the popular Bight Reef alone during peak tourist season (Homer 2000*b*). In spite of widespread recognition of the importance of environmental quality for marine-oriented tourism in the TCI, commercial fishing and development pressures are exerting increasing stress on marine ecosystems and MPAs in the TCI (Homer 2000*c*).

There is a large body of literature in economics on non-market valuation and it is widely acknowledged that viewing wildlife and scenic amenities contribute to human well-being and hence provide economic value (van Kooten & Bulte 2000). For recreational scuba divers, it is reasonable to hypothesize that the size and/or abundance of some marine species are one factor that might influence their satisfaction with any particular dive experience (e.g. Shafer & Inglis 2000; Williams & Polunin 2000). Non-extractive economic value for lobster has not been demonstrated to date. If spiny lobster were to have non-extractive economic value, it would be important for MPA planning and management for three reasons: (1) any change in size and/or abundance of lobster within an MPA is relatively easy to quantify; (2) the non-extractive recreational economic benefits of such changes occur in the short-term and are quantifiable; and (3) taxes or fees on tourist activities offer a feasible means by which developing country governments may extract part, or all, of the consumer surplus which individuals hold for the larger and/or more abundant lobsters within spatially explicit MPAs.

Do scuba divers in the TCI hold preferences such that an increase in the abundance of spiny lobster increases diver well being and adds economic value to the dive experience? This study used a paired comparison conjoint survey to elicit information about diver preferences by directly querying survey respondents about their ratings for various hypothetical dive profiles. The broader purpose of this research was to use this paired comparison approach as a pilot survey that would provide detailed insights useful in the experimental design of a more comprehensive choice experiment (i.e., Hanley *et al.* 1998; Louviere *et al.* 2001), primarily targeted on the non-extractive value of Nassau grouper, *Epinephelus striatus*. As such, the goal of this survey was to develop an increased understanding of diver preferences and marginal trade-offs with regard to the ecological attributes of the dive experience rather than a utility-theoretic estimate of consumer surplus.

Methods

A paired comparison conjoint survey (e.g. Johnson & Desvousges 1997; Johnson *et al.* 2000) was used to assess the marginal trade-offs that divers made regarding key character-

istics of the dive experience. In each survey question, respondents expressed their preferences for one profile relative to another using a rating scale. Each dive profile was composed of a bundle of attributes that were important in determining overall dive quality but that varied in level between the two profiles.

The survey was developed with input from TCI commercial dive operators, a focus group, and two pilot surveys of visiting university students and tourists. We found from preliminary feedback that several major attributes influenced the actual dive experience (rather than the entire 'tourist experience' in the TCI). Because paired comparison surveys are cognitively challenging and can lead to respondent exhaustion (Huber 1997), it is important to limit the number of questions in a survey. There is an implicit trade-off between the amount of information we can gather in a paired comparison survey and the likelihood that respondents will complete the survey. After considering a variety of different attributes that divers consider important, five key attributes were chosen for inclusion in this survey: the size of the dive group; the price of the dive; the presence of macrofauna (reef shark, sea turtle or spiny lobster); Nassau grouper abundance; and mean Nassau grouper size.

The appropriate range for each attribute was developed with input from divers and dive operators. The price of a single tank dive was set at US$ 40, US$ 41, US$ 45, US$ 50 or US$ 60. Group size was specified as small (3 to 7 divers), medium (8 to 14 divers), large (15 to 23 divers), or very large (24 to 30 divers). For the macrofauna option, divers either observed one or more spiny lobster, one or more sea turtles, one or more reef sharks, or none of these animals during the dive. Likewise, for Nassau grouper the divers could observe fish of different mean size (2.27 kg, 6.80 kg or 13.61 kg mean weight) and abundance (1, 3, 6 or 12 fish observed per 20-minute dive). All levels were set within reasonable bounds to maintain the realism of the scenarios to be compared. The survey instrument specified that other potentially important dive site attributes (e.g. water depth and clarity, coral cover, and fish diversity) were comparable at all dive sites.

Respondents were told in the self-administered survey that damage to local reefs, caused by anthropogenic impacts in the TCI, could make it necessary for dive operators to take clients farther afield, to sites with higher environmental quality. The cost of the dive to a more pristine but remote area would thus rise. The question was posed in this way after dive charter operators objected to a query about park entrance fees during the pilot surveys (because they felt revenue gathered by the government may not be used effectively to protect environmental quality within parks). From a theoretical perspective, variations in travel costs to a particular site are economically equivalent to a per trip entrance fee to the same location (Cameron 1992). Respondents were reminded that the industry standard dive price was around US$ 40 and that an increase in price to US$ 60 could result in a substantial increase in expenditures for a dive vacation in the TCI.

The survey instrument provided information about the potential impacts of MPAs on the species used in the survey and queried respondents about their personal background (a copy of the survey instrument is available from the author upon request). Respondents and TCI dive operators were assured that all information collected would remain confidential. It should be noted that tourists in the TCI very rarely engage in spearfishing or the collection of marine animals for consumptive purposes. During preliminary discussions with dive charter operators and divers, it was clear that the removal, feeding, or touching of animals by divers is contrary to established industry norms in the TCI. There is no doubt, therefore, that any preferences expressed for the presence of marine animals by divers in this research were based on non-extractive opportunities for viewing wildlife.

The survey was designed using the Sawtooth Software Conjoint Value Analysis (CVA) software (Sawtooth Software 1996). An optimally efficient paired comparison survey would be both orthogonal (i.e., attributes vary completely independently) and balanced (i.e., each attribute is shown an equal number of times). This survey used five attributes with a total of 20 levels, yielding a design space of over 921 000 possible paired comparisons. Using the CVA experimental design module, a nearly orthogonal and balanced experimental design consisting of 18 survey questions was constructed by choosing the design with the highest *D*-efficiency (Kuhfeld *et al.* 1994). Candidate surveys were generated using five pools of 108 randomly chosen conjoint comparisons each. The CVA algorithm excluded one question at a time for each of the five pools, deleting the task that contributed least to the efficiency of the overall design, until 18 questions remained. This survey generation procedure was repeated 500 times, resulting in the selection of a final survey instrument with $D = 0.903$ (where a score of 1.0 is fully orthogonal and balanced).

Question one, for example, asks respondents to compare two dive scenarios (profiles) and rate them on a scale of one to nine, indicating the strength of their preference for one scenario over the other. A rating of one indicated the respondent strongly preferred the first scenario, a rating of nine indicated they strongly preferred the second scenario, and a rating of five indicated indifference between the two choices. For the first scenario, the respondent would have to pay US$ 50 to go on a dive in a group of 3–7 divers, during which they would see one or more spiny lobsters and one small (2.27 kg) grouper (while all other factors remained constant). For the second scenario, the respondent would have to pay US$ 40 to go on a dive in a group of 24–30 divers, during which they saw one or more reef sharks and three medium (6.80 kg) grouper. Paired comparisons of this type are designed to elicit maximum information about subtle preference trade-offs and have long been used in market research (Green & Srinivasan 1978). Conjoint analysis examines preferences at the individual level, so differences that might be masked in the aggregate become apparent. For example, the responses to the first question indicated that, on average, respondents

were indifferent between the two scenarios (mean = 5.01), but there were substantial variations in preferences, with nine individuals who strongly preferred scenario one and five who strongly preferred scenario two.

At the TCI Center for Marine Resource Studies a variety of visiting university students and tourists received the self-administered survey; commercial dive charter operators also distributed the survey forms to clients. The results were collated and analysed using the CVA software. An ordinary least square (OLS) dummy variable regression was conducted for each survey respondent. The preference rating for each of 18 survey questions, the dependent variable, was re-scaled to a −4 to +4 scale. The independent variables, namely group size, number of grouper, size of grouper, presence of spiny lobster or other fauna, and the price of the dive package, were coded as 0 (not present in the question), −1 (present in the left hand profile) or +1 (present in the right hand profile). The first level of each attribute was dropped from the regression to avoid linear dependency. The CVA software calculated an intercept, divided it by the number of attributes and added the quotient to every regression coefficient. The resulting values, known in the marketing literature as part-worths (the marginal valuations of choice variables), were then available for use in market simulations.

The CVA market simulation module was used to model the market share for various hypothetical dive profiles. The strength of various types of conjoint analyses is that they allow the modelling of market share for products not currently 'on the market'; this explains their potential for valuing and modelling consumer choices about new products not yet in the market (Anderson & Bettencourt 1993; Carson *et al.* 1994) as well as the 'consumption' of non-market ecological goods and services (Hanley *et al.* 1998). In these simulations, total utility for each alternative hypothetical dive profile was calculated using the regression coefficients for each survey respondent. Each respondent was assumed to choose the dive profile with the highest overall utility in the simulation. The individual choices were aggregated to determine market share (% of respondents choosing the option) for each dive profile.

The baseline scenario for the simulations was one in which each respondent was asked to choose amongst four dive profile options which differed by group size and price: (1) a small group (3–7 divers) at a price of US$ 60 per dive per person; (2) a medium group (8–14 divers) at US$ 50; (3) a large group (15–23 divers) at US$ 45; or (4) a very large group (24–30 divers) at US$ 40. In the baseline profile, no spiny lobster, sea turtles or reef sharks were observed. The two grouper variables in the experiment were held constant across all simulations (a single 2.27 kg grouper was observed per 20-minute dive).

In the simulations, changes in the presence of macrofauna and their effects on market share for the four dive group options were modelled. Market share was calculated for the overall group and six demographic segments. The demographic segments were based on gender (male, female), age ('younger' divers < 30 years, 'older' divers 30 years and over), and dive certification level ('basic' for divers with resort or open water certification, 'advanced' for divers with rescue, divemaster or instructor certification). Differences between market share for demographic segments were tested using a *t*-test and the Bonferroni adjustment (total α-level of 0.05). Secondly, paired *t*-tests were used to test the hypotheses that the small dive group (US$ 60) market share and the market shares of other dive group options (medium, large, very large) were equal, both in the presence and absence of macrofauna (e.g. when lobster were present, was the market share of the small and medium dive profiles equal?). Thirdly, paired *t*-tests were used to test the hypotheses that the market shares for particular dive package options were equal in the presence and absence of macrofauna (e.g. was the market share for the small group profile equal when lobsters were present or absent?).

Results

A total of 87 (31%) usable surveys were returned. Of these, 46 were from females and 41 from males, 60 were from divers younger than 30 years and 27 from divers 30 years or older, and 60 were from divers with basic scuba certification and 27 from those with advanced certification. The correlation between gender and certification, gender and age, and certification and age, was 0.10 ($p = 0.351$), 0.28 ($p = 0.008$), and 0.24 ($p = 0.024$), respectively. Conjoint surveys tend to be cognitively challenging (Huber 1997; Johnson *et al.* 2000) and response rates are often lower than other types of simpler surveys (e.g. as low as 14% for Farber & Griner 2000).

The average part-worths from the regressions within the macrofauna attribute category were 0.03 for no other animals, 0.28 for one or more lobsters, 0.49 for one or more sea turtles and 0.58 for one or more reef sharks. Part-worths were used to calculate the relative importance (*RI*) of each attribute in contributing to overall utility for each respondent using the equation:

$$RI_{i,j} = (max_{i,j} - min_{i,j}) / \Sigma_i (max_{i,j} - min_{i,j}) \qquad (1)$$

for $i = 1, 2, \ldots, 5$ attributes (group size; presence of lobster, sea turtle or shark; number of grouper; size of grouper; and dive price) and for $j = 1, 2, \ldots, 87$ respondents. Mean *RI* for all respondents was 28.3 (SE ± 1.95) for dive group size, 29.8 (SE ± 1.36) for presence of lobster, sea turtle or shark, 14.9 (SE ± 1.00) for grouper abundance, 7.7 (SE ± 0.70) for grouper mean size, and 19.4 (SE ± 0.95) for dive package price. The size of the dive group and presence of other animals were more important for respondents, on average, than the price of the dive itself. Respondents derived higher utility, on average, from the presence of sea turtles and sharks compared to lobster, and higher utility from the presence of lobster compared to an absence of macrofauna.

The baseline market shares for the overall group and demographic segments are shown in Table 1. The prefer-

Table 1 Simulation market shares (%) for four dive profiles when spiny lobsters are (a) absent and (b) present.

	Market share (%) for dive profile			
	Small (US$60)	*Medium (US$50)*	*Large (US$45)*	*Very large (US$40)*
(a) Macrofauna absent				
Overall (n = 87)	28.7	34.5	18.4	18.4
Female (n = 46)	23.9	39.1	17.4	19.6
Male (n = 41)	34.1	29.3	19.5	17.1
Younger (n = 60)	16.7	41.7	18.3	23.3
Older (n = 27)	55.6	18.5	18.5	7.4
Basic certification (n = 60)	25.0	36.7	20.0	18.3
Advanced certification (n = 27)	37.0	29.6	14.8	18.5
(b) Spiny lobster(s) present				
Overall (n = 87)	60.9	13.8	13.8	11.5
Female (n = 46)	67.4	10.9	10.9	10.9
Male (n = 41)	53.7	17.1	17.1	12.2
Younger (n = 60)	60.0	13.3	13.3	13.3
Older (n = 27)	63.0	14.8	14.8	7.4
Basic certification (n = 60)	58.3	18.3	13.3	10.0
Advanced certification (n = 27)	66.7	3.7	14.8	14.8

ences of respondents for the presence of lobster led to higher market share for the more expensive small group dive when lobster were present compared to the baseline (Table 1). In the baseline, when macrofauna are absent, the null hypotheses that (a) male and female divers, and (b) divers with basic and advanced certification, were equal could not be rejected (fail to reject H_0 at $\alpha = 0.05$, $p > 0.05$). The null hypothesis that small group market share for older and younger divers was equal was rejected ($p = 0.001$). Older divers exhibited a much stronger preference for the expensive small group dive even in the baseline scenario. In the scenario when spiny lobster were present on the small expensive dive, there were no significant differences between any demographic segments. Likewise, when reef shark or sea turtle were present, there were no significant differences between any of the demographic segments in the simulations. When sea turtle were present on the small expensive dive, 82.8% of all respondents in the simulation would choose the small group, compared to 10.3% for the medium-size group. When reef sharks were present on the small group dive, 85.1% of all respondents would choose that dive compared to only 5.7% for the medium-size group.

Table 2 shows the results of tests examining the equality of the small group, and the medium, large and very large groups (e.g. $H_0: S_{i,small} = S_{i,medium}$). When macrofauna were absent, the null hypotheses of equal market shares were rejected for (1) small and medium groups for younger divers ($p = 0.010$), and (2) small and medium ($p = 0.022$), large ($p = 0.022$), and very large ($p = 0.001$) groups for older divers. Older divers preferred the small dive group profile even though it was more expensive than other groups and macrofauna were absent. When spiny lobster were present for the small group profile, the null hypothesis that the market share

Table 2 Testing the equality of small (S = 3 to 7 divers) and medium (M = 8 to 14 divers), large (L = 15 to 23 divers) and very large (VL = 24 to 30 divers) dive profile market shares for the overall sample and demographic segments when lobsters are (a) absent and (b) present. Paired *t*-test *p*-values are for total $\alpha = 0.05$, individual $\alpha = 0.00833$.

	Market share test (H_0: $S_{i,S} = S_{i,j}$) p-value for j = M, L and VL dive profiles		
	H_0: S = M	H_0: S = L	H_0: S = VL
(a) Macrofauna absent			
Overall (n = 87)	0.503	0.161	0.161
Female (n = 46)	0.197	0.497	0.660
Male (n = 41)	0.700	0.205	0.128
Younger (n = 60)	0.010	0.829	0.417
Older (n = 27)	0.022	0.022	0.001
Basic certification (n = 60)	0.253	0.568	0.437
Advanced certification (n = 27)	0.646	0.110	0.202
(b) Spiny lobster(s) present			
Overall (n = 87)	< 0.001	< 0.001	< 0.001
Female (n = 46)	< 0.001	< 0.001	< 0.001
Male (n = 41)	0.004	0.004	0.001
Younger (n = 60)	< 0.001	< 0.001	< 0.001
Older (n = 27)	0.003	0.003	< 0.001
Basic certification (n = 60)	< 0.001	< 0.001	< 0.001
Advanced certification (n = 27)	< 0.001	0.001	0.001

Table 3 Testing the equality of small dive (US$ 60) profile market shares for the overall sample and demographic segments when macrofauna are absent (S_0) and present (S_1). Paired *t*-test *p*-values are for total $\alpha = 0.05$, individual $\alpha = 0.00833$.

	Market share test (H_0: $S_0 = S_1$) p-value		
	Lobster presence	*Sea turtle presence*	*Reef shark presence*
Overall (n = 87)	< 0.001	< 0.001	< 0.001
Female (n = 46)	< 0.001	< 0.001	< 0.001
Male (n = 41)	0.010	< 0.001	< 0.001
Younger (n = 60)	< 0.001	< 0.001	< 0.001
Older (n = 27)	0.327	0.017	0.006
Basic certification (n = 60)	< 0.001	< 0.001	< 0.001
Advanced certification (n = 27)	0.003	< 0.001	< 0.001

for the small dive group was equal to any of the other groups, where lobster were absent, was rejected in all cases ($p < 0.01$; Table 2). All hypotheses regarding the equality of market shares of small group and other group market shares were also rejected when either sea turtle or reef sharks were present on the small group dive ($p < 0.01$ in all cases).

The third set of results (Table 3) shows the results of tests of equality between the small dive profile (US$ 60) when macrofauna were present or absent. When spiny lobster were present in the small expensive group, that group had significantly higher market share for all demographic segments ($p \leqslant 0.01$) except for older divers ($p = 0.327$). When sea turtle and reef shark were present on the small group dive, the null hypothesis that market share for the small expensive group was equal to market share when macrofauna were absent was rejected for all demographic segments. With the exception of the older divers, the preferences that divers held for viewing spiny lobster led to a significant increase in simulation market share for a dive package that was US$ 10 more expensive than the closest competitive package. The preferences held by divers for viewing sea turtles and reef sharks led to significant increases in market shares for all demographic segments.

Discussion

The results of these simulations clearly demonstrated that the presence of spiny lobster resulted in increased market share for a more expensive dive experience compared to a dive experience with a lower price but no lobsters. Earlier studies have shown strong demand for spiny lobster recreational fishing permits in Florida (Davis & Dodrill 1985; Hunt 1994), but the nature of the permit implied that the value of lobster was derived from consumption rather than viewing. The preferences of survey respondents upon which these simulations were based imply that spiny lobster provide non-extractive economic value to scuba divers surveyed in the Turks and Caicos Islands.

There are differences in the value that spiny lobsters contribute to the dive experience for different market segments. In particular, there was not a significant difference in market share for the small group dive profile in the presence or absence of lobsters for age 30+ divers in the market simulation. This is due to the high willingness of the older divers to pay more for even the baseline small dive scenario (56% market share). A number of survey respondents felt that small groups offered them the chance to see more of every type of animal; for these divers, there may be an implicit correlation between group size and overall dive quality that the current survey was unable to discriminate. Alternatively, the older divers may exhibit congestion effects at lower levels of crowding compared to younger divers. This may relate to affluence: 56% of the 25 older divers who reported income had household income of US$ 125 000 or more, compared to only 23% of the 56 younger divers reporting income. Note, however, that the presence of sea turtles or reef sharks significantly increased market share from the baseline for all demographic groups including the older divers. This suggests that the results are more likely due to diver preferences rather than congestion effects. Strong diver preferences for sea turtle (e.g. Williams & Polunin 2000) and reef shark are not surprising, given the high profile that these groups enjoy amongst recreational divers. These results, while interesting, do not have strong policy implications in the TCI because these animals are quite mobile and may not be afforded much, if any, protection by local MPAs.

This research was exploratory in nature and there are likely biases in the sampling. It is not known how many of the surveys given to dive charter operators for distribution to their clients were actually distributed. Charter operators tended to have substantially different market niches; some catered to experienced divers willing to pay top prices for small group charters, while others catered exclusively to large resorts that specialized in 'mass-tourism' holiday packages. Some dive operators commented that their clients did not want to spend their holiday time filling out complicated survey forms and were hesitant to actively support survey distribution. The inclusion of university students in the sample probably resulted in an over-representation of younger, less affluent survey respondents. In future research, it would be useful to conduct exit interviews at the main international airport in order to obtain a more representative and comprehensive sample of divers (and snorkellers) from all demographic segments. In the TCI, as in many other Caribbean nations, this would be relatively simple because there is a single port of entry that accounts for the vast majority of tourist arrivals. Future research might use a choice experiment or other stated preference format (e.g. Louviere *et al.* 2001) to develop formal estimates of consumer surplus that results from the diver preferences the current research has identified.

The weighted average dive price ($\Sigma_i [Share_i][Price_i]/4$) for the baseline scenario with no lobster was US$ 50.11, while

the weighted average when lobster were present during the small group dive was US$ 54.25, an increase of US$ 4.14 per dive (8.3%). Paired comparison analyses tend to overemphasize the value of individual attributes because there is a limited number of alternatives available in the questionnaire, resulting in an exaggeration of the importance of attributes that might be less salient in reality (Huber 1997). In addition, the market simulations did not take into account cross-attribute interactions (e.g. would the presence of lobster have as much of an impact on dive profile choice if more and/or larger grouper were present?), nor did the paired comparison format provide an estimate of consumer surplus, the theoretically correct measure of economic welfare for non-market valuation. Still, the study demonstrates that added value was derived from the presence of spiny lobster on dives and that it should not be unreasonable to think of values of US$ 1 to US$ 2 per dive as the non-extractive economic value of lobsters to divers in the TCI. Snorkellers are likely to hold similar non-extractive economic value for spiny lobsters. Spiny lobster is an animal that is relatively accessible for snorkellers on shallow reefs, and many snorkellers, who tend to be relatively new to the TCI and/or 'inexperienced' in tropical waters, appear at least as enthused about seeing lobsters as divers.

Is it valid to ascribe a preliminary non-extractive use value to spiny lobster even if there is not a utility-theoretic estimate of economic surplus? Even when theoretically correct calculations of consumer welfare are available, they are most often used to inform policy debates within a broader social context. A 'blue-ribbon' panel (Arrow *et al.* 1993) recommended that willingness-to-pay figures derived from contingent valuation surveys are halved as a starting point for cost-benefit analysis or litigation purposes. Economic efficiency is an important consideration in the policy process, but it is only one of several that influence policy decisions in political arenas (e.g. Weimer & Vining 1998). The results of this research have, for the first time, pointed to the existence of tourist preferences that give rise to non-extractive economic value for invertebrates that have traditionally been viewed as valuable only for extractive fishery purposes. While it would be unwise to base MPA user fees on these results, there is justification for placing some positive non-extractive economic value on spiny lobsters and to start to consider this value in policy decisions about MPAs, tourism, and spiny lobster fishery management in the tropics.

If the presence of lobster provided up to US$ 2 value for each marine-based experience and the stocks were healthy enough that lobster were seen on a regular basis, the non-extractive economic value of lobster in the TCI could be substantial. Based on a census of 10 000 dives conducted over three months in two national parks (Homer 2000*a*), it is likely that 150 000 dives are conducted each year in the TCI when all other dive sites are considered. MPAs that increased the abundance of lobster in key areas that were accessible for tourists would increase consumer surplus. Consumer surplus, in turn, could be extracted from tourists visiting protected areas to view wildlife by user fees (Chase *et al.* 1998; Gössling 1999). Nature-based tourism has been increasing in importance over the past decade and tourists generally exhibit a remarkable willingness to pay for ecological services and attractions (Gössling 1999).

Modest increases in monitoring and enforcement in terrestrial parks have increased their effectiveness in protecting biodiversity (Bruner *et al.* 2001). If similar trends hold for MPAs (e.g. Williams & Polunin 2000), even modest revenue generation from recreational sources could play an important part in leading to increased longer-term total economic benefits. While increased levels of diving and snorkelling activities have the potential to harm coral reefs (Rouphael & Inglis 1997; Plathong *et al.* 2000), the creation of MPAs can draw tourists to an area and increase the opportunities for positive spin-off benefits beyond revenue generation. In the Mediterranean, popular MPAs draw divers to see relatively rare species and provide local organizations with unique opportunities to educate visitors about the marine environment and conservation (Harmelin 2000). When recreational revenue can be used to increase the overall effectiveness of an MPA, then it becomes more likely that MPAs will persist for sufficiently long periods to have significant impacts on consumptive economic benefits resulting from spillover and larval export, or on non-market economic benefits derived from increased biodiversity and ecosystem resilience.

Fishery managers developing plans and policies for MPAs should therefore not ignore the non-extractive economic value of spiny lobster. The recreational value of spiny lobster may well prove to have an important impact on the overall economic viability of some MPAs, especially those in regions like the Turks and Caicos Islands that are highly dependent on marine-oriented nature tourism. Further exploration of tourist preferences for environmental quality and research on the impacts of these preferences on the non-extractive economic value of tropical coral reef ecosystems is warranted.

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