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Recreational SCUBA divers' willingness to pay for marine biodiversity in Barbados

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ABSTRACT

The use of natural resources and the services they provide often do not have an explicit price and are therefore undervalued in decision-making, leading to environmental degradation. To 'monetize' the benefits from these services requires the use of non-market valuation techniques. Using a stated preference survey of recreational divers in Barbados conducted between 2007 and 2009, the economic value of marine biodiversity to recreational SCUBA divers in Barbados was estimated. In addition to a variety of demographic variables, divers were asked about their level of experience, expenditures related to travel and diving, and encounters with fish and sea turtles. Divers then completed a choice experiment, selecting between alternative dives with varying characteristics including price, crowding, fish diversity, encounters with sea turtles, and coral cover. Results indicate that divers in Barbados have a clear appreciation of reef quality variables. Willingness to pay for good coral cover, fish diversity and presence of sea turtles is significantly higher than prices paid for dives. In general, divers valued reef attributes similarly, although their appreciation of low density of divers at a site and high coral cover varied with prior diving experience. The results of this study demonstrate the economic value generated in Barbados by the recreational SCUBA diving industry and highlight the potential for substantial additional economic contributions with improvements to the quality of a variety of reef attributes. These results could inform management decisions regarding reef use and sea turtle conservation, and could aid in the development of informed 'win–win' policies aimed at maximizing returns from diving while reducing negative impacts often associated with tourism activities.

1. Introduction

Increasing demand for limited resources in today's world means that conservation often entails trade-offs (Hirsch et al., 2011). Unfortunately, many of the trade-off choices lead to biodiversity loss and habitat destruction (Shogren et al., 1999; Holland et al., 2009), and these negative changes to the environment are simply viewed as an inevitable "cost of doing business". Conservation efforts are frequently seen as costly because they may preclude certain activities that have large immediate financial rewards, whilst the longer term costs associated with species loss and habitat destruction are overlooked in the pursuit of short-term economic gains.

Economic valuation can be used to better understand the costs of these trade-off decisions and can demonstrate the often very large economic consequences of natural resource mismanagement. For example, the level of degradation being experienced by Caribbean coral reefs from anthropogenic activities has been projected to result in losses of up to US$300 million per year in net revenues from dive tourism and up to US$140 million per year in reef-associated fisheries by 2015 (Burke and Maidens, 2004). The losses associated with diminished production of beach sand and coastal protection in the Caribbean as a result of this reef degradation will be even greater at a projected US$140–420 million annually over the next 50 years (Burke et al., 2011).

Numerous studies have shown that natural resources are more valuable when conserved (Loomis et al., 2000; Naidoo and Adamowicz, 2005; Burke et al., 2008). Indeed, the traditional market economy is entirely dependent upon the "free" services provided by natural systems (Daily et al., 1997). Investing in natural capital yields considerable net gains, while underinvestment in conservation efforts exposes ecologically valuable resources to degradation (Wells, 1997), leaving society worse off and often exacerbating rural poverty (TEEB, 2009). One of the challenges is that many of the benefits of conservation only occur in the future, so that there is a short-term imbalance between costs of conservation

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and the immediate gains from activities that deplete and/or degrade the environment (Daily et al., 1997). A potential solution is to increase contemporaneous net gains from conservation through promoting uses that enhance human well-being in the near term and are compatible with long term conservation objectives, for example via conservation or ecotourism subsidies or direct payment for ecosystem services (Wunder, 2007; see Abson and Termansen, 2011 for a review). Again, in order to do this, policy-makers need information about the benefits associated with compatible uses and the value of conserving biodiversity. Another challenge is that the uses of natural resources and the services they provide do not have an explicit price, such as the enjoyment derived from diving on a coral reef rich in biodiversity, or the coastal protection that is provided by a healthy reef. To 'monetize' these uses and services requires the use of non-market valuation (NMV) techniques. Despite the depth and breadth of the associated literature on NMV, it has not been applied to the majority of natural assets and the literature often provides inadequate support for policy formation (Pendleton et al., 2007).

Against this background, an adequate understanding of the economic value of environmental goods and services can play an essential role in the policy process. The protection of biological resources maintains essential ecosystem services that, while not explicitly represented in GDP (de Groot et al., 2002), serve to attract foreign exchange to developing nations via tourism (e.g. Troëng and Drews, 2004), and significantly contribute to human health and quality of life (McField and Kramer, 2007). This is extremely pertinent to the insular Caribbean region where tourism is the mainstay of most Caribbean island economies and is itself dependent upon a healthy marine environment (Burke and Maidens, 2004; Agard et al., 2007).

The Caribbean island of Barbados is no exception, with tourism being the major foreign exchange earner, directly responsible for around 15% of GDP in recent years, and generating considerably more via the construction and service sectors (UN ECLAC, 2010). With 97 km of coastline and 92 km^2 of accessible shallow reef associated habitat, Barbados relies heavily on healthy reefs. They provide habitat for numerous species including endangered green and hawksbill sea turtles (Horrocks, 2000). They support nearshore fisheries (Oxenford et al., 2008a; Schuhmann et al., 2011; Maraj et al., 2011) and watersports tourism such as reef viewing and turtle watching via SCUBA diving, snorkeling, glass-bottom boat and recreational submarine (Uyarra et al., 2005). Healthy reefs produce and protect the white sand beaches on which Barbados' tourism depends for aesthetics and recreation (Oxenford et al., 2008b, 2010) and on which the local population of endangered hawksbill sea turtles depends for nesting (Beggs et al., 2007). They also protect the coastlines on which the high density tourism infrastructure is built (National Commission on Sustainable Development, 2004). Despite the critical importance of reefs to Barbados, there has been no attempt to determine their economic value through NMV techniques, leaving coastal managers and policy makers with a knowledge gap and lack of empirical justification to support reef conservation efforts. Likewise, there is only informal recognition of the value of sea turtles, as reflected in the numerous ways in which they are used in advertising and promoting Barbados as a holiday destination. Acute threats to reef habitats (e.g. over fishing, poor water quality, sea surfacing warming) and turtle nesting beaches (e.g. coastal construction, beach erosion, beach lighting) around Barbados are growing and in some cases being exacerbated by remediation measures taken to address other problems, such as beach armoring to counteract eroding beaches and protect coastal properties, and alteration of natural drainage to relieve coastal flooding.

We use the NMV technique of choice modeling to explore SCUBA divers' willingness to pay for different attributes of dive quality including live coral cover, fish species diversity and encounters with sea turtles, and thereby begin to address the knowledge gap in the real economic value of reefs and their associated biodiversity. We explore preference heterogeneity by estimating conditional logit (CL), mixed logit (ML) and latent class (LC) specifications for diver utility. Our analysis may be useful to other researchers exploring the empirical determination of preference heterogeneity in choice modeling applications. Moreover, the value estimates derived here can support decision-making by organizations involved in the use and management of natural systems in Barbados. Given the lack of value estimates associated with reef quality and biodiversity for most Caribbean nations, the results of this work may also serve as a valuable foundation for benefits transfer applications at other sites.

2. Methods

2.1. Survey instrument

Data were collected using a survey of 165 recreational SCUBA divers in Barbados between July 2007 and April 2009. Divers were intercepted at dive shops on the west and south coasts of the island and asked to participate in the study.[1] Approximately 95 percent of divers were interviewed after returning from a dive trip.[2] The survey instrument was pre-tested on a sub-sample of divers and edited accordingly before being used in the main data collection exercise. Respondents completed a 5-page survey instrument that solicited a range of information regarding demographics, expenditures, dive experience and perceptions of coastal and marine quality encountered during their dive. The survey also incorporated a choice experiment.

2.2. Choice experiment (CE)

We used a choice model design with five attributes (one of which was price), each with four levels of condition, to ensure that the choices were cognitively manageable, whilst still permitting the estimation of non-linear main effects for each of the attributes (Kuhfeld, 2006).

Attributes that SCUBA divers consider to be important were ascertained *a priori* through a short interview survey of approximately 50 divers at two dive shops in Barbados, in which they were presented with a list of 30 dive trip attributes and asked to rate (on a scale of 1–5) the importance of each in influencing dive trip choice. The divers were also asked to indicate which single attribute was the most important in influencing their trip decisions. Variables of particular relevance to divers and to local environmental policy took precedence in our choice of attributes. Hence, coral cover, fish diversity, turtle sightings, the number of other divers at the site and price were selected as attributes to be included in the choice experiment. Water clarity, while also obviously important to divers, was not included because on the bank reefs, where much of the diving is concentrated, water

[1] To obtain a representative sample, the distribution of surveys was aligned with the distribution of divers across days of the week, weeks of the year, and across dive shops, as ascertained from key informant dive shop operators and field observation prior to the survey. To enhance the likelihood of preference variation across respondents, interviews were conducted with only one individual per traveling party.

[2] Of the 9 divers who were interviewed prior to a dive, six reported having completed their most recent dive trip in Barbados. We find no statistically significant differences between the two subsamples for ratings of dive quality with the exception of rating of supervision. Those that completed the survey immediately upon returning from a dive had a significantly higher ratings of supervision (p-value = 0.048).

clarity is strongly influenced by oceanographic conditions rather than by factors subject to policy control.[3]

Realistic levels for the chosen attributes were selected based on interviews with 10 dive shop owners and managers for price and diver crowding; on reef survey data for coral cover and fish diversity (UWI Office of Research, 2008); and on turtle sightings data for encounters with turtles (B. Krueger, Barbados Sea Turtle Project, unpublished data). These were also confirmed by asking divers, prior to the choice experiment, to describe their most recent dive in Barbados by ticking a box corresponding to presented ranges for each attribute. For example, divers could select $50–$100, $101–$150, $151–$200, or more than $200 for the price paid for their most recent 2-tank dive.

The coral cover attribute levels were presented to divers as four photographs of reefs where coral cover had been measured *in situ*. This was done to ensure that divers could appreciate the qualitative difference between levels of coral cover. Attributes and levels used in the choice experiment are shown in Table 1.

Different levels of each attribute were variously combined to create 5^4 alternative versions of a dive trip and then presented to divers in pairs as alternative choices. A total of 96 trip pairs were selected from the full factorial design using the '%choiceff' and '% mktblock' macros in SAS (Kuhfeld, 2002) and blocked into 16 sets of six paired choices, with a "neither option" alternative included for each choice to simulate market behavior. Each diver was then given one of the 16 sets of six paired choices. With each paired choice (e.g. Table 2) the diver was instructed to choose one option based on the attributes presented, assuming all other factors were equal.

3. Model specification

Attribute utility values were estimated using variations of multinomial logit (MNL) regression analysis of the choice data with the discrete choices as the dependent variable and levels of the attributes as the independent variables. Coefficient estimates were used to reveal the relative importance of attributes and their levels, and to reflect respondents' willingness to trade one attribute level for another. The willingness to substitute for other attribute levels and price was used as a measure of value or willingness-to-pay for the chosen attribute levels. We used the following relationships, based on McFadden (1973) and Ben-Akiva and Lerman (1985):

$$U_{ij} = V_{ij} + \varepsilon_{ij} \tag{1}$$

where the utility (U) derived by an individual (i) from a particular alternative (j) comprises a deterministic value component (V_{ij}) and a random component (ε_{ij}).

$$U_{ij} > U_{ik} \tag{2}$$

when an individual chooses alternative (j) over another alternative (k), this implies that the utility from the former outweighs that from the latter.

$$P\{ij\} = P\{V_{ij} + \varepsilon_{ij} > V_{ik} + \varepsilon_{ik}\} \tag{3}$$

the probability (P) of choosing alternative (j), since the utilities include a stochastic component.

[3] For example, Barbados experiences both clear blue oceanic water masses and turbid green water masses influenced by South American rivers, depending on the relative strengths of the North and South Equatorial Currents (Helleweger and Gordon, 2002; Sponaugle and Pinkard, 2003).

Table 1
Dive trip attributes and levels used in the choice experiment with SCUBA divers.

Attribute	Levels
Price ($US/2-tank dive)	$50, $100, $150, $200
Fish diversity (number of species)	Up to 5, 15, 25, more than 25
Coral cover (percent of benthos)	5%, 15%, 25%, 35%
Number of other divers at site	15, 10, 5, 0
Sea turtles encountered	0, 1, 2, 3 or more

$$P\{ij\} = \exp(V_{ij}) \Big/ \sum \exp(V_{ik}) \tag{4}$$

the probability of choosing alternative (j) assuming the stochastic elements of the choice alternative utilities follow a Gumbel distribution, is estimated using the standard multinomial logit (MNL) model.

$$V_{ij} + \varepsilon_{ij} = \beta' X_{ij} + \varepsilon_{ij} \tag{5}$$

where the elements of V_{ij} include levels of the attributes of the alternative, including price P_j, and

$$\mathrm{WTP} = -\beta_{\mathrm{A}}/\beta_{\mathrm{P}} \tag{6}$$

willingness-to-pay (WTP) obtained from β_{A}, the estimated coefficient on a particular attribute level, and β_{P}, the coefficient on price, with price being treated as a continuous variable.

By specifying a baseline level for each attribute, the MNL regression facilitated the estimation of unique coefficients for the remaining levels. In this study we set the baseline levels at the worst case scenario of: 5 fish species, 5% coral cover, 15 other divers, and no turtles.

We estimated utility values using conditional logit (CL), mixed logit (ML) and latent class (LC) specifications of the model. Conditional logit treats the coefficients for each level as fixed parameters. Preference heterogeneity can be explored by interacting attributes with demographic characteristics or by using ML or LC specifications. The mixed logit treats the coefficients as random parameters and therefore allows preferences for attribute levels to be heterogenous across the diver sample, providing estimates of both the mean and variance of preferences in the population (Train, 1999; Greene and Hensher, 2003). Mixed logit estimation requires that a distribution be selected for the random parameters, and uses simulated maximum likelihood to approximate the probabilities in equation (4) based on that distribution (see Hensher and Greene, 2003). In this study, all parameters except price were specified to be normally distributed using 1000 draws from a Halton quasi-random sequence for the simulation (SAS Institute, 2008; Train, 1999).

The latent class specification allows for examination of preference heterogeneity by assigning individuals to a finite number of underlying preference groups and estimating the components of

Table 2
Example of a single paired choice (one of six) given to SCUBA divers as part of the choice experiment.

Attribute	Option A	Option B	Neither
Price (2 tank dive)	US $150.00	US $100.00	I would not choose either of these options
Fish diversity	Up to 25 fish species	More than 25 fish species	
Coral cover	Coral Photo A	Coral Photo C	
Other divers at site	No other divers	5 other divers	
Turtles encountered	1 turtle	No turtles	
I prefer…(check one box)	☐Option A	☐Option B	☐Neither

Table 3
Descriptive statistics of responses given by surveyed recreational SCUBA divers in Barbados. *n* = respondent sample size for each question.

Variable	*n*	Mean	SD	Min	Max
First visit to Barbados (=1 if first visit, =0 otherwise)	160	0.56	0.50	0	1
Number of previous trips to Barbados	141	2.87	6.93	0	50
First visit to the Caribbean (=1 if first visit, =0 otherwise)	159	0.16	0.37	0	1
Number of previous trips to the Caribbean	148	6.55	11.46	0	100
Age (years)	161	38.65	12.83	19	65
Male (=1 if male, =0 if female)	160	0.68	0.47	0	1
Married (=1 if married, =0 otherwise)	161	0.52	0.50	0	1
Education level[a]	161	4.01	0.88	1	5
Number of adults in travel party	155	2.99	3.03	0	19
Hours traveled to Barbados	139	13.62	13.60	0	96
Years of diving experience	161	6.92	7.36	0	38
Diver certification level[b]	162	1.72	1.10	0	5
Number of lifetime logged dives	158	88.77	209.81	0	2000
Number of lifetime logged dives in the Caribbean	161	40.11	127.74	0	1500
Own SCUBA gear (=1 if own gear, =0 if no)	163	0.42	0.49	0	1
Travel for sole purpose of diving (=1 if yes, =0 if no)	164	0.47	0.50	0	1
UK resident (=1 if from UK, =0 otherwise)	165	0.45	0.50	0	1
US resident (=1 if from US, =0 otherwise)	165	0.32	0.47	0	1
Canada resident (=1 if from Canada, =0 otherwise)	165	0.13	0.34	0	1
Caribbean resident (=1 if from Caribbean, =0 otherwise)	165	0.02	0.13	0	1

[a] Education levels coded as 1 = Primary, 2 = Secondary, 3 = High school, 4 = College/University, 5 = Masters or higher.
[b] SCUBA certification levels coded as: 0 = None, 1 = Open water, 2 = Advanced open water, 3 = Master diver, 4 = Rescue diver, and 5 = Dive master or higher.

Table 4
Descriptive statistics of diver satisfaction and actual quality responses and characteristics of their most recent dive given by surveyed recreational SCUBA divers in Barbados. *n* = respondent sample size for each question.

	n	Mean	SD	Min	Max
Satisfaction variables					
Visibility rating[a]	162	3.91	0.87	1	5
Coral cover rating[a]	162	3.90	0.96	1	5
Viewing a variety of fish and sea life rating[a]	162	3.86	0.93	1	5
Viewing of large numbers of fish rating[a]	162	3.69	1.09	1	5
Viewing of large fish rating[a]	160	2.80	1.13	1	5
Underwater supervision provided by operator/dive master rating[a]	155	4.57	0.76	1	5
Level of crowding or congestion at the dive _undersite rating[a]	159	4.51	0.76	1	5
Overall satisfaction with the dive rating[a]	160	4.29	0.76	1	5
Barbados diving rated as best (=1 if best, =0 otherwise)	165	0.07	0.25	0	1
Barbados diving rated better than most places (=1 if better, =0 otherwise)	165	0.42	0.50	0	1
Barbados diving rated same as most places (=1 if same, =0 otherwise)	165	0.30	0.46	0	1
Barbados diving rated worse than most places (=1 if worse, =0 otherwise)	165	0.05	0.23	0	1
Barbados diving rated the worst (=1 if worst, =0 otherwise)	165	0.01	0.08	0	1
Actual quality variables					
Price paid (USD)[b]	154	105.58	38.40	75	201
Fish species encountered[c]	157	19.80	7.52	5	31
Coral cover (%)	159	27.73	10.57	5	35
Other divers at site	159	4.12	3.85	0	13
Turtles encountered[d]	160	1.73	1.52	0	5[c]

[a] Rated on a scale of 1–5, with 1 meaning "not at all satisfied" and 5 meaning "very satisfied".
[b] "More than $200" coded as $201.
[c] "More than 30 species" coded as 31.
[d] "More than 4 turtles" coded as 5.

utility separately for each group (Greene and Hensher, 2003; Beharry-Borg and Scarpa, 2010). Group membership is probabilistic rather than observed, and may be based on individual characteristics (Provencher and Bishop, 2004). Maximum likelihood estimation of the LC specification necessitates the designation of a finite number of classes, yet because the latent heterogeneity and the associated group membership are unknown to the analyst, respondents must be sorted into groups by "testing down" from a hypothesized number of groups on the basis of statistical information criteria such as the Bayesian Information Criterion (BIC) (Greene and Hensher, 2003; Milon and Scrogin, 2006).[4] Greene and Hensher (2003) suggest that the ML and LC specifications deliver marked statistical improvement over the standard CL, but it may not be possible to unambiguously select one approach as preferable to the other. Indeed, as noted in Shen and Saijo (2009), the ML specification can be regarded as a special case of the LC model, where each individual is in their own class.

4. Results

4.1. Pretest

Average attribute rankings across all respondents were highest for the amount of living coral on reefs and viewing a diversity of marine life. These two attributes were also listed most often as the most important attribute influencing dive trip decisions. Clear water, underwater supervision, viewing a large number of fish and lack of crowding at the dive site also received high ratings in terms of importance to divers.

4.2. Diver characteristics and levels of satisfaction

The full survey was administered to a total of 165 recreational divers with the majority responding to all questions and partaking in the choice experiment. Most respondents were vacation travelers from the UK (46%) or the US (32%). The average age of respondents was 38 years, and more than three quarters were male. Approximately half of the survey respondents were married. The sample was generally affluent and highly educated, with an average of 7 years of diving experience. Most (81%) had been to the Caribbean previously and nearly half had been to Barbados prior to the current trip. Descriptive statistics for the sample are shown in Table 3.

An investigation of diver satisfaction with various dive characteristics indicated a high degree of satisfaction with most attributes. Highest average satisfaction scores were given for the level of supervision (4.57) and lack of crowding at the dive site (4.51). Water clarity or 'visibility' (3.91), coral cover (3.90), viewing a variety of fish species (3.86) and viewing a lot of fish (3.69) earned favorable ratings; while viewing large fish (2.80) received the lowest rating of all quality variables measured. Many divers in the sample rated the quality of diving in Barbados as better than most places they had been diving (42%) or of equal quality (30%).

Responses were coded using the midpoint of the respective range (e.g. if a respondent indicated that they paid between $50

[4] BIC = −LL + (K log(N)/N) where K is the number of parameters in the model and N is the number of observations. Smaller values are preferred (Greene and Hensher, 2003).

Table 5
Summary of results for the choice experiment applied to recreational SCUBA divers in Barbados, using fixed (conditional logit), random (mixed logit) and latent class parameter models.

Attribute	Parameter	Conditional logit		Mixed logit		Latent class logit	Latent class logit
						Class 1	Class 2
Price	Mean	−0.0079***	−0.0083***	−0.010***	−0.0123***	−0.005***	−0.017***
15% coral cover	Mean	0.421***	0.476***	0.544***	0.703**	0.437**	0.170
	SD	–	–	0.042	0.098	–	–
25% coral cover	Mean	0.754***	0.811***	0.952***	1.158***	0.746***	0.700***
	SD	–	–	0.042	0.098	–	–
35% coral cover	Mean	0.971***	1.131***	1.223***	1.594***	1.138***	0.647***
	SD	–	–	1.412**	0.889	–	–
Up to 15 fish species	Mean	0.551***	0.608***	0.634***	0.780**	0.683***	0.275
	SD	–	–	0.488	1.249	–	–
Up to 25 fish species	Mean	0.690***	0.785***	0.838***	1.089***	0.668***	0.976***
	SD	–	–	0.003	0.141	–	–
>25 fish species	Mean	0.871***	0.913***	1.013***	1.209***	0.932***	0.848***
	SD	–	–	0.064	0.029	–	–
10 other divers	Mean	0.409***	0.430***	0.489***	0.565***	0.544***	0.170
	SD	–	–	0.351	0.587	–	–
5 other divers	Mean	0.595***	0.695***	0.749***	0.937***	0.619***	0.709***
	SD	–	–	0.351	0.587	–	–
0 other divers	Mean	0.804***	0.940***	1.009***	1.297***	0.984***	0.602***
	SD	–	–	1.196	1.702	–	–
1 turtle encountered	Mean	0.454***	0.486***	0.618***	0.658***	0.395**	0.503**
	SD	–	–	0.287	1.049	–	–
2 turtles encountered	Mean	0.614***	0.622***	0.775***	0.832***	0.728***	0.191
	SD	–	–	0.030	0.808	–	–
3+ turtles encountered	Mean	0.777***	0.828***	1.006***	1.168***	0.738***	0.935***
	SD	–	–	0.542	0.759	–	–
Coral cover × logged dives	Mean	–	−0.00003***	–	−0.00004**	–	–
Divers × no certification	Mean	–	0.107***	–	0.1528***	–	–
Trip A asc		0.117	−0.055	−0.0521	−0.3160	2.422***	0.069
Trip B asc		0.070	−0.064	−0.1185	−0.3121	2.297***	0.087
Class probability		–	–	–	–	0.6321***	0.3679***
Log likelihood		−850.40	−804.30	−848.18	−802.12	−780.339	
Pseudo *r*-squared		0.1342	0.1473	0.2202	0.2298	0.2825	

Standard errors not reported to save space. *, **, and *** denote statistical significance at the 10%, 5%, and 1% level, respectively.

and $100 for the dive, their response was coded as $75) or the minimum possible value for an open-ended response (e.g. if a respondent indicated that they paid more than $200, the response was coded as $201). The distribution of actual attribute levels provided additional support for our selection of levels for the choice experiment. Average quality in Barbados lies near the center of our attribute ranges for price, number of species and turtles encountered and between the third and fourth highest levels for coral quality and for crowding at the dive site. Summary statistics for diver satisfaction and actual quality conditions are provided in Table 4.

4.3. Choice experiment

The results of the choice experiment models are summarized in Table 5. All attribute coefficients are highly significant in the conditional and mixed logit models. Relative coefficient magnitudes for attribute levels show that higher quality and lower crowding are generally preferred, with apparent diminishing marginal utility between levels.

Statistical significance of the standard deviation for a parameter in the ML model indicates preference heterogeneity for the associated quality characteristic (SAS Institute, 2008). Preferences for dive trip attributes and levels are largely homogenous across the sample (standard deviation not statistically significant), with the exception of the highest level of coral cover (Table 5). The standard deviation for the lowest level of diver crowding (no other divers at the site) was marginally significant.[5] Divers therefore appear to differ in their preference for the highest level of cover (or in their ability to distinguish between high levels of cover in the presented images) and in their preference for zero crowding.

To investigate sources of heterogeneity of preferences for the coral cover and diver crowding attributes in the ML model, continuous versions of the coral and crowding variables were interacted with respondent characteristics and dive experience variables. No variation in preferences for these attributes was found across demographic variables such as age, education, income, or country of origin. However, dive experience variables introduced significant variation when interacted with coral cover and diver crowding (Table 5). Specifically, divers who had logged more dives or owned their own gear were less likely to choose trips with the highest level of coral cover and divers who did not have any level of

[5] The *p*-value for the standard deviation of the lowest level of crowding was 0. 1775. While not significant at traditional levels, this parameter appears to differ relative to other parameters in the model.

Table 6
Recreational SCUBA divers' willingness to pay for quality improvements in dive characteristics relative to baseline attribute levels (US dollars). 95% confidence intervals estimated via the Delta method in parentheses. Results are based on a choice experiment applied to surveyed divers in Barbados.

Attribute		Conditional logit	Mixed logit	Latent class logit	
Baseline level	Variable level			Class 1	Class 2
5% coral cover	15% coral cover	52.94 (18.58, 87.30)	54.53 (20.08, 88.99)	87.96 (8.76, 167.15)	10.21[a] (−12.75, 33.18)
	25% coral cover	94.89 (57.96, 131.82)	95.53 (58.81, 132.24)	150.23 (56.13, 244.32)	42.01 (18.54, 65.48)
	35% coral cover	122.25 (82.74, 161.75)	122.63 (80.26, 165.00)	229.14 (103.69, 354.59)	38.86 (16.73, 60.98)
5 fish species	Up to 15 fish species	69.40 (34.80, 104.01)	63.64 (25.47, 101.80)	137.47 (47.80, 227.13)	16.51[a] (−7.87, 40.90)
	Up to 25 fish species	86.81 (49.93, 123.69)	84.10 (45.76, 122.43)	134.42 (42.22, 226.62)	58.63 (36.55, 80.70)
	>25 fish species	109.65 (71.78, 147.53)	101.58 (62.46, 140.70)	187.75 (81.76, 293.75)	50.89 (28.76, 73.03)
15 other divers	10 other divers	51.50 (17.74, 85.26)	49.04 (9.96, 88.13)	109.47 (29.28, 189.66)	10.21[a] (−14.36, 34.78)
	5 other divers	74.92 (40.03, 109.81)	75.12 (35.07, 115.18)	124.64 (38.91, 210.37)	42.55 (17.70, 67.40)
	0 other divers	101.23 (64.50, 137.96)	101.21 (59.12, 143.29)	198.20 (85.61, 310.78)	36.17 (13.18, 59.15)
0 turtles	1 turtle encountered	57.18 (22.90, 91.45)	62.03 (23.58, 100.48)	79.60 (4.05, 155.16)	30.22 (5.89, 54.55)
	2 turtles encountered	77.32 (42.13, 112.50)	77.74 (41.33, 114.16)	146.62 (52.80, 240.43)	11.46[a] (−13.33, 36.25)
	3+ turtles encountered	97.77 (61.38, 134.16)	100.86 (62.45, 139.28)	148.59 (53.81, 243.37)	56.16 (32.33, 79.99)

[a] Willingness to pay not statistically different from zero.

dive certification were more likely to choose trips with higher levels of diver crowding. It is worth noting that interacting coral cover with years of diving experience and logged dives in the Caribbean did not produce significant variation in preferences for coral cover, but interactions with total logged dives and logged dives outside the Caribbean did.

Also indicative of a relatively homogenous sample, the Bayesian Information Criterion (BIC) values for different numbers of classes in the LC logit suggested the existence of only two distinct preference classes.[6] Members of class 1 appear to differentiate between all levels of all attributes, with preferences for higher quality. Members of class 2 do not appear to differentiate between the baseline (worst case) levels and low levels of quality.

The coefficient estimates in Table 5 were used to approximate willingness to pay for quality measures relative to the baseline level of each attribute as in Equation (6). Standard errors were generated using the Wald procedure (Delta method) in NLOGIT 4.0, which allowed for the estimation of 95% confidence intervals for willingness to pay. These results are shown in Table 6. Willingness to pay estimates are similar across the CL and ML models, and considerably higher for members of class 1 in the LC model. Differences in willingness to pay values between non-baseline levels can be interpreted as the willingness to pay for changes between levels. For example, the willingness to pay for improving coral cover from 15% to 25% is roughly US$41 (ML and CL models) and may be as high as US$62 (LC model, class 1) per 2-tank dive. Divers appeared to derive significant economic value from encounters with sea turtles. Our estimates suggest that divers were willing to pay over US$57 for the first encounter with a sea turtle, and approximately US$20 per 2-tank dive for each additional encounter.

5. Conclusion

Estimates of willingness to pay for attributes of dive quality were derived using a choice experiment administered to 165 recreational SCUBA divers. Our results suggest that SCUBA divers have a clear appreciation of, and willingness to pay for, lower levels of site crowding and higher levels of coral quality, fish species diversity and sightings of sea turtles. Logit coefficient estimates were highly significant for attribute levels, indicating that divers do differentiate between the presented levels of quality. Consistent with economic theory, it is also apparent that marginal utility and willingness to pay diminish with incremental improvements in quality, and that preferences for various aspects of dive quality are generally homogenous. Divers with more dive experience outside the Caribbean may be less inclined than other divers to differentiate between the higher levels of coral cover found in the Caribbean. Experience at dive locations where coral cover is higher than that in the Caribbean may cause these divers to be less sensitive to marginal differences in cover at the upper end of the coral quality scale, or may be indicative of stronger relative preference for other quality attributes. Alternatively, because more experienced divers are likely familiar with typical Caribbean conditions, their expectations of coral cover may simply be more realistic than the expectations of novice divers. Divers were generally willing to pay to avoid crowded dive sites, but divers with limited experience may value the presence of other divers at a site. We can infer that crowded dive sites generally detract from enjoyment and value, but divers with little training derive comfort from having more people in the water.

While we have focused our discussion on monetary measures of value, the multi-attribute choice experiment employed in this study also reveals the importance of natural attributes relative to one another. Coupled with the examination of preference heterogeneity across respondents, our results provide valuable insight into many aspects of trade-off analysis, such as those articulated by Hirsch et al. (2011), which include recognizing the possibility of negative outcomes for some user groups. Pairing these results with an understanding of the cost of marine quality improvements or changes in marine resource management allows conservation policy makers to garner support for difficult choices and make more efficient use of scarce financial resources.

For example, the finding that SCUBA divers value observation of more sea turtles during their dives adds to the importance of supporting conservation programs aimed at recovering previously depleted sea turtle stocks in the region. Ecological services provided by sea turtles through their interactions with other components of marine ecosystems e.g. their role in controlling disease (Jackson et al., 2001) and their role in mediating sponge–coral interactions (Hill, 1998), have also been recognized but are not yet valued, although their worth is likely to magnify with increasing numbers of animals (Bjorndal and Jackson, 2003). We can therefore infer that significant economic value would be generated by programs that enhance conservation of sea turtles

[6] BIC values for 4, 3 and 2 classes were 1.88, 1.82 and 1.79 respectively. The LC models with more than 2 classes produced some class probabilities less than 10%, suggesting that these classes are subsets of larger classes.

around Barbados (Beggs et al., 2007), as well as other habitats in the region used during migratory phases of their life cycles. Our results also suggest a need to quantify the consumptive value of sea turtles in areas of the Caribbean where turtle harvest remains legal or turtle and egg poaching is significant (Bräutigam and Eckert, 2006). Given the significant values derived from living turtles described here, it seems reasonable to suppose that reducing or eliminating turtle exploitation will result in economic gains that exceed earnings from illegal or unsustainable harvest.

Similarly, the significant values that divers derive from coral cover and fish diversity provide further economic incentive for protecting coral reefs and marine biodiversity in Barbados, beyond the fact that healthy reefs with high coral cover and biodiversity have greater resilience in the face of climate change than degraded reefs (West and Salm, 2003; Hughes et al., 2010) and are essential for a host of other critical ecosystem services that support the tourism industry in Barbados (Oxenford et al., 2010).

More generally, our results suggest that significant net gains are derived by divers in Barbados. We can infer that increasing diver fees could serve to transfer at least some of this economic surplus to the local economy, potentially motivating and/or funding further stewardship and policy action, provided that dive experiences are of a certain quality. For example, fish diversity at dive sites could be enhanced by restricting fishing, and reef fishers could be compensated for avoiding specific areas under a ‘payment for environmental services’ PES scheme (Wunder, 2007). Such a system of compensatory payments coupled with designated activity zones would fit naturally into a marine spatial planning framework that could improve reef management, recreational opportunities and nearshore fisheries (e.g. Scholz et al., 2010) and aid the transition toward ecosystem based management (Lester et al., 2010). Our results suggest the potential for increased diver fees to compensate dive operators for capping the number of clients using a particular site at any one time and to fund the maintenance of mooring buoys. This would help mitigate diver crowding and diver and anchor damage to heavily used sites (e.g. Tratalos and Austin, 2001).

Of course, benefits to SCUBA diving recreationists represent only one of many aspects of the total economic value of the nearshore marine resources of Barbados. This work adds to the growing array of empirical studies suggesting that conservation is good economic policy, and that investments in natural capital and biological assets may be as important to economic growth and development as investments in physical and human capital. Public dissemination of these results can aid in raising general awareness of, and support for, the benefits of environmental stewardship, enhancing the potential for the favorable situation created when economic gains from conservation motivate further action (Tallis et al., 2008). Finally, the WTP estimates derived here may serve as a valuable foundation for benefits transfer applications at other sites in the Caribbean where conditions are similar and the resources available for valuation work are limited.

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