Visitor Preferences for Coral Reef Conservation in Ras Mohammed National Park

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Abstract

In order to successfully achieve the dual goals of reef protection and income generation, the management of Ras Mohammed needs to understand visitor preferences for reef quality, congestion level, dive sites, entrance fees and other attributes of the park. Management plans and tourist opportunities should be based on these preferences as well as the physical characteristics of reef sites. Especially, there is an urgent need to plan for the increasing number of visitors. By incorporating these preferences for distinct alternatives featuring different levels of the attributes, welfare measures can be estimated and thus more efficient targeting of efforts can be achieved. Based on the results presented in this study the attribute that the visitors attach the highest value is the reef quality which indicates to the importance of maintaining this feature in order to keep the popularity of Ras Mohammed as tourist destination.

Keywords: Coral reefs; Recreation; Choice experiments; Random parameters; Preference heterogeneity; Willingness to pay.

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1. Introduction

Ras Mohammed National Park declared in 1983 and covering an area of 460 kilometres squared. The area includes the islands of Tiran and Sanafir and all shorelines fronting the Sharm el Sheikh tourism development area. Ras Mohammed is home to some of the most spectacular coral reefs and best known SCUBA diving areas in the world. This recognition is based on the diversity of flora and fauna, clear warm water devoid of pollutants, their proximity to shorelines and their breathtaking beauty (South Sinai Protectorates brochure). This combination plus the accessibility in most weather conditions and proximity to European tourists form the basis of Ras Mohammed popularity as a tourist destination. The number of visitors to Ras Mohammed increased from hundreds in 1988 to more than 350,000 last year. The volume of tourists has degraded the reefs, a swimmer, snorkeler or diver resting, walking or standing on a coral surface damage the fragile tissue surface of the animal. Over-development along the coast, dredging, pollution, sedimentation, sewage and overfishing are other threats to coral reefs. Bryant et al. (1998) cited in Spalding et al. (2001) noted that around 61% of the coral reefs in Egypt are at a serious risk from anthropogenic threats. There has been a decline in coral cover by 20 to 30 % at many sites in the Red Sea (Jameson et al 1997). The reef degradation and the loss of productivity and biodiversity would have serious consequences. Lack of awareness, insufficient enforcement of protective legislation, market failure and undervaluation of resources are the root causes of several threats to coral reefs.

Of great interest to the management of Ras Mohammed, is the need to: capture and develop additional and potential revenue sources and retain at least a portion of these revenues to pay for the necessary and sudden expenses; establish formal connection between those taking an action and those affected by it; incentives systems for stakeholders to conserve natural treasures; better governance for fisheries and marine ecosystems to overcome the legal mandates overlapping; and solid cooperation at the highest national levels, involving the coast guards and police, to stop different threats to coral reefs and illegal fishing. Finally, unless economic values are taken into account, efforts to manage coral reefs are not likely to be effective. If decision makers are aware of reef services, and the amount of money that reefs bring to their economy, then a more concerted and united efforts can be effectively established.

2. Characteristics of the Study Area

"*It is the first time any country has made a marine park its first national park, and Egypt can be proud of it. Ras Mohammed is an example of what can be done to save a precious part of our planet, truly one of the seven underwater wonders of the world*" Eugenie Clark.

The unique geological and bio-geographic features of the Red Sea provide appropriate environment for numerous species and habitats. It may be the most diverse coral reef area away from the coral reefs in Southeast Asia (Spalding et al. 20001). The salinity varies from 36.5ppt at the south to more than 41ppt at the north in summer with minimal freshwater inflows and high rates of evaporation (Kotb et al. 2004). The water is clearer in the north (40-50 m) compared to the south (~5 m) (Hassan et al. 2002). The water temperatures range between 21°C and 30°C (Hawkins and Reports, 1994). The fringing reefs lying close to the shore is the basic form of coral reefs in the Red Sea. In the north, Sinai Peninsula divides the Red Sea into the Gulfs of Suez and Aqaba which both have markedly different morphologies. The Gulf of Suez is a flat bottomed basin with a depth of 73 m (average 30m), length of 250 km and breadth of 32 km. The western side of the Gulf of Suez has discontinuous fringing reefs, where the eastern side is characterized by much smaller broken up fringing and patch reefs. The Gulf of Aqaba is a deep steep basin with a maximum depth of greater than 1800 m. However, it is shorter and narrower with a length of 150 km and a breadth of 16 km. It has a narrow fringing reefs and vertical dropoffs (Spalding et al. 2001, Ashworth 2004).

Table 1: *Number of genera and species of reef building corals in the Egyptian Red Sea*

Region	Genera	Species
Gulf of Aqaba	47	120
Gulf of Suez	25	47
North Red Sea	45	128
Central Red Sea	49	143
South Red Sea	31	74

(Source: Abou Zaid, 2000)

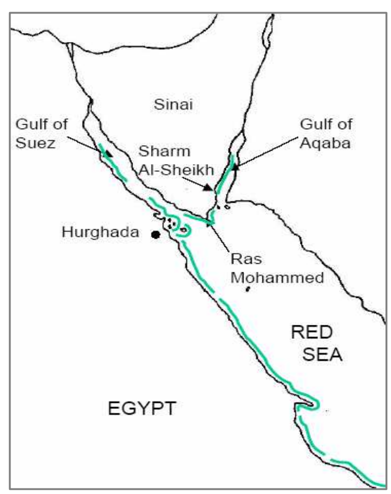


Figure1: *Coral reef coverage along the Egyptian coastline*

The Red sea has high biodiversity including approximately 209 hard coral species (Veron 2000). The coral diversity is greater in the centeral, northern Red Sea and the Gulf of Aqaba (Pilcher and Abou Zaid 2000). A total of 1000 species of fish have been recorded of which 17% are endemic to the Red Sea (Randall 1983, Ormond and Edwards 1987 cited in Ashworth 2004). The status of coral reef in the Red Sea is generally good with average percentage of live coral cover 45% at 5m and 33% at 10m (Hassan et al. 2002). The northern Red Sea has not been affected by the 1998 bleaching event (Kotb et al. 2004). Egypt has 1,800 km of coastline and 3,800 km^2 of reef (Cesar et al. 2003). Live coral cover varies from 11 to 35% on the reef flats, 5 to 62% on reef slopes and from 12 to 85% along reef walls (Abou Zaid 2000).

Ras Mohammed occupies part of the southern portion of the Sinai Peninsula (27°44'N 34°15'E) extending from a point opposite the Qad Ibn Haddan lighthouse on the Gulf of Suez to the southern boundary of the Nabq Protected area on the Gulf of Aqaba. The area includes the islands of Tiran and Sanafir and all shorelines fronting the Sharm El-Sheikh tourism development area, and covers an area of 460 km^2 (327 km^2 of sea area and 133 km^2 land area and covers 56 km of coastline) . Sharm El-Sheikh is a large tourism resort on the Gulf of Aqaba and is one of Egypt's best known and most visited resorts. It is located to the north of Ras Mohammed. The coastline of Sharm El-Sheikh was declared a Protected Coastline in 1992. The Coral reef ecosystems found in Ras Mohammed are recognized internationally as among the world's best. They vary from shallow slopes with sandy plateau (e.g. Turtle Beach) to steep walls (e.g. Shark Reef and Shark Observatory) (Pearson and Shehata 1998). The fringing reefs are the most common reef type in the park with a reef flat ranging between 5 and 50 m along the coastline and a reef slope depth ranges from 10 to 85 m. The Patch reefs occur in the strait of Tiran and the northeast the park with a shallow sandy platform ranging between 10 and 140 m and a reef slope drops to depths range from 3 to 200 m. The western side of Ras Mohammed has discontinuous fringing reefs with a shallow reef flat ranging between 200 and 1800 m in width (PERSGA, 2003). It is believed that the popularity of Ras Mohammed as a destination for tourists depends on the natural attractiveness, the aesthetic value and the diversity of coral reefs. In addition, the endemic species living in this area give it a global significance as a repository of biodiversity (Kotb et al. 2004). Moreover, Ras Mohammed is deemed the major marine environmental education for Egypt.

3. Data

A visitor survey was conducted between March and August of 2008 to obtain data on the perception, socio-economic characteristics of visitors to Ras Mohammed and their attitudes towards coral reefs. The questionnaire included a short introduction explaining the reason for it. The first section is designed to elicit respondents' experience visiting the reef sites in the park and other substitute reef sites, reasons for visiting, trip information such as mode, length and associated costs. The next section comprised background information, opinion on the importance and the satisfaction with reef quality, level of congestion and dive sites number. This is followed by questions about the lacking facilities at Ras Mohammed, the respondent' expectations to visit the park again, and the respondent' information about coral reefs and decline causes. The third section covered the choice experiment questions in which the attributes of coral reefs in terms of recreational benefits form the hypothetical market. A short descriptive introduction to define the context in which respondents are to assess each choice set was provided with a synopsis about coral reefs and related information in terms of challenges and possible solutions as background information to elicit WTP while some justifications for not willingness to pay were presented. The improvement levels were visualised by digital images depicting either more or less of the underlying attributes in order to avoid misinterpreting verbal descriptions and clarify the changes in attribute levels. The final section was on socioeconomic characteristics of the respondents. Because of the diverse nationalities of tourists, English, Italian, Russian and Arabic formats of the questionnaire were used.

A series of interviews and consultations were held with marine biologists, coral reef group and experimental design experts from the University of East Anglia and tour operators, park managers and staff from Ras Mohammed to design the survey and to confirm questions appropriateness and attributes definition. Focus groups were arranged to assure respondent understanding to the questions and the ability to complete the choice tasks. Then a pilot survey was carried out to test readability of the questionnaire and identify the potential problems with the survey and its administration. Suggestions made on the most effective matter in which problems could be solved. Consequently, many improvements were added to the main survey, which were proved that they were correct decisions as the questions worked very well in the field.

4. Survey results

Completed questionnaires were obtained from 1,200 respondents. The survey was designed under the assumption that there are two distinct populations: International Tourists (IT) and National Tourists (NT).

97% of IT came to Sharm El_Sheikh by plane where 75% of NT used the bus. More than 90% of IT visits were for holiday purposes, with the remainder being for work, business, conference or other purposes. Diving was mentioned as a purpose of visit by 31% of IT (18% of NT), while snorkelling represented 71% (34% for NT). The length of stay was 9 nights on average for IT and 5 nights for NT. As for the type of vacation package, 96% of IT and 74% of NT had an all-inclusive vacation package with an average price $1,742 ($197 / night) for IT and LE 2,655 (LE 503 / night) for NT.

The distribution of number of yearly visits to Ras Mohammed in which visitors were sampled is reported in table 2. From its content it is noticeable that 9% of IT and 37% of NT cited this visit as a repeat visit. 39% of IT (28% of NT) indicated that they have visited other reef sites in Egypt and 21% (3.5% of NT) indicated that they have visited reef sites in other countries within the last year.

Table 2: *Distribution of number of visits.*

number of visits	IT		NT	
	Frequency	Cumulative %	Frequency	Cumulative %
1	546	91.00%	378	63.00%
2	21	94.50%	70	74.67%
3	13	96.67%	55	83.83%
5	9	98.17%	42	90.83%
7	5	99.00%	18	93.83%
10	5	99.83%	19	97.00%
15	0	99.83%	8	98.33%
20	1	100.00%	4	99.00%
50	0	100.00%	5	99.83%
>50	0	100.00%	1	100.00%

33% of IT (28% of NT) hold diving certificate and 89% (70% of NT) have snorkelling skills. The number of dives and snorkelling times range from 7 to 9 times on average for the two sets of tourists. IT felt the most important features to their visit to Ras Mohammed were, in decreasing order, reef quality, level of congestion, and number of dive sites while the importance order for NT was reef quality then number of dive sites and finally level of congestion.

Table 3: *attributes importance to visitors*

	IT			NT		
	reef quality	level of congestion	number of dive sites	reef quality	level of congestion	number of dive sites
not important	1%	5%	10%	1%	8%	4%
somewhat important	3%	14%	10%	3%	17%	7%
important	16%	29%	32%	12%	27%	24%
very important	33%	30%	29%	21%	27%	34%
extremely important	48%	23%	19%	63%	21%	31%

The third of respondents expressed their dissatisfaction with the level of congestion at the park while 80% were satisfied with reef quality and dive sites number. 32% of IT and 61% of NT affirmed that Ras Mohammed need more facilities such as toilets and showers (29%), shelters (16%), rubbish bins and cleaning (16%), staff and patrols (15%), cafeteria (15%), signs (10%), first aid and ambulance (8%), paved tracks (6%), brochures (6%), new dive sites (5%), buoys (4%), visitor centre (3%), diving equipments (2%), and souvenir shops (2%). In regards to information about coral reefs, half of respondents confirmed their knowledge of reasons behind reef decline. They attributed this decline at Ras Mohammed to walking and standing on the reef (30%), lack of awareness (27%), mass tourism (25%), pollution and waste (15%), boat accident (13%), overfishing (6%), natural threats (5%), and other reasons (2%).

The sample demographic profile for IT was 49% male, in the age bracket 25-45 (86%). 30% of the respondents hold a bachelor degree while 42% completed high school. 13% are members in environmental organisations. The monthly income is above $1,000 for 66% of the respondents. The family size was between 1-4 persons for 92% of the respondents. 40% of the respondents had no children and 11% were single. Visitors from 19 countries participated in the survey. The main countries represented in the sample are Italy (42%), Russia (16%), United Kingdom (12%), Poland (8%), France (5%), Germany (4%), Austria (4%), Netherlands (2%), USA (2%), and others (5%). For NT, most (73%) respondents in the sample were males, in the age bracket 25-45 (89%). 58% of the respondents hold a bachelor degree while 23% completed high school. 19% are members in environmental organisations. Only 6% of the respondents reported a monthly income above $1,000. The family size was between 1-4 persons for 56% of the respondents. 15% had no children and 2.5% were single. The sample included participants from 24 governorates mainly from Cairo (20%), Alexandria (12%), Giza (8%), Dakhalia (7%), Ismailia (6%), Sharqia (6%), South Sinai (5%), Monufia (5%), and others (31%).

5. Methods

5.1 Contingent Valuation vs. Choice Experiments

Morrison et al. (1996) summarised the main differences between contingent valuation (CV) and choice experiments (CE) in the behavioural and theoretical basis, statistical analysis, and methodology. The dichotomous choice (DC-CV) and binary choice experiments were employed in this study to reduce such differences.

Both methods are based on Random Utility Theory (RUT). For the CV method, RUT assumes that the probability of choosing a good from an array of goods is dependent on the utility of this good relative to the utility of other goods (Hanemann and Kanninen, 1996). The utility of a good depends on observable components (V), containing a vector of attributes (X) and socio-economic characteristics (S) as well as unobservable components (ε) which are assumed to be random.

$$U_{ji} = V(X_{ji}, S_j) + \varepsilon_{ji}$$

The CE method is an application of RUT combined with the characteristics theory of value (Lancaster 1966). Respondents derive utility from the characteristics or the attributes of goods rather than from the goods themselves (Alpizar et al., 2001). As with CV, there is an observable component and an unobservable component for the utility. The method depends on the estimation of a response between choice probabilities and attribute levels. The probability of choosing an alternative increases as the levels of desirable attributes rise relative to the levels of the attributes in the other alternatives (Bennett, 1999). Thus, the respondent *i* will choose the alternative *g* over alternative *h* if and only if:

$$\text{Prob}(U_{gi} > U_{hi}, \forall h \neq g) = \text{Prob}\{V_{gi} + \varepsilon_{gi} > V_{hi} + \varepsilon_{hi}\}$$

When the error terms are assumed to be independently and identically distributed (IID) with an extreme value (weibull) distribution, the probability of an alternative *g* being chosen can be described in terms of the logistic distribution (McFadden, 1973):

$$\text{Prob}(g) = \frac{\exp(\mu V_{gi})}{\sum_j \exp(\mu V_{ji})}$$

where μ is a scale parameter which is inversely related to the standard deviation of the error distribution and *j* refers to different alternative in the choice set.

Alpizar et al., (2001) concluded that the economic model of DC-CV can be considered as a special case of the model underlying CE, where there are only two profiles (before and after the programme). In addition, both methods utilise binary logit. However, CV does not require experimental design and the statistical technique is less sophisticated. The elicitation question forms the most obvious difference between the two methods. In the dichotomous choice CV respondents were asked whether they are willing to pay for their recreation experience with healthier reef. In CE respondents were asked to choose their preferred alternative. Since CE method shares the same random utility framework and a common basis of empirical analysis in limited dependent variable econometrics (Greene, 2007) as dichotomous choice CV, the same sample of individuals, terminology, hypothetical setting and attributes describing the change to be valued were used in both methods to get comparable estimates. Moreover, two functional forms were utilised to elucidate the difference between the two methods. The first is a simple analysis with bid and alternative attributes as the only independent variables. This simple analysis allows comparison between the two methods. Another analysis that includes socio-economic and attitudinal characteristics and alternative functional forms were performed.

5.2 Fixed Parameters vs. Random Parameters

There are an increasing number of applications and growing popularity of using random parameters models to estimate willingness to pay and account for the preference heterogeneity. Because they are more flexible and powerful, the random parameters models have overshadowed other models. They have the ability to treat correlated and heteroskedastic alternatives, increase the opportunity of indentifying sources of preference heterogeneity, make the discrete choice model less restrictive in its behavioural assumptions, allow for unrestricted substitution patterns and approximate any random utility model with total precision (McFadden and Train, 2000; Hensher and Greene, 2003). In addition, these methods are preferable if the sampled individuals are drawn from a larger population (Greene, 2007) and “simply because people are different” (Eggert and Olsson, 2009). The random utility expression is restated and the structure of the random parameter vector β_i is presented as follow (Hensher and Greene, 2003):

$$U_{jti} = \beta_i X_{jti} + \varepsilon_{jti}$$

$$\beta_i = \beta + \Delta z_i + \eta_i = \beta + \Delta z_i + \Gamma v_i$$

where t is the choice situation, z_i is observed data, η_i is a random term whose distribution over individuals relies on underlying parameters, v_i represents a vector of uncorrelated random variables and Γ is a lower triangular matrix that allows the random parameters to be correlated. The conditional probability for choice g is given by the product of logit functions:

$$\Pr ob_{gti}(g \mid \Omega, x_{ti}, z_i, h_i, v_i) = \frac{\exp(\beta_i' x_{gti})}{\sum_g \exp(\beta_i' x_{gti})}$$

The unconditional probability for choice g is a mixture of logits with f as the mixing distribution: $\Pr ob_{gti}(g \mid \Omega, x_{ti}, z_i, h_i) = \int \Pr ob_{gti}(g \mid \Omega, x_{ti}, z_i, h_i, v_i) f(\beta_i \mid \Omega, z_i, h_i) d\beta_i$.

where Ω represents the component structural parameters, and h_i is a vector of variables (e.g. individual characteristics) that enter the variances. The integral is approximated by simulation and a value of β_i is drawn from its distribution for many draws. From these values a sampling distribution can be built and inferences about the mean and standard deviation can be obtained.

Each element of β_i has mean and standard deviation and specified as a random parameter as opposed to a fixed parameter that treats the standard deviation as zero (Hensher et al., 2005). By allowing for random taste variation and correlation in unobserved factors, the random parameters models overcome the limitations of standard logit models (Train 2003).

More behavioural information could be added by accounting for heterogeneity in the variance (Heteroskedasticity) of unobserved effects (Greene et al., 2006). This shed light on the sources of heterogeneous preferences within the sampled population. Moreover, recent studies allowed the preferences to vary both within and between individuals and addressed other sources of heterogeneity. Hensher (2006) and Puckett and Hensher (2009) discussed the process heterogeneity and how respondents process information throughout the different choice tasks. Hess et al., (2008) investigated the reference effects and the presence of asymmetry in preferences. Rose et al. (2009) elucidated the impacts of the design dimensions and nationalities on the behavioural outputs of choice models.

5.3 Willingness to Pay (WTP)

The marginal rates of substitution (MRS) between attributes could be estimated by modelling how respondents change their preferred option in response to the changes in the attribute levels (Bennett, 1999). Thus MRS between any two attributes is the ratio between their parameters (e.g. the amount of visitor access people would be willing to forego to have higher reef quality). By using the cost variable (i.e. the entrance fees attribute in this study), it is possible to estimate the willingness to pay to achieve more of an attribute (implicit price). The WTP (for a linear utility function) for an attribute is the ratio of that attribute's parameter estimate to the parameter of cost estimates (Hensher and Greene, 2003). Moreover, the willingness to pay to move from the current situation to a specific alternative can be estimated. Thus the value of aggregate changes as well as the value of changes in the individual attributes can be estimated by employing choice experiments (Morrison et al., 1996).

$$WTP = b_p^{-1} In \left\{ \frac{\sum_i \exp(V_i^1)}{\sum_i \exp(V_i^0)} \right\}$$

Where V^0 is the utility of current situation, V^1 is the utility of the alternative option, and b_p is coefficient of the price attribute.

The drawback of this way is that the estimated model parameters are not constant but random variables with a certain probability distribution (Armstrong et al., 2001). The random parameters models dispense with this problem by deriving WTP values using either the population moments (unconditional parameter estimates) or the common-choice-specific (conditional) parameter estimates (Hensher et al., 2005). Several models with different specification were estimated to illustrate the problems associated with the derivation of welfare estimates with each class of models.

6. Implementation

The sets of options were presented to the visitors to determine how they would like to see Ras Mohammed reef sites managed and which characteristics matter to them. These options defined in terms of four attributes: reef quality (REEF); uncrowding conditions (PEOPLE); number of dive sites (D_SITES); and the possible increase in entrance fees (FEES). $C_i = f(REEF_i, PEOPLE_i, D\_SITES_i, FEES_i)$

Reducing the level of congestion and maintaining the reef quality are considered to be a mechanism to manage reef carrying capacity and allow certain tourists to enjoy less crowded reef sites. The need to assess the preferred number of dive sites as an important attribute was stressed by park managers. The willingness to pay for park entrance to access the reef sites, with some improvements to the park and reef quality, was expected to be greater than the current entrance fees. The range of increase in entrance fees was chosen according to the results of the focus groups and the pilot survey. However, any higher amount than $25 was felt to be unrealistic for a daily entrance fees to Ras Mohammed. The survey instrument was identical for both national and international tourists. The only exceptions were the language used and the denomination of the entrance fees. This is in accordance with the applied system, where the foreign tourists pay the entry fee in US dollars and Egyptians pay it in Egyptian pounds. Four levels were used to secure sufficient variation in the alternative option. Table 4 lists the attributes and levels presented in the choice experiments.

Table 4: *attributes and levels used in the choice experiments*

Attribute	Short Name	Levels
Increase in Reef Quality	REEF	No change; 15%; 30%; 45%
Congestion Level	PEOPLE	usual number; 25% fewer people; 50% fewer people; 75% fewer people
Number of Dive Sites	D_SITES	15; 20; 25; 30
Increase in Entrance Fees	FEES	$5; $10; $15; $20 for IT LE5; LE10; LE15; LE20 for NT [a]

[a] [a] The exchange rate in August 2008 was $1= LE 5.5.

The hypotheses are: higher percentages of reef quality are preferred to lower percentages (ceteris paribus); less crowded reef sits are preferred to more crowded sites (cet. Par.); more diving sites are preferred to less diving sites (cet. Par.); and cheaper visits are preferred to more expensive visits (cet. Par.).

16 choice sets were produced and presented to respondents for estimation purposes. The design was blocked into four versions, each with four choice sets containing two alternatives. Versions were balanced such that the attribute levels appeared the same number of times within each attribute for the design to ensure that every attribute has equivalent statistical power and not correlated with the intercept. Such binary choice experiment considered as the attribute-based method of the dichotomous choice model used in the contingent valuation (Holmes and Adamowicz, 2003). However, respondents are asked to make a sequence of choices regarding different situations instead of being asked only one question regarding one proposed situation. The current situation option was included in the choice set to avoid overestimation or forcing respondents to select between the available alternatives. Also, this makes CE model more consistent with utility maximising and demand theory (Hanley et al., 2002). Respondents were asked to compare an alternative option against the current situation. If respondents choose the alternative option, then they are assumed to prefer the levels of attributes in that option over the levels of attributes in the current situation. The attributes of the alternative option were expressed as increments to the current situation (figure 2 shows an example of a choice set). Thus, the values of interest are the additional benefits and costs resulting from the implementation of the alternative policy. The model framework was established in accordance with the concept of change at the margin and consistent with the principles of benefit cost analysis. Respondents were asked explicitly to consider only the attributes introduced in the choice task and to treat each choice task independently. Also, they were reminded to take in account their own personal income constraints and all other things that they have to spend money on.

	Current Situation	Option A
Increase in Reef Quality	no change	15%
Number of People	usual number	25% fewer people
Number of Dive Sites	15	20
Increase in Entrance Fees	-	$5
I would choose	☐	☐

Figure 2: *A representative choice set*

7. Results

The best specification for the attributes should be examined and whether they should be linear, not linear, interacted with other attributes or with characteristics of respondents. Consistent specifications for the logit models were found. First, the standard logit models were employed by entering the variables in the utility function in linear form. Then the impacts of different coding methods were produced with comparison between the linear and non-linear models. The random parameter models were presented after that, accounting for taste variation in the preferences of visitors and allowing for correlation in unobserved factors.

7.1 Binary Logit Models

International vs. national tourists

The preferences of international and national tourists were expected to be distinct. This assumption was confirmed by conducting a likelihood ratio test (Swait and Louviere, 1993; Hearne and Salinas, 2002). The formula for this test is:

$$-2\ (LL_{\text{pooled data}} - LL_{\text{international tourists}} - LL_{\text{national tourists}}) = 54.8 \sim \chi^2_5$$

Given that the corresponding critical Chi-square value at the 95% confidence level is 11.07, the equality of the combined parameters between the two sets was rejected. Since the two populations represent different preference orderings and have underlying models with different parameters, two models were presented.

***Table 5**: Results from Logit models* [a]

Variable	International Tourists		National Tourists	
	Coefficient	P-value	Coefficient	P-value
CONSTANT	-0.993662	0.0000	-0.704863	0.0018
REEF	0.036770	0.0000	0.056975	0.0000
PEOPLE	0.013509	0.0000	0.003217	0.0540
D_SITES	0.031006	0.0001	0.027455	0.0010
FEES	-0.074814	0.0000	-0.088171	0.0000
Log Likelihood	-1492.605		-1392.649	
Chi-squared	339.9700	0.0000	527.0673	0.0000
Hosmer-Lemeshow chi-squared [b]	46.48249	0.0000	48.22675	0.0000
Correct prediction	66.50%		72.25%	
Observations	2400		2400	

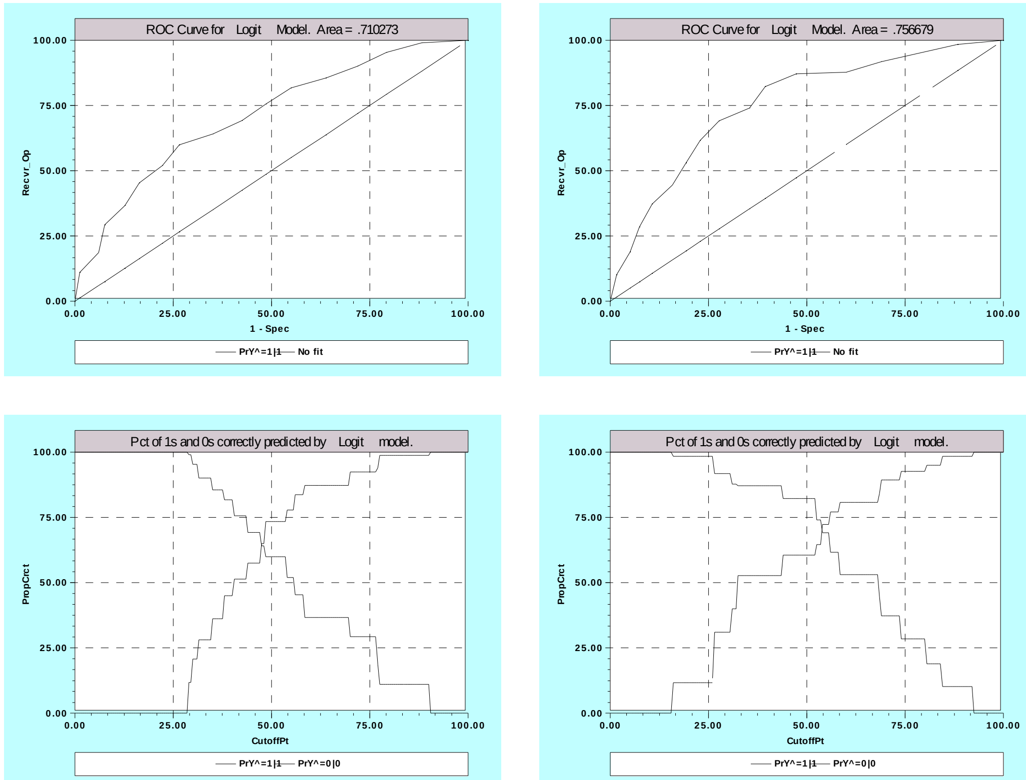
a The logit models were estimated using NLOGIT, version 4.0 (Greene, 2007).

b The Hosmer-Lemeshow chi-squared statistic is specific for the binary choice models and it assesses the match between actual and predicted values (Greene, 2007). If the value of the statistic is large, the model is inappropriate.

The two models are statistically significant (Chi-square equal to 339.970 and 527.067 for the international tourists and national tourists respectively with 4 degrees of freedom and P-values equal to zero). In both models all the attributes are statistically significant, have the expected signs and their changes in magnitude are consistent with the hypotheses (i.e. higher reef quality, lower congestion, more dive sites and lower entrance fees will result in higher utility level and a higher probability of that alternative option being selected).

It is worth noticing that the coefficient of congestion level in NT model is significant at 90% probability level. Therefore, whereas the international tourists prefer less people at reef sites, this attribute is not highly significant among national tourists. The choice probabilities for each respondent within the sample were calculated and the sum of the probabilities for the alternative option was 1,234 within 2,400 choice sets (51.4%) for international tourists and 1,294 (53.9%) for national tourists. The contingency table of the predicted choice outcomes as based on the model produced versus the actual choice outcomes was examined to determine model performance. The choice model correctly predicted the actual outcome for 66.5% and 72.3% of the total number of cases for international and national tourists respectively.

Figure (3) presents ROC (receiver operating characteristics) which produces a measure of fit and can be used to compare models (Greene, 2007). A greater area under the ROC curve means a greater model fit. An area of 0.5 implies a model with no fit. For example, the area under the ROC curve shows improvement in fit from 0.71 in IT model to 0.75 in NT model. The second chart depicts the cross tabulation of predicted values versus observed values. Since the no of observations are predicted to be a “0” when the actual value is zero is significant and almost equals the no of observations are predicted to be a “1” when the actual value is 1, this shows that both models are stable, balanced and perform well.



International Tourists **National Tourists**

Figure 3*: ROC curve and cross tabulation of predicted values versus observed values*

The impacts of coding methods and attribute specifications

Models with both linear and non-linear specifications were investigated to test the impacts of the coding method upon the models utilised. The non-linear dummy codes were assigned to attribute by attribute when the linear effects format was retained for the remaining attributes to test whether an attribute should be specified as being either linear or non-linear. Multiple Wald-tests for linear restrictions were performed to examine the specification of the experiment attributes. The resultant probability values of these tests were less than α of 0.05. Thus at 95% level of confidence, the linear effect would sufficiently capture the information observed using the non-linear effect specification, except for the congestion level and dive sites attributes in NT model, where the p-values of Wald-test for linear restrictions were high and exceeded alpha of 0.10. Although, the test proved that the preceding attributes should be specified as non-linear, the log likelihood ratio-test showed that this specification does not statistically improve the model (-2LL values were 2.3 and 4.3 for the congestion level and dive sites number respectively which are less than corresponding critical Chi-square value of 5.9). There therefore exists a trade-off between the estimates derived for the attributes employed and the overall model performance which may leave the analyst in a quandary. Hauck and Donner (1977) showed that the Wald approximation underestimates the change in log-likelihood and the test gives small statistic values and p-values larger than those of the likelihood-ratio test. In a similar vein, Nelson and Savin (1988) demonstrated that the finite sample power function of Wald test can be non-monotonic and perform poorly compared to the likelihood ratio and Lagrange multiplier tests.

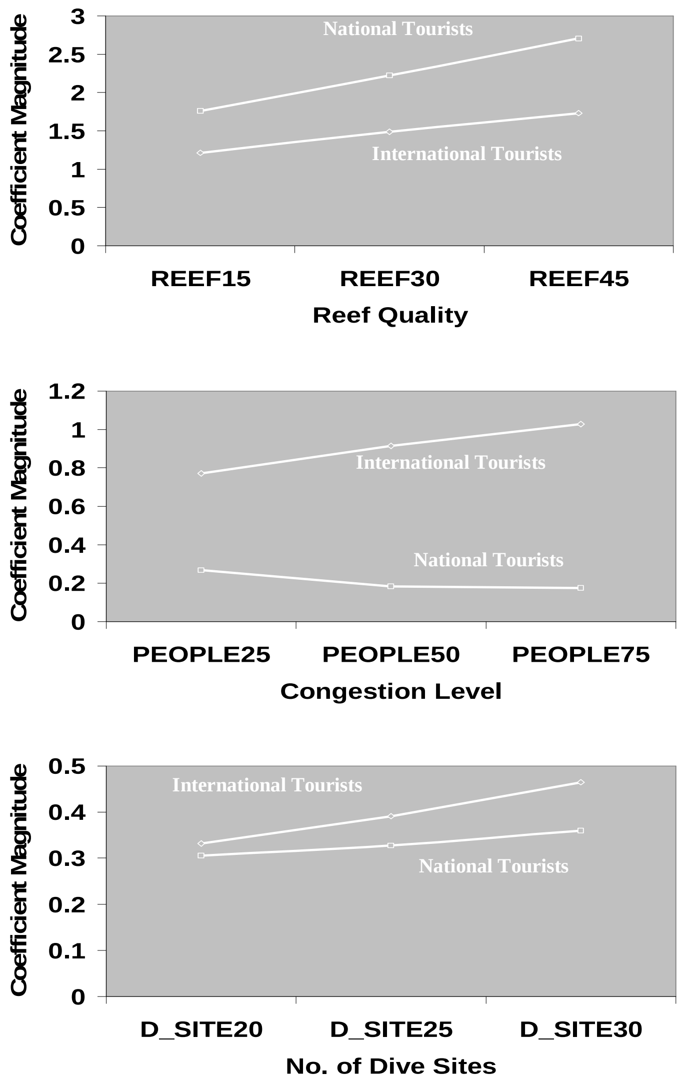


Figure 4: *Coefficient magnitude*

Policy Scenarios Valuation

The choice probabilities and WTP were calculated to rank and assess different management options. The most preferred scenario relating to the alternative option for the two sets was that included improving the reef quality by 45%, reducing the number of people at the reef site by 75%, increasing the number of dive sites to 30 sites, and paying additional entrance fees of $5 (LE5 for NT). Approximately 90% of respondents who answered this choice set chose the alternative option over the current situation with WTP ranging from $41 to $43 for IT and from LE32 to LE36 for NT.

Table 6: *Choice probabilities and WTP for policy scenarios.*

	Reef Quality	People	Dive Sites	Fees	Probability		WTP			
							Linear		Non-linear	
					IT	NT	IT	NT	IT	NT
1	no change	25% fewer people	25	+$10	37%	34%	4.88	-1.30	6.66	-3.08
2	15%	50% fewer people	15	+$20	43%	37%	2.62	-3.81	10.49	2.60
3	30%	25% fewer people	30	+$20	42%	43%	11.69	9.64	19.02	13.14
4	45%	25% fewer people	15	+$15	71%	76%	17.85	19.66	20.89	19.57
5	15%	25% fewer people	20	+$5	66%	73%	15.18	11.83	28.20	22.38
6	no change	50% fewer people	30	+$15	31%	21%	6.46	-3.83	4.76	-8.68
7	no change	usual number	15	+$5	8%	6%	1.22	-0.33	-5.00	-5.00
8	45%	50% fewer people	20	+$10	63%	75%	29.43	27.13	32.69	27.40
9	15%	75% fewer people	25	+$15	55%	42%	16.28	5.21	22.73	11.30
10	30%	75% fewer people	15	+$10	60%	75%	24.50	16.79	26.04	17.88
11	30%	50% fewer people	25	+$5	88%	83%	29.13	23.99	35.02	26.79
12	45%	usual number	25	+$20	34%	62%	12.48	16.86	10.44	15.26
13	15%	usual number	30	+$10	53%	71%	9.81	9.03	14.05	14.64
14	no change	75% fewer people	20	+$20	31%	14%	1.83	-11.04	-0.51	-14.16
15	30%	usual number	20	+$15	51%	65%	8.03	10.61	11.07	14.65
16	45%	75% fewer people	30	+$5	91%	88%	43.09	36.16	41.22	32.67
		Average			51%	54%				

Although it is expected that respondents act to maximise their individual utility in the short term and thus they choose the least restrictive policy scenario, Manning (1999) showed that if the study area was overused, respondents generally accept use restrictions. The least desirable option with the predicted probability around 7% was the one contains the same levels of current situation except an additional entrance fee of $5 (LE5 for NT). Scenario 7 also had the lowest WTP ($-5 – $1.22) for international tourists. However and in contrast to a priori expectations, scenario 14 which encompasses a 75% reduction in the congestion level had a lower implicit price than scenario 7 for national tourists who would require compensation between LE11.04 and LE14.16 before they would accept it. Moreover, in scenarios 1 and 6, the levels of each attribute were increased except for the reef quality, which was held constant. The WTP values for these scenarios were negative indicating that importance of the reef quality attribute to the respondents and their willing to support a use limitation in exchange of higher reef quality.

Elasticities and marginal effects

Louviere et al (2000) defined the direct elasticity as "the percentage change in the probability of choosing a particular alternative in the choice set with respect to a given percentage change in an attribute of that same alternative". Since binary experiments are employed in this study, only direct elasticity is addressed (for other types of elasticities and the different methods of calculations, see for example: Louviere et al (2000) and Hensher et al. (2005)). Unlike elasticities, marginal effects are expressed as unit changes (not percentage changes).

Table 7: *Elasticity and marginal effect for attribute in probability*

Variable	Elasticity		Marginal Effects	
	IT	NT	IT	NT
CONSTANT			-0.24776	-0.17423
REEF	0.392437	0.572864	0.00917	0.01408
PEOPLE	0.240298	0.053910	0.00337	0.00080
D_SITES	0.330918	0.276047	0.00773	0.00679
FEES	-0.443595	-0.492518	-0.01865	-0.02179

The elasticity for fees attribute is calculated as -0.44 and -0.49 for IT and NT respectively. This suggests that a 1% increase in entrance fees will decrease the probability of choosing the alternative option by 0.44 in the IT model and 0.49% in NT model, ceteris paribus. This is consistent with the hypothesis and demand theory (raising the price is likely to decrease the demand). However, the entrance fees elasticity is relatively inelastic (<1). For the park management, this suggests that the revenue gained by any increase in the entrance fees will outweigh the negative impacts the fees increase will bring. Another noteworthy issue is the small percentage of the elasticity for congestion level attribute in the NT model (0.05) which implies that any changes in this attribute will slightly affect the choice outcomes. The inverse effect is evidence for reef quality attribute. It is also informative to calculate the marginal effects. For instance, an increase in the entrance fees of 1 unit will decrease the probability of selecting the alternative option by 0.018 for IT and 0.021 for NT, all else being equal.

The Results Conditioned on Individual Characteristics

In order to distinguish between respondent segments, identify which attributes are perceived to be valuable for different visitor types and investigate the impacts of socio-economic characteristics on the model parameter values and welfare estimates, the results were conditioned on these characteristics.

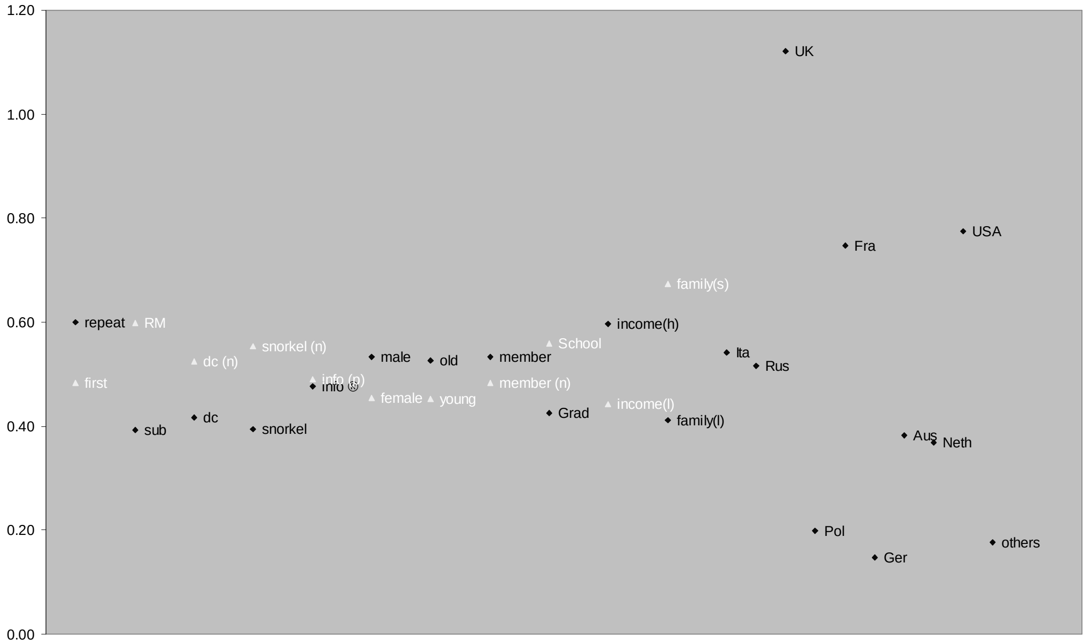


Figure 5: *WTP values of different segments of respondents for reef quality*

As can be seen from figure 5 the individual characteristics have an effect on the welfare estimates. In the IT model, the WTP for higher reef quality is greater when the respondent is male, old, member in environmental organisation, repeat visitor, has high income, has small family, or visits the reef sites only in Ras Mohammed. Also, the highest WTP values are for the visitors from UK and USA where the visitors from Germany (not significant) and Poland have the lowest WTP. For NT, the respondents hold diving certificate, have snorkelling skills, are females, young, or graduates are WTP more for improving reef quality. In addition, the respondents from Dakahlia and Ismailia have the greatest WTP whilst the lowest WTP values are for respondents from South Sinai and Monufia. Interestingly, the respondents who have rich information about coral reefs or have small families are WTP more for uncrowding conditions in IT model. In terms of nationality, Italians and Russians have the highest WTP values for this attribute. Conversely, the different groups in the NT model have low or negative WTP values for this attribute.

7.2 Random Parameters Models

Impacting on the marginal rates of substitution between attributes, the heterogeneity should be included in the model to obtain efficient estimates of choice model parameters. The preference heterogeneity could be defined by the random parameters through the standard deviations and through the interactions with other attributes and individual characteristics (Hensher et al., 2005). Five specifications of random parameters were estimated in which (i) the underlying attribute parameters were randomised; (ii) the heterogeneity around the mean was considered; (iii) the heteroskedasticity of the standard deviation was allowed; (iv) the correlated parameters were incorporated; and (v) the distribution of random parameters was constrained.

Base Model with Random Parameters Only

Table 8: *Random Parameter Logit*

Variable	International Tourists		National Tourists	
	Coefficient	P-value	Coefficient	P-value
	Non-random parameters			
CONSTANT	-0.931781	0.0001	-0.654621	0.0021
	Means for random parameters			
REEF	0.055612	0.0001	0.072535	0.0000
PEOPLE	0.021770	0.0000	0.005473	0.0007
D_SITES	0.044955	0.0000	0.029408	0.0001
FEES	-0.156004	0.0000	-0.112044	0.0000
	Scale parameters for dists. of random parameters			
REEF	0.137939	0.0000	0.170274	0.0000
PEOPLE	0.083611	0.0000	0.006586	0.0436
D_SITES	0.053148	0.0000	0.040249	0.0000
FEES	0.332348	0.0000	0.213529	0.0000
Log Likelihood	-1340.438		-1279.022	
Chi-squared	304.3336	0.0000	227.2531	0.0000
shuffled Halton draws	200		200	
Individuals	600		600	
Observations	2400		2400	

Both models are found to be statistically significant with 9 degrees of freedom and P-values equal to zero. The parameter values for the attributes and their corresponding standard deviation are significant. Statistically significant parameter estimates for derived standard deviations of the experiment attributes in the two models refer to the presence of heterogeneity over the sampled population around the mean parameter estimate. As such, different respondents have parameter estimates that may be different from the sample population mean parameter estimate. In comparison to the binary logit models, the estimation of RPL models results in a substantial improvement of fit and the hypothesis of homogeneity of the models parameters is rejected (-2LL values were 304.33 and 227.25 for IT and NT respectively which are greater than the corresponding critical Chi-square value of 9.48). It is obvious that the individual-specific parameters characterise the log-likelihood function more precisely, presenting more accurately the observed choices. In addition, it is worth referring to the larger mean values for the attribute parameters of the RPL models compared with those in the basic models. The explanation of this enlargement is the specification of random parameters decomposes the unobserved component of utility, normalises the parameters through the scale factor μ and diminishes the variance of the stochastic term (Sillano and Ortúzar, 2005). Different distributional forms were assigned to test for better model fits and the model was re-estimated with greater number of draws to ensure results stability. 200 intelligent draws (shuffled Halton sequences) was found producing statistically similar results to higher draws (300, 500 and 1000).

To illustrate the difference across respondents in the coefficients, a centipede plots were produced for the respondent expected values of the coefficient on experiment attributes. For each of the 600 respondents, the range was given by the mean ± two standard deviations. This range captures at least 95% of the distribution. The individual specific point estimates are presented by the dots in the centres of the bars. The figures (6, 7) show that there is a considerable amount of variation across respondents in both means and standard deviation. In addition to individual level heterogeneity, these graphical summaries of estimates present general conclusions about relationships among variables. The Kernel density estimators were plotted for the distribution of individual parameters. Such estimators outperform the traditional histogram because they do not rely on the assumed bins and the underlying distributions are continuous (Hensher and Greene, 2003).

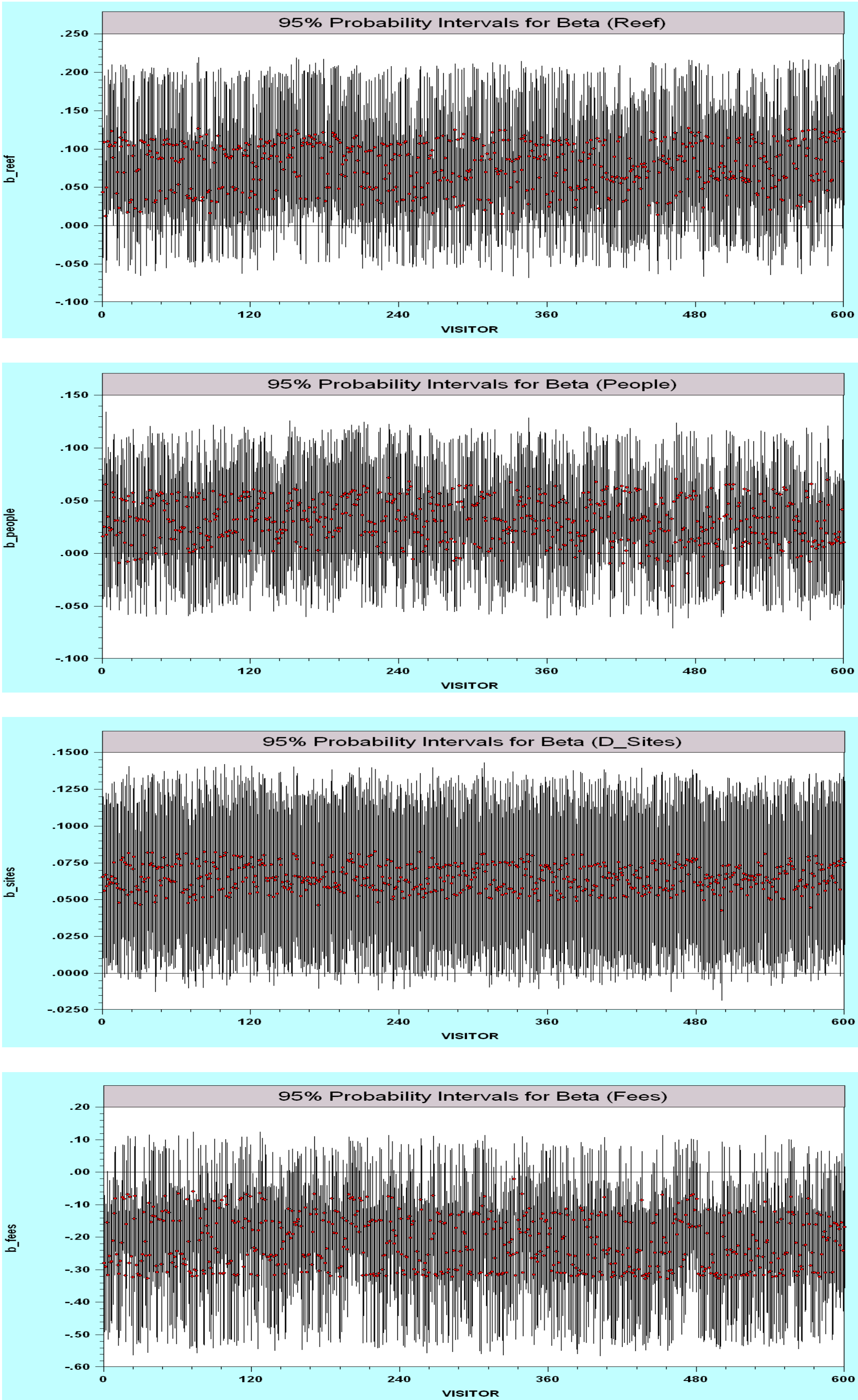


Figure 6: *Confidence intervals for conditional means in IT model*

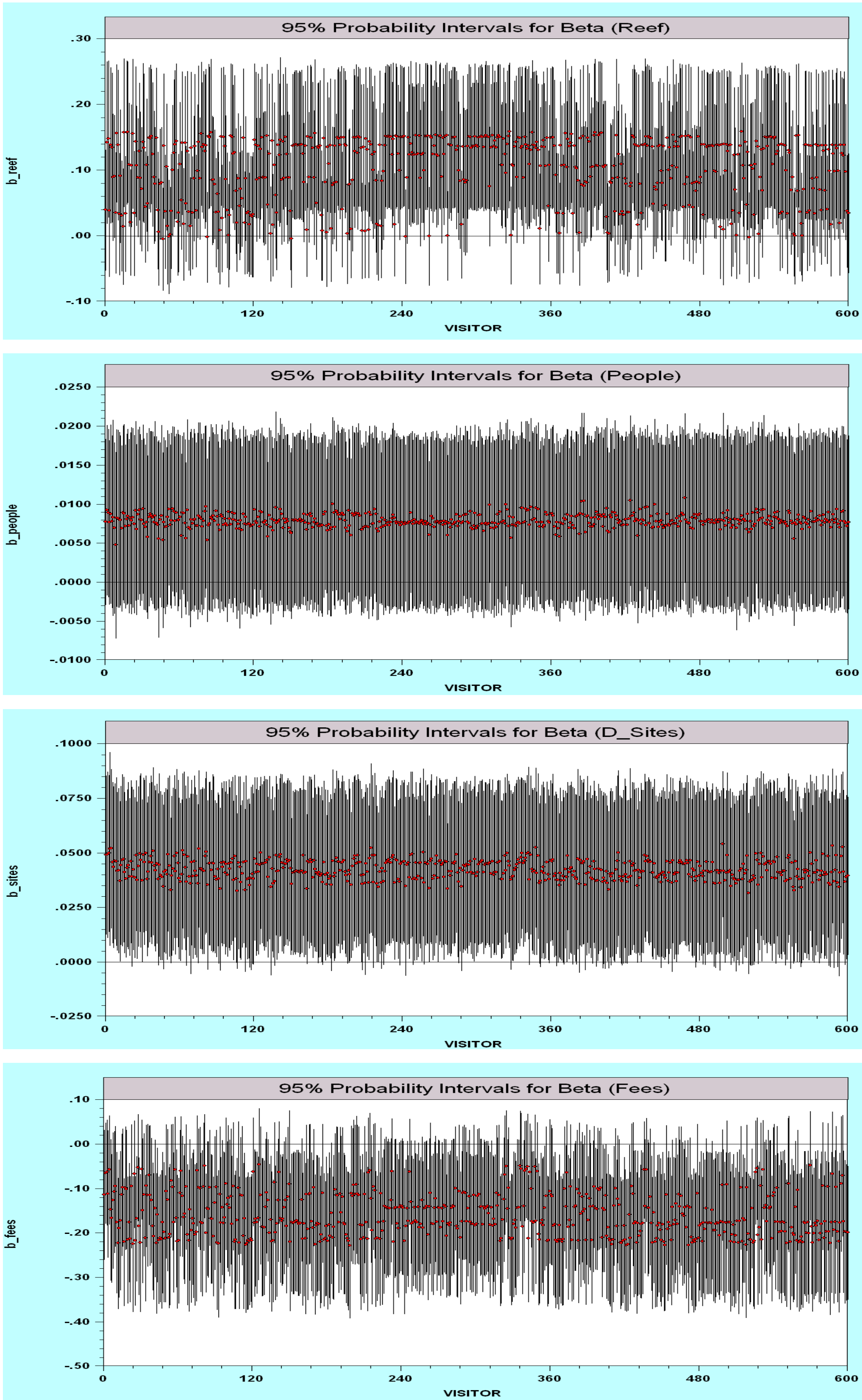


Figure 7: *Confidence intervals for conditional means in NT model*

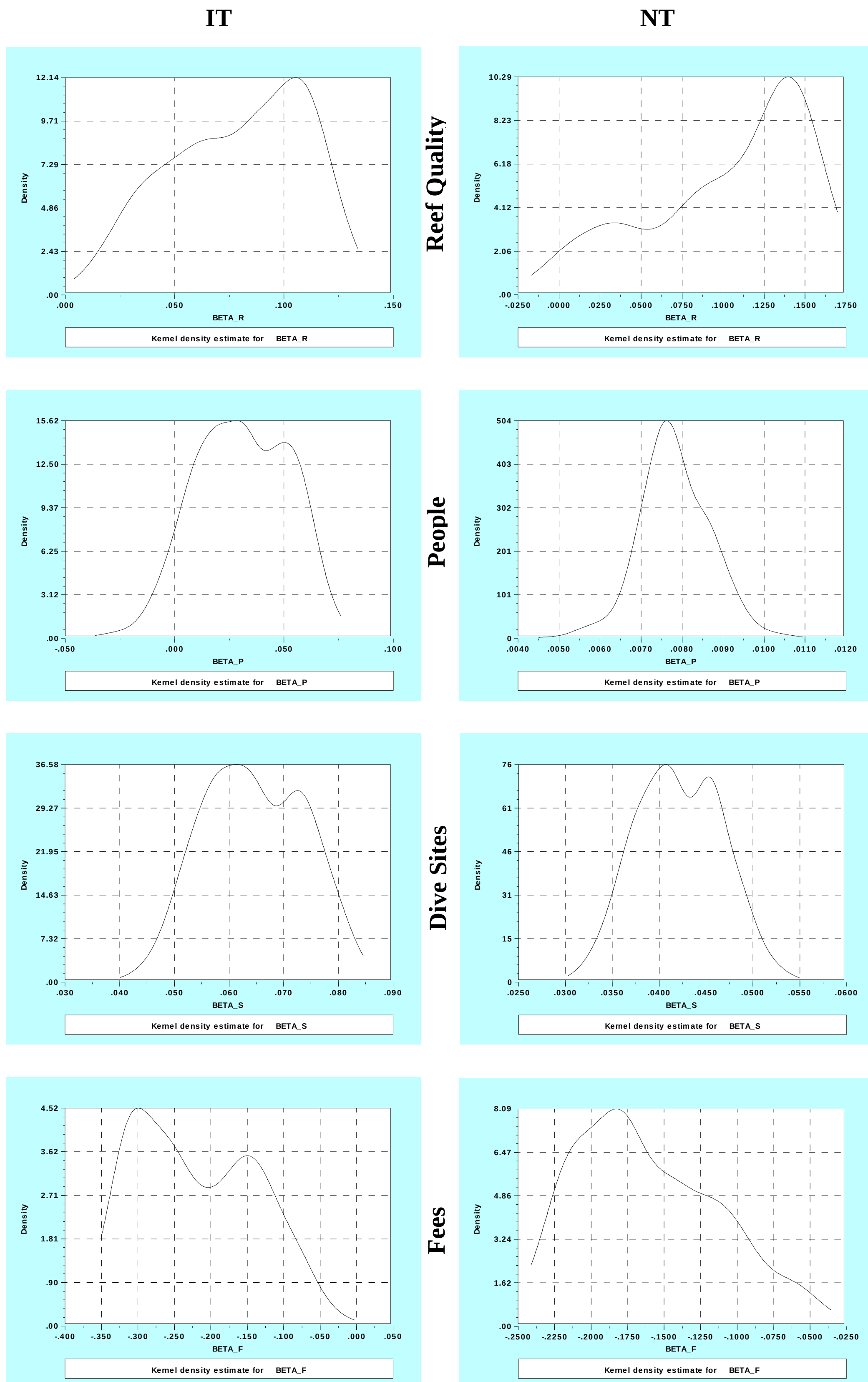


Figure 8: *Distribution of individual specific means*

Revealing Preference Heterogeneity around the Mean of Random Parameters

In the preceding section, the RPL models were used to determine whether there exists heterogeneity around the mean through the estimation of a standard deviation parameter associated with underlying attributes random parameters. In this section, RPL models were used to determine the possible sources of preference heterogeneity.

In contrast to the attributes of the good under evaluation, those of the individual remain the same across alternatives and thus can not enter into the model directly. The interactions between the individual characteristics and constant term or choice-specific attributes were used in many studies to incorporate the observed heterogeneity into the model. However the preference heterogeneity around the mean and its sources can be revealed by using the random parameters instead of creating the interaction effects through the data. Table 9 summarises the sample characteristics for the two sets. Little difference was observed in terms of age and education; however the average income of the international tourists is far greater (≈5 times) than the national tourists. Also, the family size and the proportion of males are higher in NT. While more international tourists hold diving certificates, national tourists have better snorkelling skills.

Table 9: *Sample Characteristics*

Variable	*Description*	*Mean*	
		IT	NT
Individual Characteristics			
MALE	Equals 1 if male, 0 if female	0.49	0.73
AGE	Age in years	33.87	32.20
MEMBER	Equals 1 if member in environmental organisation	0.13	0.19
EDU	Years in formal education	14.09	15.43
INCOME	Monthly income ($)	2602.38	493.96
FAMILY	Visitor's family size	2.92	4.32
CERT	Equals 1 if respondent has diving certificate	0.33	0.28
SKILL	snorkelling skills (1= very bad to 5=excellent)	0.67	3.15
INFO	Information about corals (1= v. poor to 5 = v. good)	3.42	2.92
Trip Characteristics			
PERIOD	Length of Stay (nights)	9.05	5.11
TC	Travel cost ($)	1742.08	482.67
N_VISITS	Number of visits to Ras Mohammed	1.28	2.64
REPEAT	Equals 1 if it is a repeat visit to Ras Mohammed	0.37	0.09
SUB	Equals 1 if respondent visited alternative reef sites	0.29	0.48
N_DIVES	Number of dives	7.50	8.38
N_SNORKEL	Snorkelling times	7.70	8.74

The insignificant heterogeneity in the mean parameter estimates was removed and the models were re-estimated.

Table 10: *Random Parameter model with interaction effects*

Variable	International Tourists		National Tourists	
	Coefficient	P-value	Coefficient	P-value
	Non-random parameters			
CONSTANT	-0.975535	0.0000	-0.653417	0.0023
	Means for random parameters			
REEF	0.087506	0.0000	0.075117	0.0000
PEOPLE	0.022784	0.0000	0.009063	0.0002
D_SITES	0.047803	0.0000	0.019167	0.0157
FEES	-0.165078	0.0000	-0.159575	0.0000
	Scale parameters for dists. of random parameters			
REEF	0.132042	0.0000	0.172093	0.0000
PEOPLE	0.082874	0.0000	0.017774	0.0000
D_SITES	0.068221	0.0000	0.030541	0.0000
FEES	0.328535	0.0000	0.215746	0.0000
	Heterogeneity in the means of random parameters			
REEF:REPEAT			-0.017037	0.0015
REEF:SUB	-0.010813	0.0152	0.019968	0.0000
REEF:MEM	0.025018	0.0062		
REEF:EDU	-0.001561	0.0279		
REEF:INCOME	0.000002	0.0575		
REEF:FAMILY	-0.003996	0.0273		
PEOPLE:SUB	0.010510	0.0001		
PEOPLE:CERT	-0.009305	0.0001		
PEOPLE:INFO	0.002703	0.0212		
PEOPLE:MALE			-0.004110	0.0681
PEOPLE:MEMBER	0.011323	0.0409		
PEOPLE :FAMILY	-0.003681	0.0008		
D_SITES:REPEAT			0.021024	0.0002
D_SITES:MEMBER			0.014181	0.0035
FEES:MALE	0.017811	0.0080		
FEES:AGE	-0.001333	0.0001		
FEES:MEMBER	-0.044756	0.0334		
FEES:EDU	0.002658	0.0542	0.002753	0.0158
FEES:INCOME	0.000004	0.0745		
Log Likelihood	-1310.095		-1264.098	
Chi-squared	365.0195	0.0000	257.1012	0.0000
shuffled Halton draws	200		200	
Individuals	600		600	
Observations	2400		2400	

The overall models are found to be statistically significant (Chi-square statistics equal to 365.019 and 257.101 for the international tourists and national tourists respectively and P-values equal to zero). The mean sample population parameters estimates and the spread of the underlying attributes are all statistically significant. The likelihood ratio test showed that the inclusion of interaction effects led to gains in model fit but at the cost of 15 and 6 additional parameters in IT and NT models respectively (-2LL values were 60.69 and 29.85 for IT and NT which are greater than the corresponding critical Chi-square values of 24.99 and 12.59 respectively).

The significant interaction terms explain as to why the preference heterogeneity may exist. Foreign tourists who visit other reef sites, have higher education or have larger families are more sensitive to reef quality while those with higher incomes or are members in environmental organisations tend to be less reef-quality-sensitive. Respondents with larger families or holding dive certificate appear to be more sensitive to uncrowding conditions while those visit substitute reef sites, have a membership in an environmental organisation, have sufficient information about coral reefs are less sensitive for reducing the number of people at the reef site. Also, male, more educated respondents or those with high income are likely to be less sensitive to entrance fees where old visitors or the members in environmental organisations tend to be more fees-sensitive. It is worth mentioning that interacting the D-Sites random parameter with the observed individual variables produced statistically insignificant results for the IT suggesting that the differences in the marginal utilities held for this attribute cannot be explained by these variables. Moreover, the snorkelling skills variable does not explain preference heterogeneity in any of the underlying attributes.

National tourists who are repeat visitors or members in environmental organisations are less sensitive to the number of dive sites. Respondents who visit substitute reef sites or are more educated are less sensitive to reef quality and entrance fees respectively while repeat or male visitors tend to be more sensitive to reef quality and lower congestion level respectively. There is no apparent explanation for the surprising results that the respondents who are more educated (in IT model) and the repeat visitors (in NT model) are more sensitive to reef quality or for foreign tourists who hold diving certificate or are members in environmental organisation and being more sensitive to lower congestion level and entrance fees respectively.

Heterogeneity in Variances (Heteroskedasticity)

Heterogeneity in the variances is as important as heterogeneity around the mean of random parameters. The influences of specific characteristics of sampled individuals may be rejected in one domain and resurface through the other (Greene and Hensher, 2007). The random parameters models allow the unequal variances to be dependent on individual characteristics.

Table 11: *Heteroskedastic Random Parameter models*

Variable	International Tourists		National Tourists	
	Coefficient	P-value	Coefficient	P-value
		Non-random parameters		
CONSTANT	-0.704616	0.0022	-0.512509	0.0147
		Means for random parameters		
REEF	0.055582	0.0000	0.068742	0.0000
PEOPLE	0.022839	0.0000	0.006494	0.0000
D_SITES	0.043219	0.0000	0.024360	0.0011
FEES	-0.171407	0.0000	-0.109389	0.0000
		Scale parameters for dists. of random parameters		
REEF	0.084314	0.0000	0.235040	0.0000
PEOPLE	0.063279	0.0000	0.005377	0.8187
D_SITES	0.113799	0.0000	0.072826	0.0926
FEES	0.238604	0.0000	0.201243	0.0098
		Heterogeneity in the variances of random parameters		
REEF:EDU	0.022437	0.1197	-0.017304	0.2063
PEOPLE:EDU	-0.008190	0.5098	0.030685	0.9122
D_SITES:EDU	0.026560	0.0410	0.085731	0.0244
FEES:EDU	0.131299	0.0000	0.279856	0.0000
Log Likelihood	-1345.903		-1282.528	
Chi-squared	293.4043	0.0000	220.2423	0.0000
Halton draws	200		200	
Individuals	600		600	
Observations	2400		2400	

Although both models are statistically significant with Chi-square values of 293.40 and 220.24 for IT and NT models respectively, the log likelihoods are flat indicating to the lack of fit of the models. The education has a statistically significant influence on number of dive sites and entrance fees. The positive sign on both D_SITES and FEES suggests that more educated visitors are much more heterogeneous in terms of the marginal utility associated with these attributes.

Correlated Parameters

The random parameter models allow the error components in the choice sets to be correlated. Having done that, the standard deviations have been no longer independent and the Cholesky decomposition matrix parameters should be used instead.

Table 12: *Random Parameter model with correlated error components*

Variable	International Tourists		National Tourists	
	Coefficient	P-value	Coefficient	P-value
	Non-random parameters			
CONSTANT	-1.058210	0.0000	-0.792370	0.0004
	Means for random parameters			
REEF	0.056711	0.0000	0.083816	0.0000
PEOPLE	0.024421	0.0000	0.008438	0.0000
D_SITES	0.050921	0.0000	0.047290	0.0000
FEES	-0.158147	0.0000	-0.156461	0.0000
	Diagonal elements of Cholesky matrix			
REEF	0.112604	0.0000	0.189874	0.0000
PEOPLE	0.047896	0.0000	0.004830	0.4148
D_SITES	0.020665	0.1860	0.131031	0.0000
FEES	0.176224	0.0000	0.032230	0.0038
	Below diagonal elements of Cholesky matrix			
PEOPLE:REEF	-0.069255	0.0000	0.021134	0.0029
D_SITES:REEF	0.016593	0.3394	0.078271	0.0000
D_SITES:PEOPLE	-0.145662	0.0000	0.069819	0.0000
FEES:REEF	-0.013293	0.6797	-0.220670	0.0000
FEES:PEOPLE	0.035690	0.1799	0.053029	0.0626
FEES:D_SITES	-0.248943	0.0000	-0.419242	0.0000
Log Likelihood	-1334.346		-1272.273	
Chi-squared	316.5182	0.0000	240.7505	0.0000
shuffled Halton draws	200		200	
Individuals	600		600	
Observations	2400		2400	

The overall models fit are adequate; however, it can not be concluded that these models are any better than the main effects models (the log likelihood ratio test produces a Chi-square values equal to 12.18 for IT and 13.49 for NT compared to a Chi-square critical value of 12.59). Significant diagonal elements in the Cholesky decomposition matrix suggest significant variance directly attributable to the underlying random parameters while significant below-diagonal elements refer to significant cross-product correlations among the random parameters previously confounded with the standard deviation parameter estimates (Greene, 2007).

Restricting the Distribution

Following Hensher and Greene (2003) the sign and the range of a triangular parameter were restricted by constraining the spread to that of the mean of the random parameter in order to derive behaviourally plausible WTP values. The symmetry of this appealing distribution around the mean makes the results interpretation easier and bypasses the biased mean value caused by the long tail of the log-normal distribution.

Table 13: *Constrained Triangular Distribution*

Variable	International Tourists		National Tourists	
	Coefficient	P-value	Coefficient	P-value
	Random parameters in utility functions			
REEF	0.063057	0.0000	0.091221	0.0000
PEOPLE	0.025852	0.0000	0.006297	0.0037
D_SITES	0.087665	0.0000	0.058013	0.0000
FEES	-0.180801	0.0000	-0.155497	0.0000
	Nonrandom parameters in utility functions			
CONSTANT	1.914950	0.0000	1.069480	0.0001
	Derived std. dev. of parameter distributions			
REEF	0.063057	0.0000	0.091221	0.0000
PEOPLE	0.025852	0.0000	0.006297	0.0037
D_SITES	0.087665	0.0001	0.058013	0.0000
FEES	0.180801	0.0000	0.155497	0.0000
Log Likelihood	-1380.491		-1300.154	
Chi-squared	566.1251	0.0000	726.7987	0.0000
Halton draws	200		200	
Individuals	600		600	
Observations	2400		2400	

Comparison of log likelihood functions of these models with those of the base models suggest worsening in the models fit. However, the two models are statistically significant (Chi-square value of 566.12 for IT and 726.79 for NT with 5 degrees of freedom and P-values equal to zero). The means of random parameters are statistically significant and of the expected signs.

Comparison of Models

Five RPL models were estimated for each set, staring with the base model and moving to more complicated and general models. The models are identified as follows:

BNL: Binary logit model

RPL1: Base model with random parameters only

RPL2: RPL1 plus observed heterogeneity around the mean of random parameters

RPL3: RPL1 plus heterogeneity in the variances of random parameters

RPL4: RPL1 plus correlated parameters

RPL5: All random parameters were drawn from constrained triangular distributions

Table 14: *Model comparison and log-likelihood ration test*

Model	Chi-Square Statistic	Degrees of freedom	Critical value at 5%
International Tourists			
RPL1 vs BNL	304	4	9.48
RPL2 vs RPL1	60.69	15	24.99
RPL3 vs RPL1	-10.93	4	9.48
RPL4 vs RPL1	12.18	6	12.59
RPL5 vs RPL1	-80.11	4	9.48
National Tourists			
RPL1 vs BNL	227	4	9.48
RPL2 vs RPL1	29.85	6	12.59
RPL3 vs RPL1	-7.01	4	9.48
RPL4 vs RPL1	13.48	6	12.59
RPL5 vs RPL1	-42.26	4	9.48

The flat profile of values across most RPL models indicates little if any behavioural improvement when proceeding from the base model to the more complex models. Allowing for correlation or interaction leads to improvements in model fit, which are however not significant when taking into account the additional parameters, or smaller than those obtained with the recognition of the repeated choice nature in expression of preference heterogeneity. Hensher et al. (2005) noted that the inclusion of the separate attributes along with their interaction is likely to induce multicollinearity. Furthermore, the constrained triangular distribution may be problematic with this inclusion (Greene, 2007). Finally, using heteroskedastic model with correlated parameters may make the model inestimable. On the basis of the above discussion, the recommended model structure is the base model (RPL1).

7.3 Contingent Valuation

In order to achieve consistency, identical formats and questions were used for both CE and CV. The choice sets in the former were replaced with a WTP question in the latter. The respondents were asked to evaluate a programme that maintaining healthier coral reefs, reducing the congestion at the park, increasing the number of dive sites and considering the reef carrying capacity and indicate their WTP to carry out this programme. A vector of four entrance fees was chosen for the implementation of the dichotomous choice format and the respondent was asked whether he would pay this entrance fee for his recreation experience with this programme.

The first model contains the bid and the intercept (all of the underlying attributes are lumped into the intercept). Various individual variables were included in the model but most of them were found to be statistically insignificant. To calculate the welfare estimates, a new model was estimated by dropping insignificant variables.

Table 15: *Results of contingent valuation (basic models)*

Variable	International Tourists		National Tourists	
	Coefficient	P-value	Coefficient	P-value
CONSTANT	2.775770	0.0000	2.699228	0.0000
BID	-0.104060	0.0000	-0.088460	0.0000
Log Likelihood	-286.5652		-272.6549	
Chi-squared	30.11466	0.0000	20.36235	0.0000
Correct prediction	79.83%		82.00%	
Observations	600		600	

Table 16: *Results of contingent valuation models including individual variables*

Variable	International Tourists		National Tourists	
	Coefficient	P-value	Coefficient	P-value
CONSTANT	3.369470	0.0000	2.580645	0.0000
BID	-0.118894	0.0000	-0.092290	0.0000
MALE	-0.346543	0.0477		
AGE	-0.020316	0.0592		
INCOME	0.000205	0.0003	0.000435	0.0877
Log Likelihood	-276.2765		-269.5774	
Chi-squared	50.69218	0.0000	26.51742	0.0000
Correct prediction	80.00%		82.00%	
Observations	600		600	

The two models are statistically significant (χ^2 equal to 30.11 for IT model and 20.36 for NT model and P-values equal to zero). In both models bid variable is statistically significant and has the expected sign. The choice model correctly predicted the actual outcome for 80% and 82% of the total number of cases for international and national tourists respectively. According to the likelihood ratio test, the inclusion of socio-economic variables slightly improves the model fit (-2LL values were 20.57 and 6.15 for IT and NT which are greater than the corresponding critical Chi-square values of 7.81 and 3.84 respectively). The coefficient of income is positive and significant implying that a respondent with higher income has a higher WTP which is consistent with the economic theory. The negative coefficients of gender and age in IT model suggest that the female and young respondents have higher WTP values for the proposed programme.

7.4 Marginal Willingness to Pay

Comparison between BNL and RPL Models

There are different methods to derive WTP estimates. They could be calculated by the ratios of population means. Both attributes to be used in the calculation should be statistically significant (Hensher et al., 2005). However, the resultant values are derived from the coefficients of the average individual for each parameter and are not the mean values of WTP and should not be used in cost-benefit analysis (Sillano and Ortúzar, 2005). Furthermore, if the underlying parameters are estimated as random parameters, then the WTP calculations should consider this specification. Using the ratios of population means to derive WTP values ignores the sampling variance makes the extra estimation effort ineffectual. In addition to such point estimates, the WTP could be derived using all the information in the distribution. Simulation is used in this way, drawing from the estimated covariance matrix for the parameters (Hensher and Greene, 2003). The mean WTP is calculated for each draw and this process is repeated for many draws. That provides the estimated mean WTP (the means of the ratios). For selecting a final WTP value, Sillano and Ortúzar (2005) referred to the superior explanatory power of the RPL models and the extra variance explained by them. WTP values can be estimated using either the unconditional parameter estimates or the conditional parameter estimates. In the former the population must be stimulated and a large random draws are taken for each parameter allowing frequencies to be calculated sampling WTP distribution where the individual-level parameters are calculated using the simulated maximum likelihood estimates and conditioning them with the respondent choices. The unconditional parameter estimates yields some negative and behaviourally implausible WTP values. Table 17 shows that the negative WTP values were augmented with using the population parameters while the actual values were accounted by utilising the individual parameters. Moreover, the simulation process produces some values which are close to zero for the entrance fees parameter which makes the spread of the population parameters distributions extremely large and yields large WTP values. Sillano and Ortúzar (2005) argued that removing parts form the distribution seems to be rationale when the WTP values are derived for the sampled population. They added that the simulation process yields countless numbers of values for people who do not even exist especially with the extreme values. Therefore, small and equal percentages (3%) were cut off from each tail of the WTP distribution for the experiment attributes (truncated distribution). In addition, it may be desirable to impose constrains on the random parameter distributions to guarantee non-negative WTP measures. Although the constrained distribution may outperform the truncated distribution because of the concern associated with arbitrarily removing part of the distribution, a behavioural rational should be existed for imposing such constrains.

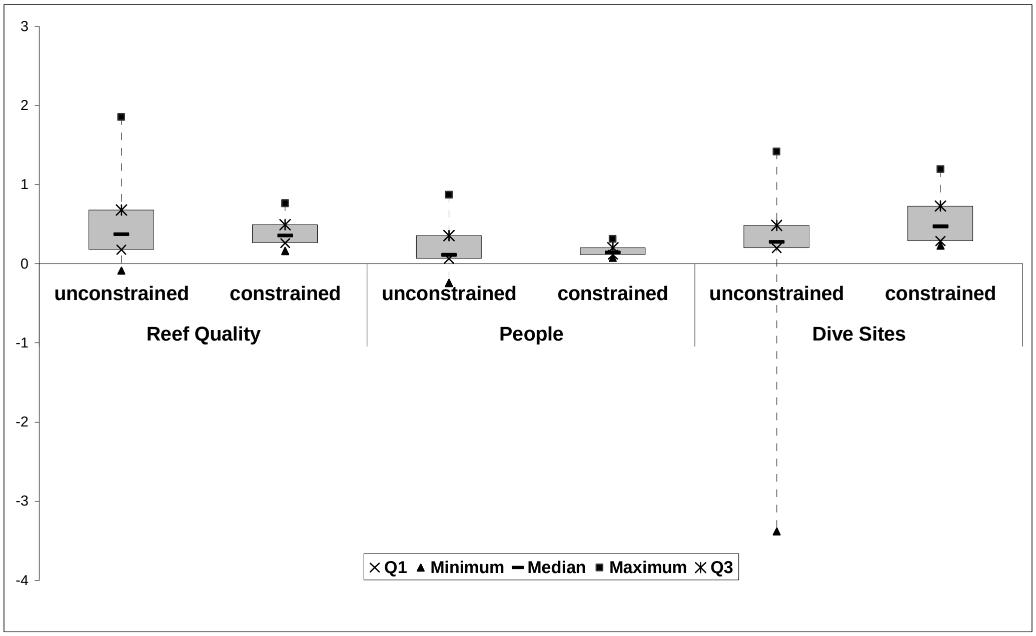
Table 17: *Percentage of WTP values with negative sign*

	International Tourists		National Tourists	
	Unconditional	Conditional	Unconditional	Conditional
Reef Quality	30.63%	0.17%	26.88%	2.33%
Fewer People	40.38%	5.17%	12.29%	0.00%
Dive Sites	14.54%	0.17%	14.17%	0.00%

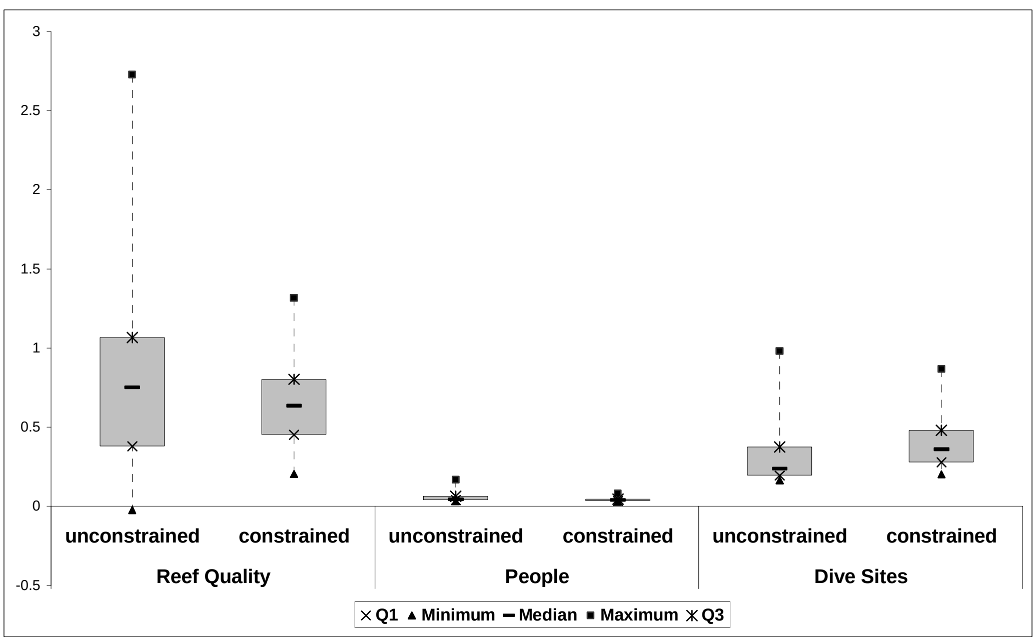
Different WTP estimates were obtained to investigate the affect of model specification and preference assumption on the results. Table 18, depicts the WTP for each attribute for the standard logit model together with corresponding figures of the RPL models. The results obtained by the conditional RPL models are consistent with those of the binary logit models. The foreign tourist is WTP an extra $0.5 for each 1% increase in the reef quality, $0.2 for each 1% decrease in the congestion level and $0.4 for each additional dive site while the national tourist is WTP an extra LE0.7 for each 1% increase in the reef quality, LE0.05 for each 1% decrease in the congestion level and LE0.3 for each additional dive site. The box plots presented in figure 9 show WTP values derived from unconstrained and constrained conditional distributions.

Table 18: *WTP values derived from BNL and RPL models*

	BNL	Unconditional Parameters	Unconditional (truncated) distributions	Conditional (unconstrained) distributions	Conditional (constrained) distributions
International Tourists					
Reef Quality					
Mean	**0.49**	**0.0038**	**0.2399**	**0.49597**	**0.3884**
Std. Dev.		14.5112	1.4936	0.40973	0.1591
Minimum		-353.4960	-6.1625	-0.0884	0.1643
Maximum		195.4700	7.6008	1.85042	0.7632
Uncrowding Conditions					
Mean	**0.18**	**-0.0392**	**0.0804**	**0.20527**	**0.1586**
Std. Dev.		7.3565	0.7572	0.20878	0.0605
Minimum		-179.2470	-3.1653	-0.2416	0.0755
Maximum		99.0530	3.8121	0.87082	0.3128
No of Dive Sites					
Mean	**0.41**	**0.0833**	**0.2204**	**0.36624**	**0.5472**
Std. Dev.		8.4278	0.8674	0.28577	0.2501
Minimum		-205.2220	-3.4980	-3.3815	0.2294
Maximum		113.6060	4.4955	1.41715	1.1959
National Tourists					
Reef Quality					
Mean	**0.65**	**-0.1959**	**0.5667**	**0.79351**	**0.63657**
Std. Dev.		28.6163	2.5174	0.58493	0.26538
Minimum		-766.9810	-10.4251	-0.0228	0.2046
Maximum		348.4510	11.4188	2.7263	1.31606
Uncrowding Conditions					
Mean	**0.04**	**0.0023**	**0.0444**	**0.05591**	**0.04324**
Std. Dev.		1.5784	0.1389	0.02676	0.01202
Minimum		-42.2908	-0.5619	0.03352	0.02876
Maximum		19.2324	0.6430	0.16951	0.0804
No of Dive Sites					
Mean	**0.31**	**-0.0008**	**0.2373**	**0.30527**	**0.40663**
Std. Dev.		8.9319	0.7858	0.16276	0.15391
Minimum		-239.3360	-3.1936	0.1643	0.20353
Maximum		108.8210	3.6245	0.98148	0.86813



International Tourists



National Tourists

Figure 9: *Box plots of WTP estimates*

Comparison between CE and CV

The comparison of welfare estimates derived by the two methods may be feasible because they share the same theoretical base and a common econometric analysis technique as previously discussed. Moreover, the same sample of individuals, hypothetical setting and attributes describing the change to be valued were used in both methods. However, for the CV, only the situational changes can be examined and therefore it may be better to compare them with the policy scenarios valuation shown in the preceding sections (table 6). Two model specifications were used for the CV method. CV1 is the basic CV model that includes only the bid and the intercept while CV2 considers socio-economic variables. The results show that the mean WTP per person values derived from CV method are $26.67 ($28.34 in CV2) for foreign tourists and LE30.51 (LE27.96 in CV2) for national tourists. The mean WTP for scenario 11 (this includes improving the reef quality by 30%, reducing the number of people at the reef site by 50%, and increasing the number of dive sites to 25 sites)[1] derived from CE is $29.13 ($35.02 in non-linear model) for IT and LE23.99 (LE26.79 in non-linear model) for NT. As can be seen, there is no significant difference found between the values derived from the two methods. However, this may be data dependent and the results may be sensitive to the assumptions made regarding the specification of choice preferences. Adamowicz et al. (1998) showed that CE and CV methods yield similar results. In addition, they argue that the CE generates smaller variances for welfare estimates compared to CV concluding that the CE may outperform CV in applied analysis. However, they based their test on a joint model which deems a re-parameterisation of separate models for CV and CE. Thus, their test may not present the optimal way to prove the equivalence between the two methods. Moreover, the CE welfare estimates depend on a much larger number of observations than CV. Therefore, the associated variances cannot be directly compared (Kriström and Laitila, 2009). Finally, many studies have showed the significant impacts of the model specification and experimental design on the results in CE.

[1] The scenario 11was used as an approximate average of scenarios 5 (least incremental increase) and 16 (highest incremental increase).

WTP Values Derived from Different Specifications of RPL Models

Progressing from the base model to more complicated models provides an analytical way of investigating the gains in the behavioural outputs of interest. The results suggest that accounting for heterogeneity in the variance tends to reduce the mean WTP values for the underlying attributes in the two sets while accounting for heterogeneity around the mean or allowing for correlated parameters produce mean WTP values close to those of the base model. Figure 10 confirms these results and shows significant movements downwards and upwards to the base model (RPL1) on the outer domains of the distribution in the IT model whilst such movements are very obvious in RPL4 compared to RPL1 as we move to the edges of the distribution in NT model.

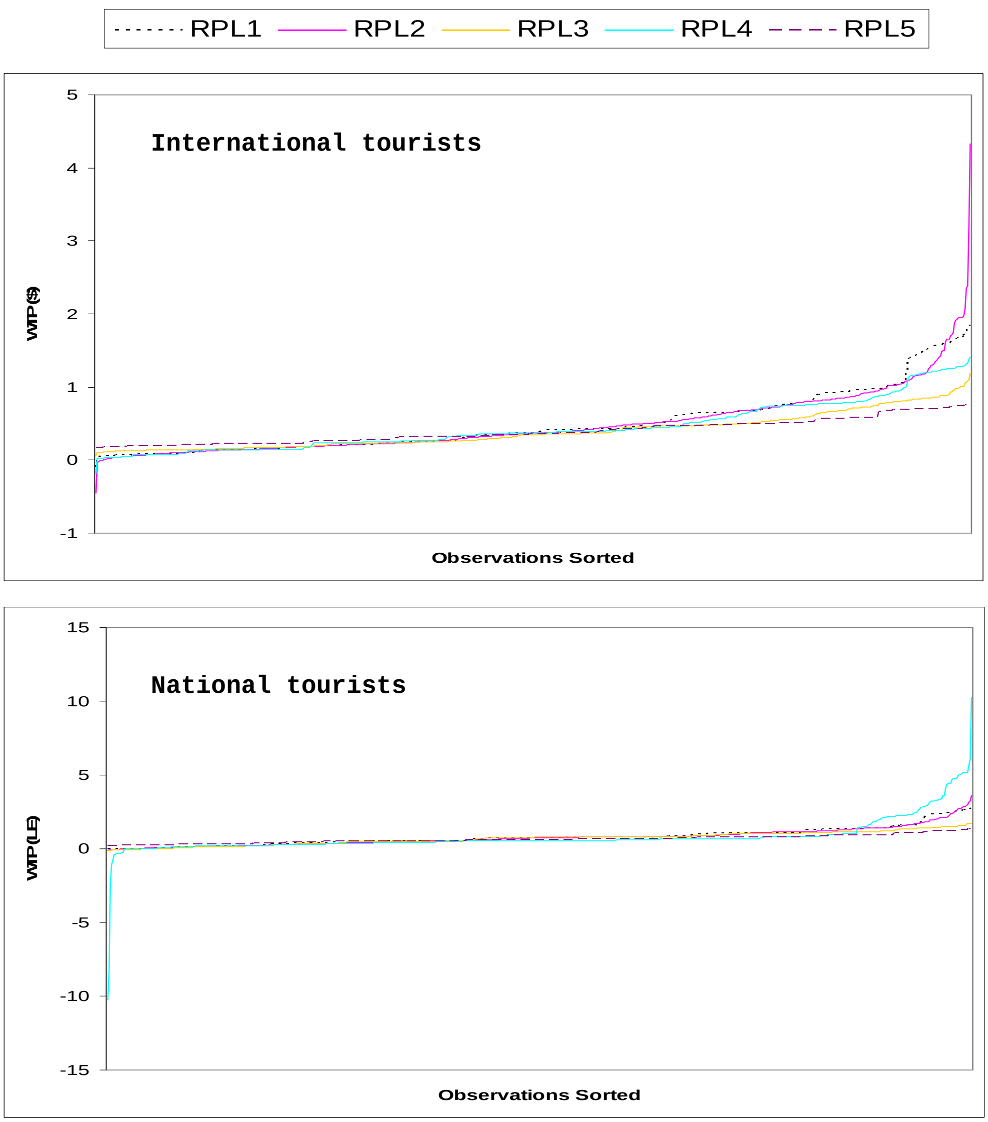


Figure 10. *The WTP distributions for the random parameter specifications*

8. Discussion and Conclusions

The coral reefs ecosystem is the greatest asset Ras Mohammed has, and it is what it is selling to the world market. The park management needs to understand the visitor preferences to maintain or increase benefits for them while protecting the reef. The choice experiments method was used to analyse preferences of national and international tourists towards the conservation of coral reefs at Ras Mohammed and to investigate the contributions of attributes of alternatives and characteristics of individuals to elucidating choice behaviour, identifying the impact of changes in levels of attributes and estimating the value of one attribute relative to another. This can help in incorporating such preferences into the design and the development of the park management plan. Four attributes were considered in the experiment for this purpose: the reef quality, the uncrowding conditions, the number of dive sites, and the increase in entrance fees. The both sets of tourists preferred high reef quality, low congestion, more dive sites and low entrance fees. However, international tourists showed significant preference for reducing congestion level and were willing to have restrictions on the number of visitors to reef sites in exchange of healthier reef, while national tourists did not demonstrate strong preference for this reduction. One of the explanations of this result is the vast majority of Egyptians live along the narrow Nile Valley and Delta, and the rest of the country is sparsely populated, meaning that approximately 99% of the population uses only about 5.5% of the total land area. Thus, the perception of congestion may be different.

The study attempted to take the main advances in the area of discrete choice analysis. The random parameters models were presented and contrasted with the basic logit models. Their estimation results in a substantial improvement of fit over the basic models because of the increased explanatory power of the specification (Train, 1998). Also, they overcome the limitations of the standard logit models (i.e. the rigidity of its error structure and the limited ability to account for unobserved heterogeneity). The WTP for every individual can be retrieved by utilising these methods and the distribution of these values prove to be more informative than the single values of mean estimated by the basic models. The highest WTP value was found for an improved reef quality (the greatest contributor to welfare).

The increasing number of visitors to Ras Mohammed can pose various threats to coral reefs in the park. The management of Ras Mohammed should look at the impacts of mass tourism on coral reefs and estimate appropriate carrying capacities for the different dive sites. However, there are other factors should be considered. The behaviour and characteristics of visitors may have greater influence on coral reefs. Salm (1985, 1986) found that underwater photographers are the most damaging of all divers observed. Damaging contacts with coral reefs could be reduced by giving environmental awareness briefing before diving (Medio et al., 1997) and the intervention by the dive leader (Barker and Roberts, 2004). An ongoing monitoring programme and a GIS database focusing on the reef sites should be developed and the number of mooring buoys should be increased and well distributed inside the park. The heavily used dive sites may be closed for a period of time to allow corals to recover and shifting use to new sites.

The coral reefs ecosystem is fragile and needs investment to be maintained and managed. The collected user fees should be used to pay for better management of the park. The successful implementation of the entrance fees requires allocating access rights and the ability to enforce these rights. The management of Ras Mohammed faces a problem with setting the entrance fees at the appropriate amount and enforcement of the access to the reef sites particularly in Tiran island and Sharm El-Shiekh coastline. A two-tier entrance fee is implemented where the foreign tourist pays \$5 while the Egyptian pays LE 5 (≈ \$1). The rationale of this system is foreign tourists do not pay taxes to the local government (Seenprachawong, 2002) and they have higher income than the national tourists. Supplementary fees may be levied for visiting special or sensitive reef sites. Many respondents suggested imposing a hotel tax room of \$1 per night. This may be a convenient alternative to the current system because Ras Mohammed includes the coastline of Sharm El-Sheikh and all the visitors and business in the city benefit from the coral reefs. The expected revenues generated by this tax (≈ \$7 millions) is greater than the revenues from the current entrance fees (≈ \$2 millions) while the required operation cost and logistics are less. Also, this small tax would not affect the tourism industry.

With the cheap package holidays to Sharm El-Sheikh, the elite tourism has disappeared and replaced by mass tourism. Without a comprehensive policy and a sustainable level of tourism and the institution of certain measures to ensure that any adverse effects on reef ecosystem are minimised, this industry will destroy itself in Sharm El-Sheikh. Moreover, the park managers should know which of coral reef conservation management strategies are preferred, which are not, and which combinations of strategies are most preferred by visitors.

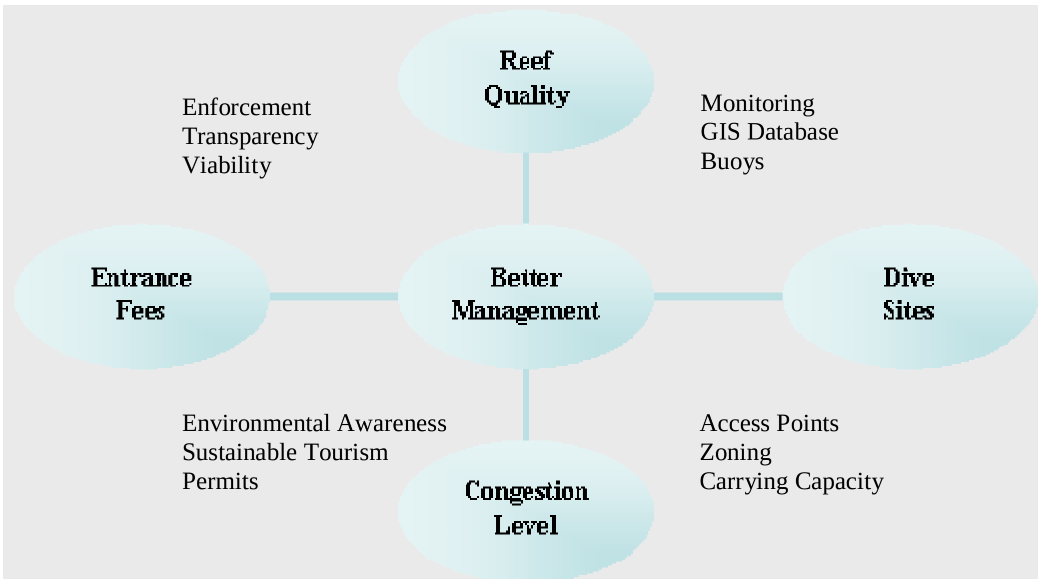


Figure 11: *Choice experiments attributes and management strategies.*

The results presented in this study could provide useful information for the policy makers concerning decisions of improving reef quality, regulating some activities inside the park, and the allocation of resources for each attribute. Although these results are based on responses of visitors to Ras Mohammed, they elucidate the stated preferences when applied to reef attributes. They may be legitimately employed at other reef sited in Egypt if they have similar markets, characteristics, demographic and preference profiles specifically the welfare estimates produced by CE are likely to be less site-specific.

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