VALUING BENEFITS OF IMPROVED COASTAL WATER QUALITY FOR BEACH RECREATIONISTS IN TOBAGO: A DISCRETE CHOICE EXPERIMENT APPLICATION

By
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To my Family and Andrew

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Abstract

The island of Tobago is located in the Caribbean, the world's most tourism intensive region. Tobago's beaches are an important attraction and contribute to making it the eighth most visited island in this region of the world. Beach-related activities are therefore among the most popular recreational activities carried out by both visitors and locals. The quality of the coastal waters is now a major environmental issue in Tobago due to the importance of this resource in supporting the economically important tourism sector and for safeguarding public health.

The goal of this thesis is to estimate the economic benefits that beach recreationists derive from attributes linked to improved coastal water quality. This environmental valuation study is carried out using the stated preference technique of discrete choice modelling. The design of the study also incorporates methodological advances from the field of discrete choice modelling in order to improve the accuracy of these estimates. Three discrete choice experiments are designed and their results are reported. The first two experiments evaluate the effects of observed and unobserved taste heterogeneity for two groups of beach recreationists: snorkellers and non-snorkellers. The third experiment is designed to investigate whether respondents selectively avoid tradeoffs between all the attributes they are asked to consider when completing a discrete choice experiment. The analysis of all three experiments includes an evaluation of willingness to pay estimates and incorporates these in recommended policy actions.

This thesis delivers two core contributions. The first is that it demonstrates the importance of using preference elicitation and estimation methods to account for systematic and random variation in individual tastes. The second is that it investigates one source of random variation stemming from respondents who exclude attributes in a discrete choice experiment. The result is that the use of these methodological advances is shown to help in modelling individual preferences in discrete choice experiments. This in turn helps with the prioritisation of policy initiatives for protecting the quality of coastal waters in Tobago.

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Declaration

I hereby declare that, unless otherwise indicated in the text, the research presented in this thesis is original work undertaken by myself, Nesha C. Beharry, between October 2003 and December 2007. Some parts of this thesis have appeared previously in the papers listed below. In all cases, the major contributions were made by myself with input from Professor Riccardo Scarpa.

The work in Chapter 4 is an extension of the work first presented at an International Society of Ecological Economics conference in 2006 (Beharry & Scarpa 2006) and will appear in a chapter of the book entitled Payment for Ecosystem Services in 2008 (Beharry & Scarpa 2007*b*). The work presented in Chapter 4 is also an extension of the work presented at the Environmental and Resource Economics conference in 2007 (Beharry & Scarpa 2007*c*).

Part of the data collected in this thesis was used for work on measuring gender differences in preferences towards improvements in coastal water quality. This work was first presented at the Environmental and Resource Economics conference in 2005 (Beharry & Scarpa 2005). This work has been submitted to the Environmental and Resource Economics Journal (Beharry & Scarpa 2007*a*) in October 2007 for peer review.

List of Abbreviations

Abbreviation	Meaning
AIC	Akaike information criteria
AIC-3	Akaike information criteria 3
BIC	Bayesian information criteria
BRMP	Buccoo reef marine park
ASC	Alternative specific constant
CV	Contingent valuation
CV	Compensating variation
GEV	Generalised extreme value
GBP	Great Britian pound
GDP	Gross domestic product
IIA	Independence from irrelevant alternatives
iid	Independently and identically distributed
iff	If and only if
LCM	Latent class model
LL	Log-likelihood
WTP	Willingness to pay
RUM	Random utility model
RUT	Random utility theory
MPA	Marine protected area
MNL	Multinomial logit
MMNL	Mixed Multinomial logit
SLL	Simulated log-likelihood
SQ	Status quo
TT$	Trinidad and Tobago dollars

Chapter 1

Introduction

1.1 Tobago's beaches and coastal water quality degradation

Trinidad and Tobago is a twin-island country, Tobago being the smaller of the two islands. It is located in the south-east corner of the Caribbean Sea, off the coast of Venezuela (§ Figure 1.1). The coastal and marine environment of Tobago provides users with a range of resources for activities, from traditional swimming to more specialised activities such as scuba diving, snorkelling, yachting and fishing. With 42 beaches distributed over its 300 square kilometres of land area, beach-related activity is one of the most popular recreational activities on the island (§ Figure 1.2).

Tobago's beaches have historically been an important attraction for both overseas and domestic visitors. Its popularity as a tourist destination is related to attractions such as the Buccoo Reef Marine Park and Little Tobago. Consequently, the economy of Tobago is heavily reliant on the tourism industry, this industry having become a major factor in its economic growth over the past 15 years (SEDU 2002). This contrasts with Tobago's sister island Trinidad where the main economic activity is oil and gas production. Travel and tourism in Trinidad and Tobago has grown by over 40 percent since the mid-1990s when measured in terms of international arrivals. This equals or exceeds the growth recorded by other Caribbean islands over the same thirteen-year period. The tourism industry in Tobago accounted for 31 percent of the island's Gross Domestic Product (GDP) in 2004 (WTTC 2004). Furthermore, industry projections for 2005 showed that the tourism industry in Tobago was expected to account for 46 percent of the island's GDP and provide 56.8 percent of the islands employment, making it one of the most tourism intensive economies in the world.

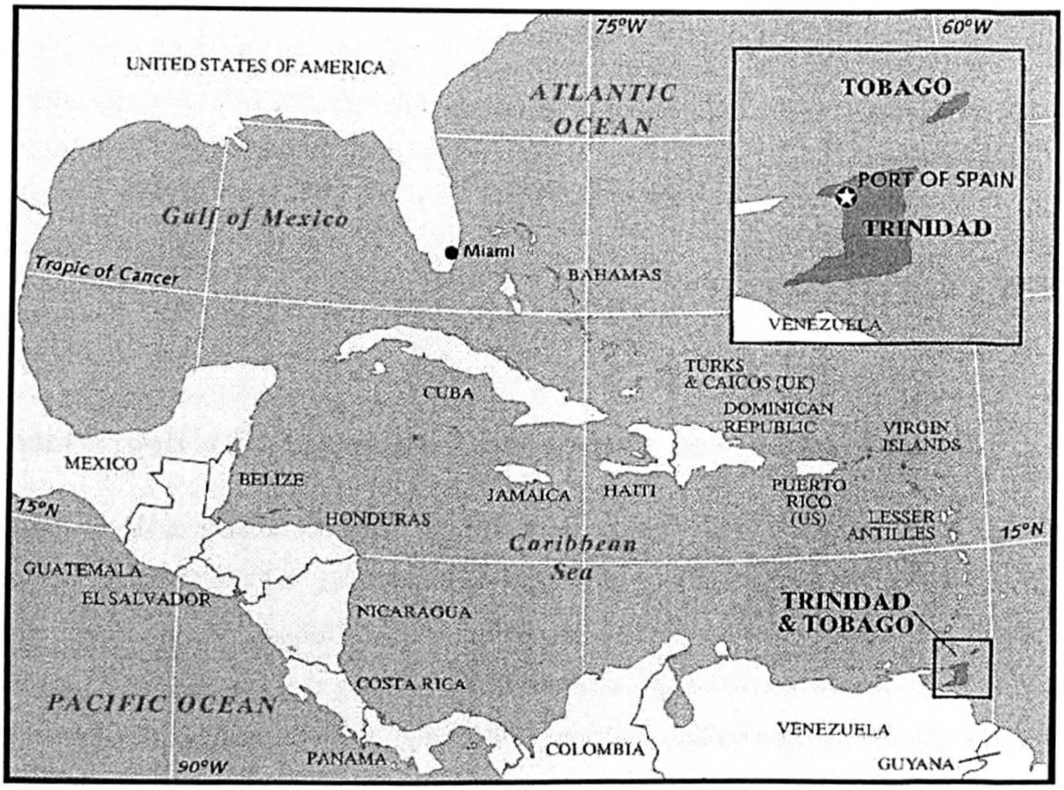


Figure 1.1: Location of Trinidad and Tobago (Wood 2000)

The tourism industry has and is expected to continue to bring substantial rewards to the island through the generation of employment, foreign exchange earnings and government revenues (Lalta & Freckleton 1993, WTTC 2004). However, considerable environmental problems have also emerged in the past two decades. These include coastal water eutrophication, harmful algal blooms, fish kills and loss of seagrasses and coral reefs (IMA 2006, Lapointe et al. 2004, Agard & Gobin 2000, Siung-Chang 1997). The main source of these problems has been identified as local land-based nutrient pollution. In a recent study done on coastal water quality, ecologists identified that the most considerable source of nutrient pollution is improperly treated sewage. Other sources include runoff due to increasing deforestation, agriculture and urbanisation (Lapointe 2003). Nutrient pollution and the consequent deterioration of coastal water quality has a direct impact on the recreational benefits to both the resident and visitor populations on this island. As a

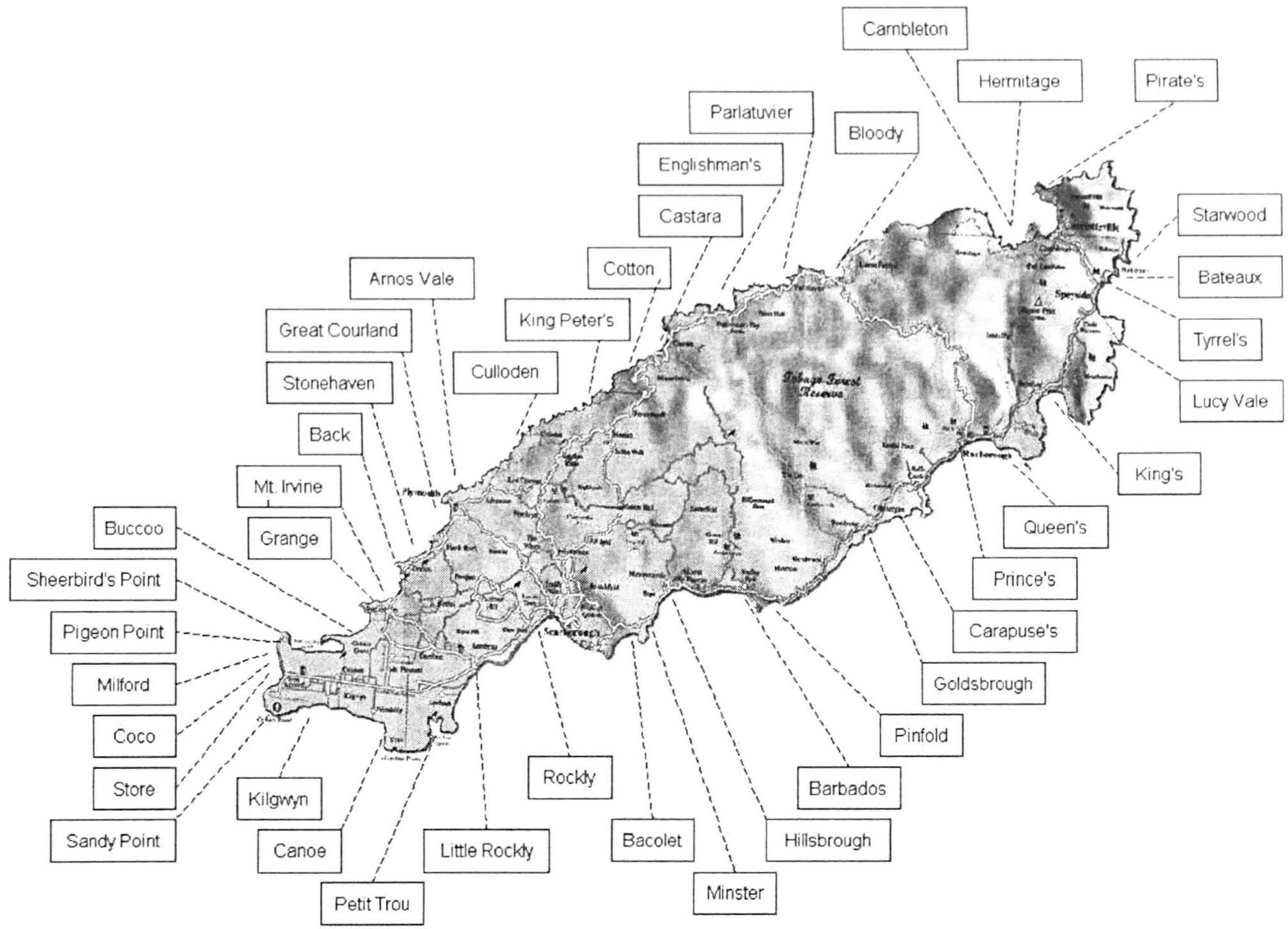


Figure 1.2: Map of 42 beach sites in Tobago

result, tourism related activities that depend on the quality of the coastal waters may be negatively impacted. Despite the partial awareness and documentation of the impact of degradation of coastal water quality, there exist no valuation estimates on the benefits of potential improvements to this natural resource.

1.2 Motivation of this thesis

There are two motivating factors for the research carried out in this thesis. *The first motivation is to address the lack of valuation estimates on the economic benefits of improving the quality of coastal water.* The derivation of these estimates is important since they can provide information to government bodies and stakeholders, thereby enabling them to design and implement more effective policies for the improvement of coastal water quality. These values are especially important in the context of a small island developing country where there is a need to prioritise policy recommendations due to limiting financial resources and conflicting objectives for natural resource management. There are a large number of benefits that can be derived from improving the quality of coastal water. This thesis focuses on one in particular: that of valuing the benefits of improved coastal water quality for beach recreationists. Deriving the recreational benefits of a resource provides an important link between people's preferences and their behaviour. This has been used since the late 1970's to influence environmental policy decisions and hence promote conservation of the resource in question (Hanemann 1978, Bockstael et al. 1989).

The second motivation of this thesis is to explore how two recent advances in discrete choice modelling can be used to improve valuation estimates. Discrete choice theory is the theoretical basis of discrete choice modelling. The stated preference technique of discrete choice modelling is the valuation method used in this thesis. Discrete choice theory assumes that utility of any good can be specified to be a function of a systematic (observable) component made up of attributes and a random (unobservable) component. The unobservable or random component represents the researcher's inability to fully observe or understand choice behaviour. A great majority of methodological work done by researchers in the field of discrete choice modelling has to do with finding better methods to model the random component of utility to realistically represent, and hence improve, the understanding of choice behaviour. This work takes place not only in the field of environmental economics but to a larger extent in the fields of transport, marketing and health economics. These methodological advances are important to researchers in environmental economics as they allow them to obtain more representative estimates (such as willingness to pay), thereby improving the validity and reliability of policy recommendations. Two key areas of recent methodological research are applied and investigated in this thesis: the first is the capturing of taste heterogeneity (§ Chapter 4); the second is the understanding of attribute relevance and, in particular, attribute exclusion in decision making (§ Chapter 5).

1.2.1 Taste heterogeneity

Taste heterogeneity captures differences of individuals' tastes or preferences within a sampled population. It has been shown that ignoring this difference can lead to biased estimates. Taste heterogeneity may be purely random (unobserved taste heterogeneity), or systematic (observed taste heterogeneity). For example, (Morey 1981) demonstrated the relevance of observed taste heterogeneity in modelling the utility of ski areas to recreationists. This was done through what is known as the classic method of capturing observed taste heterogeneity: introducing observed characteristics such as socioeconomic variables in the systematic part of utility. There are two techniques currently available that aim to capture unobserved taste heterogeneity. These involve using two flexible econometric models: the mixed multinomial logit model (MMNL) and latent class model (LCM). In the MMNL model, each individual's tastes for an attribute is assumed to be random and defined from a specified distribution. On the other hand, the LCM model assumes that each individual belongs to exactly one group but that group membership is based on unobservable segmentation regarding tastes.

One of the main advantages of using the LCM and MMNL models is that they allow the calculation of estimates of tastes for each individual in the sample. This information provides a better understanding of how tastes vary within sampled populations, something which is increasingly important in designing economically optimal and effective policies. In

Chapter 4, observed taste heterogeneity is accounted for through the design of two choice experiment surveys for two groups of beach recreationists and unobserved taste heterogeneity is investigated by using the LCM and MMNL models. The results are then used to derive policy recommendations for improving attributes linked to better coastal water quality on the island of Tobago.

1.2.2 Decision making and attribute exclusion

Decision making lies at the heart of discrete choice theory. Decision makers are traditionally assumed to make choices that are rational, thus satisfying the axioms of consumer theory. Increasingly however, research has shown that human decision behaviour is highly sensitive to a wide variety of task and context factors (Payne et al. 1988). This leads to the adoption of a number of strategies used by individuals to solve decision problems. One such strategy is described as a "non-compensatory strategy". This implies that respondents do not process all the relevant information presented to them and hence selectively avoid tradeoffs (Payne et al. 1993).

One of the assumptions underlying discrete choice theory (and by extension the discrete choice experiment) is that respondents do indeed consider all attributes and alternatives presented to them. Selectively making tradeoffs represents another source of random variation which, if not accounted for, can lead to biased estimates. For example, DeShazo (2002) and Swait & Adamowicz (2001*b*) have shown that complexity (as defined by the number of attributes and alternatives) has a negative impact on the consistency of estimates. Follow-up investigations which have specifically focussed on the impact of varying numbers of attributes presented to an individual on a choice card have shown that respondents may be altogether excluding attributes from their consideration (Hensher 2006*a*, Scarpa et al. 2007).

The results of these aforementioned studies motivated further investigations in this thesis to determine if attribute exclusion was a characteristic of the two choice experiments carried out in Chapter 4. The results of the follow-up questions confirmed that attribute exclusion was also taking place in this study and prompted the design of an exploratory study reported in Chapter 5 to understand why respondents were indeed ignoring attributes. There are many contributory factors as to why respondents could be ignoring attributes in a discrete choice experiment. The investigation described in Chapter 5 hypothesises that attribute exclusion was possibly unique to each individual and based on each individual's recreational activities during beach visitation.

1.3 Research objectives

Three research objectives are defined for this thesis which together aim to achieve the overall goal of providing more accurate valuation estimates on which sounder policy making for protecting coastal waters can be based. These objectives thereby attempt to close the gap between methodological innovation in environmental valuation and its role in informing natural resource and environmental policies.

The first objective of this thesis stems from the first motivation of this research described in Section 1.2; that of addressing the lack of valuation estimates on the economic benefits of improving the quality of the coastal waters. The second objective stems from the second motivation of this research; that of exploring how two recent advances in discrete choice modelling can be used to improve valuation estimates:

Objective 1: To determine valuation estimates of the recreational benefits of improved coastal water quality for beach recreationists in Tobago using the discrete choice experiment method.

Objective 2: To increase the reliability of valuation estimates by incorporating two methodological advances in the design of the study through:

- accounting for and investigating the presence of observed and unobserved taste heterogeneity. The former will be done through the design of two discrete choice experiment surveys for two groups of beach recreationists: snorkellers and non-snorkellers. The latter will be done through the use of more flexible econometric models.
- an investigation into whether any attributes are excluded by individuals in decision making. This will be done through the design of a systematic study that

seeks to determine if attribute relevance is a contributory factor to attribute exclusion.

The third objective is to utilise the valuation estimates as well as the investigation into taste heterogeneity and attribute exclusion to provide more reliable policy recommendations:

Objective 3: To help develop policy recommendations for attributes linked to improved coastal water quality through the evaluation of the valuation results, and to refine these recommendations by the application of recent methodological developments.

1.4 Thesis contributions

In achieving the three research objectives previously described, this thesis delivers five contributions. The first four contributions together fulfill the first two research objectives while the final contribution fulfills the third research objective.

Contribution 1: Unlike previous studies which have investigated the environmental impact of poor water quality in Tobago, the studies reported in Chapters 4 and 5 are the first to identify preferences and quantify values for attributes linked to improved coastal water on the island. This is also the first study that derives the economic benefits of improved coastal water quality for beach recreationists in the context of a developing country.

Contribution 2: The study carried out in Chapter 4 is the first study to capture observed taste heterogeneity in order to investigate the specific preferences of visitors and locals. This was done by categorising beach recreationists into two groups, snorkellers and non-snorkellers.

Contribution 3: The study carried out in Chapter 4 confirms the value of using more flexible econometric methods to account for unobserved taste heterogeneity. This has important implications for the provision of more informed recommendations to policy makers.

Contribution 4: The study carried out in Chapter 5 is to the author's knowledge the first to show that, in some situations, attribute exclusion does not significantly impact valuation estimates. The approach to eliciting the way individuals exclude attributes during the decision making process is also novel.

Contribution 5: Finally, the results from the studies in Chapters 4 and 5 are used to help recommend the prioritisation of policy initiatives for improving attributes linked to better coastal water quality for Tobago.

1.5 Achieving the objectives: The thesis plan

The remainder of this thesis is set out as follows:

- Chapter 2 provides an overview of the theory behind discrete choice modelling and a point of reference for the analysis carried out in Chapters 4 and 5. In particular, the assumptions underlying three discrete choice models, the multinomial logit (MNL), the mixed multinomial logit (MMNL) and latent class model (LCM), are highlighted and derived. Individual-specific estimates derived from the MMNL and LCM models are also used to obtain the respective willingness to pay (WTP) estimates.

- Chapter 3 describes the design and development of the three discrete choice experiment surveys carried out in Chapters 4 and 5. These include surveys for (1) snorkellers (2) non-snorkellers and (3) respondent-selected respondents. A key objective of this chapter is to present the results of the various research methods used and demonstrate how these guided the development of the questionnaires. The rationale for choosing each attribute is described in such a way that it highlights the link between the recreational use of the beach and coastal water quality. An important component of this chapter is a description of the experimental designs that guided the development of the three surveys. Finally, detailed descriptions of each section of the final questionnaires administered in the surveys are described and contrasted.

- Chapter 4 provides the results of the valuation estimates which account for observed and unobserved taste heterogeneity in the two sampled groups of beach recreationists:

snorkellers and nonsnorkellers. This chapter starts off by providing the rationale for this systematic categorisation of beach recreationists. This is followed by a review of related literature that investigates the economic benefit to marine recreationists of coastal water quality improvements. The results of the analysis are then presented, beginning with a comparison of the descriptive statistics of both recreational groups. The LCM and MMNL models are used in the analysis to investigate if there exist any sources of unobserved taste heterogeneity in the data. These results are compared to determine which model specification provides the greatest explanatory power in describing the choice behaviour of the two recreational groups and the respective parameter estimates are used to calculate WTP estimates. Individual-specific WTP estimates are also derived using parameter estimates from MMNL and LCM model specifications. These results are instrumental in developing, evaluating and prioritising the attribute-specific management recommendations for policy makers. Finally, this chapter also reports the results of follow-up questions and consistency tests which examined monotonicity and stability of the responses. The results of these tests provided evidence that respondents were not attending to all attributes in the presented choice cards.

- Chapter 5 presents the results of a novel exploratory study designed to determine whether valuation estimates are affected by a respondent ignoring attributes in a discrete choice experiment. This chapter begins with a review of the disparate angles of related research on varying decision making strategies as used in psychology, marketing, economics, transport and environmental economics. Two datasets are defined and compared in this study. The first is termed the researcher-selected dataset which contains responses from a 'typical' discrete choice experiment where respondents are asked to consider all attributes presented to them by the researcher. The second is termed the respondent-selected dataset and contains choices from the experiment designed to include or exclude attributes specified by the respondent. In order to determine if allowing the respondent to choose their attributes affects valuation estimates, the datasets are pooled and compared using the scale ratio test. This chapter concludes with an evaluation of the effect that the respondent-selected method of attribute choice has on willingness to pay estimates.

- Finally, Chapter 6 summarises the main contributions of the thesis and recommends directions for further research.

Chapter 2

Methodology

Abstract

The objectives of this chapter are twofold. The first objective is to provide an overview of the theoretical background on discrete choice experiments. The second objective is to serve as a point of reference for the analysis done in Chapters 4 and 5. The discrete choice experiment method is a stated preference valuation technique based on random utility theory (RUT) and the justification for its use in this thesis is presented in Section 2.1. In Section 2.2, the theoretical background of the discrete choice model is discussed and derived. The common properties of discrete choice models and estimation issues are also discussed in this section. Following this, the specification of three discrete choice models, namely the multinomial logit model (MNL), mixed multinomial logit model (MMNL) and the latent class model (LCM) are discussed in Sections 2.3, 2.4 and 2.5 respectively. One important highlight of these latter sections is the discussion on taste heterogeneity and the inability of the MNL model to account for it (§ Section 2.3.2). Finally, economic measures of welfare including marginal willingness to pay (WTP), individual-specific WTP and compensating variation are discussed in Section 2.6.

2.1 Introduction

A stated preference approach was used in this thesis as opposed to a revealed preference approach such as travel cost method since the objective was to value anticipated changes in beach visitation from potential levels of improvements to the coastal water quality. The chosen stated preference technique of discrete choice modelling was the preferred approach for this study as opposed to contingent valuation. This was because of its ability to estimate multiple changes for specific attributes of coastal water quality that could be linked to beach recreation. In addition, these estimates could be used to generate more detailed information such as individual-specific willingness to pay and compensating variation estimates for each attribute and multiple policy scenarios.

The discrete choice experiment method[1] belongs to the family of stated preference valuation techniques. In the field of environmental valuation, the main aim of this method is to estimate the economic value for a technically divisible set of attributes of an environmental good (Holmes & Adamowicz 2003). This method is consistent with random utility theory (RUT). Therefore, the surveys used to collect responses on the environmental good are designed to elicit people's preferences for the specific attributes. The inclusion of a cost attribute makes it possible to indirectly obtain the respondent's willingness to pay for the environmental good in its entirety (an alternative) or the marginal WTP for each attribute (Kjaer 2005). Experimental design theory is then used to construct choice sets which consist of alternatives (i.e. combinations of attributes) and are designed to force the respondent to make a choice between each alternative based on their preferences. Ultimately, this provides information on willingness to pay which is then used to provide resource managers and policy makers with detailed information about public preferences for multiple states of the environment.

The discrete choice experiment method has evolved from techniques such as conjoint analysis[2] and random utility analysis[3] used in the marketing, transportation, food and health economics fields. Conjoint analysis was widely used in the field of marketing in the 1970's and 1980's to help predict the demand for new products by asking respondents to rank or rate scenarios according to their preferences (Cattin & Wittink 1982). Also in the 1980's, researchers in the field of transportation used the multinomial logit model (MNL) which utilised random utility theory (McFadden 1974) to model transportation

[1]The "discrete choice experiment method" is also known as the"choice experiment method", "discrete choice modelling" or " choice modelling".

[2]The term "conjoint analysis" is a generic terms that was coined by Green & Srinivasan (1978) to cover models and techniques that emphasise the transformation of subjective responses into estimated parameters.

[3]According to (Ben-Akiva & Lerman 1995) this covers models that are based on the random utility approach which was formalised by (Manski 1977).

demand (Ben-Akiva & Lerman 1995). The development of the discrete choice experiment method can be traced back to the initial studies done by Louviere and Woodworth (Louviere & Woodworth 1983, Louviere 1984, 1986). Here, the researchers integrated the techniques developed in conjoint analysis and random utility analysis to model the choices that individuals made between alternatives in the field of marketing and transport. Discrete choice experiments originated in the field of marketing and transport and the first non-market valuation application was done by Adamowicz et al. (1994). Since then there have been numerous applications within the non-market valuation field (Boxall et al. 1996, Hanley et al. 1998, 2001).

In addition to the discrete choice experiment method, there are three other choice methods which have been used in non-market valuation, namely contingent ranking (Garrod & Willis 1997, 1998, Machado & Mourato 1999), contingent rating (Alvarez-Farizo & Hanley 2002) and paired comparisons (Johnson & Desvouges 1997). These techniques differ in the quality of information they generate, in their degree of complexity and also in their ability to provide WTP estimates that can be shown to be consistent with the usual measures of welfare change (Hanley et al. 2001). In a discrete choice experiment, the respondents have to choose one alternative out of a given number of alternatives. In contingent ranking, respondents have to rank the set of alternatives. In contingent rating, respondents have to rate a number of scenarios individually on a numeric or semantic scale. In a paired comparison, respondents have to choose their preferred alternative out of a set of two choices and then indicate their strength of preferences using a numeric or semantic scale. The discrete choice experiment method has been noted to be the simplest and most reliable of these four methods. One reason for this is that, in comparison to rating and ranking exercises, it is the least cognitively burdensome and therefore requires less strong assumptions on the cognitive ability of humans. In general, the stronger the assumptions which have to be made on human cognitive abilities the less likely these assumptions will be satisfied and the more likely that the measures based on these assumptions will be biased (Louviere et al. 2000).

2.2 Theoretical background of discrete choice experiments

The discrete choice model forms the theoretical basis of the discrete choice experiment. This model has its foundation in classic economic consumer theory and is based on two main extensions, namely: the Lancastrian Economic Theory of Value and Random Utility Theory. This section provides a brief outline of the key concepts of economic consumer theory and a description of the two extensions will be presented to show how they come together to form the theory behind the discrete choice model.

The objective of economic consumer theory is to provide the means for the transformation of assumptions about desires into a demand function expressing the action of a consumer under given circumstances (Ben-Akiva & Lerman 1995). For example, one basic assumption of economic consumer theory states that consumers are rational decision makers. Therefore, when faced with a set of possible consumption bundles of goods, they assign preferences to each of the various bundles and then choose the most preferred bundle from the set of affordable alternatives. Given that these preferences are complete, reflexive, continuous and transitive, the utility function can be derived which, by associating a real number with each good, summarises the consumer's preference orderings (Varian 1992). Consumer behaviour can then be expressed as an optimisation problem in which the consumer selects the consumption bundle such that their utility is maximised subject to their budget constraint (Walker 2001). This optimisation function can be solved to obtain the demand function. The demand function can be substituted back into the utility equation to derive the indirect utility function, which is the maximum utility that is achievable under the given prices and income (*ibid.*).

The first extension to economic consumer theory is the Lancastrian economic theory of value. Whereas consumer theory assumes goods are the direct objects of utility, Lancaster (1997) proposed that it is the attributes of the goods that determines this utility. Therefore, utility can be expressed as a function of the attributes of the good. However, in discrete choice experiments individuals have been observed not to select the same alternative in repetitions of the same choice situations (Ben-Akiva & Lerman 1995). As a result of this, a probabilistic choice mechanism[4], namely Random Utility Theory, has been used to explain behavioural inconsistencies. This theory, the second extension to economic consumer theory, was originally proposed by Thurstone (1927) and further developed by Marschak (1960) and Luce (1959). The central idea behind random utility theory is that the decision maker is assumed to select the alternative with the highest utility and any observed deficiencies in choice behaviour is due to the analyst's observational deficiencies. However, the utilities are unknown to the analyst with certainty and are therefore treated by the analyst as random variables consisting of an *observable* and *unobservable* component. As described by Ben-Akiva & Lerman (1995), Manski (1977) identified four sources of uncertainty: unobserved attributes, unobserved taste variations, measurement errors and instrumental variables.

In consumer theory a continuous space of alternatives is assumed, whereas in discrete choice theory the assumption is that the alternatives are discontinuous or discrete (Train 2003). By definition, the set of alternatives in a discrete choice situation must exhibit three characteristics (Train 2003). The first is that the alternatives must be mutually exclusive from the decision maker's perspective. Secondly, the choice set must be exhaustive so that all possible alternatives are included. Finally, the number of alternatives must be finite. The use of a discrete representation of alternatives necessitates a different analytical approach. This involves the direct use of utility functions instead of deriving demand functions as is done in consumer theory[5].

2.2.1 Derivation of the discrete choice model

Using the two extensions as described above, a discrete choice model can be derived following McFadden (1974) and Train (2003). In a discrete choice experiment a decision maker n faces a choice among a set of alternatives J which differ in their level of utility. The utility that the decision maker n obtains from alternative j is U_{nj}, $j = 1, \ldots, J$. As stated in Section 2.2, the utility is known to the decision maker but not to the analyst.

[4]Probabilistic choice theories arose from the field of psychology where they were used to explain experimental observations of inconsistent and transitive preferences (Luce & Suppes 1965).

[5]See (Ben-Akiva & Lerman 1995) for an explanation of this analytical approach.

The behavioural model is therefore:

Decision maker n chooses alternative i if and only if:
$U_{ni} \geq U_{nj}, \quad \forall j \in C_n$
where C_n is the set of J_n alternatives faced by n.

The analyst does not observe the decision maker's utility but observes some attributes of the alternatives x_{nj} as faced by the decision maker, and some characteristics of the decision maker s_n. The analyst can then specify a function that relates these observed factors to the decision maker's utility. This function is denoted by:

$$V_{nj} = V(x_{nj}, s_n) \tag{2.1}$$

and is known as the representative component of utility (Train 2003). Utility depends on V_{nj} which includes aspects specific to the decision maker s_n as well as to the choices x_{nj}. The attributes x_{nj} varies across choices and possibly across the decision makers as well. The components of s_n contain the characteristics of the decision maker n and are therefore the same for all choices carried by out by n (Greene 1997). As a result, these individual-specific terms s_n will fall out of the probability equation (Equation 2.14 in Section 2.3) because they do not vary across the alternative (§ Section 2.3). If the model is to allow individual-specific effects, then it must be modified as described in Section 2.2.2.

Since there are aspects of utility that the analyst does not observe, $V_{nj} \neq U_{nj}$. Utility is therefore composed of two components. One component of the utility function represents the portion of utility observed by the analyst, often called the deterministic or observable component V_{nj}. The second component is the difference between the unknown utility used by the individual and the utility estimated by the analyst ε_{nj}. In particular, ε_{nj} is not defined for a choice situation *per se*. Rather, it is defined relative to the researcher's representation of the choice situation. Formally this is denoted by:

$$U_{nj} = V_{nj} + \varepsilon_{nj} \tag{2.2}$$

where: U_{nj} is the true utility of alternative j for decision maker n,
V_{nj} is the deterministic or observable component of the utility estimated by the analyst and,
ε_{nj} is the error component of the utility and is unknown to the analyst.

The analyst does not know any information about the error term ε_{nj} and so treats it as random. The joint density of the random vector $\varepsilon_n = \langle \varepsilon_{n1}, \ldots, \varepsilon_{nJ} \rangle$ is denoted by $f(\varepsilon_n)$. Within this density the analyst can make probabilistic statements about the decision maker's choice. Thus, the probability that a decision maker n will choose alternative i over alternative j, given the set of alternatives J is denoted by:

$$\begin{aligned} P_{ni} &= \text{Prob}(U_{ni} > U_{nj},\ \forall j \neq i) \\ &= \text{Prob}(V_{ni} + \varepsilon_{ni} > V_{nj} + \varepsilon_{nj},\ \forall j \neq i) \\ &= \text{Prob}(\varepsilon_{nj} - \varepsilon_{ni} < V_{ni} - V_{nj},\ \forall j \neq i) \end{aligned} \tag{2.3}$$

Equation 2.3 shows that the probability of decision maker n choosing alternative i is equal to probability of the difference in the observed component of utility associated with i compared to alternative j (i.e. $V_{ni} - V_{nj}$) being greater than the difference in the unobserved component of utility of alternative i compared to alternative j (i.e. $(\varepsilon_{nj} - \varepsilon_{ni})$ after evaluating each and every alternative in choice set J.

The probability is a cumulative distribution function, namely the probability that each random term $(\varepsilon_{nj} - \varepsilon_{ni})$ is below the observed quantity $V_{ni} - V_{nj}$. The cumulative distribution function can be rewritten as:

$$\begin{aligned} &= \text{Prob}(\varepsilon_{nj} - \varepsilon_{ni} < V_{ni} - V_{nj},\ \forall j \neq i) \\ &= \int_{\varepsilon} I(\varepsilon_{nj} - \varepsilon_{ni} < V_{ni} - V_{nj},\ \forall j \neq i) f(\varepsilon_n) d\varepsilon_n \end{aligned} \tag{2.4}$$

where $I(\cdot)$ is the indicator function equaling 1 when the expression in parentheses is true and 0 otherwise. This is a multidimensional integral over the density of the unobserved component of utility, $(f(\varepsilon_n))$. Therefore, the probability that a respondent chooses an alternative is the expected value of the indicator function, where the expectations are the possible values of the unobserved portion of utility. Simplifying assumptions on the distributions of the random error terms are made in discrete choice models in order to maintain a parsimonious structure. This leads to the formulation of different discrete choice models. For example, McFadden (1974) proved that an IID Gumbel assumption yields the Multinomial Logit (MNL) choice model (Section 2.3). Alternatively, a generalised extreme value (GEV) distribution gives rise to the nested logit model. The mixed multinomial logit model (MMNL) is based on an assumption that one component follows any distribution as specified by the analyst while the other component follows an IID Gumbel distribution (Brownstone & Train 1999).

2.2.2 Common properties of discrete choice models and their implications

There are common properties which affect the specification and estimation of discrete choice models (Train 2003) which will be described in this section and subsequent sections. The first property is that the absolute level of utility is irrelevant to both the decision maker's behaviour and the analyst's model. If a constant is added or multiplied to all of the alternatives, then the alternative with the highest utility does not change. As shown in Equation 2.3, the choice probability depends on the difference in utility and not the absolute level. The fact that only differences in utility matter has several implications for the identification and specification of discrete choice models. One such implication is that, for the parameters such as alternative specific constants (Section 2.2.2) and socio-demographic variables (Section 2.2.2) to be identified and estimated, these have to be specified in such a way that they capture differences across alternatives. The second property (as described further in Section 2.2.2) is that the scale of utility is arbitrary.

Alternative specific constants

Discrete choice models are usually specified with alternative specific constants (ASC's). The observed part of utility is usually specified to be linear in parameters with this constant:

$$V_{nj} \quad = \quad x_{nj}\beta + k_j, \quad \forall j \tag{2.5}$$

where x_{nj} is a vector of variables that relate to alternative j as faced by decision maker n,

β are the coefficients of the variables, and k_j is a constant that is specific to alternative j. The alternative specific constant for an alternative captures the average effect on utility of all the factors that are not included in the model. However as stated above, since only differences in utility matter, only differences in alternative specific constants are relevant, not their absolute levels. In terms of estimation with J alternatives, $(J - 1)$ alternative specific constants can enter the model, with one of the constants being normalized to zero.

ASC's are included in the discrete choice model for two main reasons. The first is that they are included when the alternatives are labelled and not generic. On the other hand, if the alternatives are generic, then the ASC for that alternative is assumed to be zero since the difference in utility between the alternatives is caused by the attributes which have already been included in the model (Kjaer 2005). ASC's can also be included to explicitly account for the status quo in discrete choice experiments (Scarpa, Ferrini & Willis 2005, Adamowicz et al. 1995) as also done in Chapter 4. The ASC specified here represents the utility of choosing the status quo alternative when everything else is kept constant (Holmes & Adamowicz 2003). A negative sign on the ASC parameter indicates that choosing the status quo decreases utility. A positive sign indicates a positive preference for the status quo and means that individuals attach some positive utility to the status quo situation.

Sociodemographic variables

Sociodemographic variables can only enter a discrete choice model is they are specified in such a way that they create difference in utility across the alternatives. As stated in Section 2.2.1, the characteristics of the decision maker do not vary over the alternatives. Therefore, they can only enter the model if they are specified in ways that create differences in utility over the alternatives. One way to do this is to create a set of dummy variables for the choices and multiply each of them by the characteristics of the individual (Greene 1997, Train 2003).

Scale of utility

The scale parameter in a discrete choice model is proportional to the inverse of the variance of the error term in the utility function (Adamowicz et al. 1998). The scale parameter also affects the value of the estimated taste parameters (*ibid.*). Therefore, a small variance in the error term implies that the scale parameter (as well as the absolute value of the coefficients of the taste parameters) is larger. The scale parameter λ is multiplicative and gives an absolute value for utility. However, the absolute value of the scale parameter does not affect utility since only parameters that can capture differences across alternatives affect utility. Therefore, the alternative with the highest utility is the same no matter how it is scaled. To take this into account, the scale of utility is usually normalised (Train 2003). The standard way of doing this is to normalise the variance of the error terms since this is linked by definition to the scale parameter. Since it is known that when utility is multiplied by $(1/\lambda)$, the variance of the error term changes by $(1/\lambda^2)$, normalising this variance is equivalent to normalising the scale of utility. An example of how this is done for the MNL model is given in Section 2.3.

Scale parameter in combining datasets

Traditionally, different discrete choice models are scaled by different numbers. This is not an issue because utility is not affected, but it becomes an issue when models have to be compared and when multiple data sets are pooled. This is because the estimated parameters of two data sets to be compared are confounded with their respective scale factors (Swait & Louviere 1993). Therefore, in order to facilitate comparison of the parameters between pooled data sets, the scale factor differences must be isolated (*ibid.*). This is done by normalising one scale parameter to unity and letting the scale parameter for the second data set vary in the estimation process (*ibid.*). This method recognises that, in the estimation of one data set, the scale λ is not identifiable but the ratio of the scale factor of one data set relative to another can be identified $((\lambda_1) \ / \ (\lambda_2))$. This allows the analyst to determine whether the parameters differ due to the fact that one data set is noisier than the other or whether the parameters actually differ after taking the scale factor into account. This procedure allows the analyst to test the hypothesis of parameter equality between the two data sets while permitting the scale factors to differ between the two data sets[6]. The log-likelihood ratio test can then be implemented to test the equal parameter hypothesis as

[6]As reported in Chapter 5, this procedure is done in this thesis using the software package Biogeme.

follows:

$$\text{LLratiotest} = -2[LL_{pooledDS} - (LL_{DS1} + LL_{DS2})] \tag{2.6}$$

where (LL_{DS1}) are (LL_{DS2}) are the log-likelihood values for separate data sets and $(LL_{pooledDS})$ is the log-likelihood value of the pooled data sets . The test statistic is asymptotically chi-squared distributed with (K+1) degrees of freedom, where K is the number of parameters. If the critical value is exceeded, then the assumption of parameter equality can be rejected. On the other hand, if it is not exceeded, then this leads to the acceptance of the hypothesis of equal parameters between the two data sets.

2.2.3 Estimation of discrete choice models

The goal of model estimation is to make inferences on values of the unknown utility parameters in Equation 2.5. There are several statistical approaches to estimating the parameters of discrete choice models, the most common and straightforward being maximum likelihood estimation (Ben-Akiva & Lerman 1995). The idea behind maximum likelihood estimation is that a given sample could be generated by different populations and is more likely to come from one population than another (Louviere et al. 2000). Therefore, the set of maximum likelihood estimates is that set of population parameters that generates the observed sample most frequently (*ibid.*). The search procedure used to identify these parameters is iterative and uses a numerical maximisation algorithm. As shown in Figure 2.1, the most widely used approach is to find the parameter values $\hat{\beta}$ which maximises the log of the likelihood function LL(β) = $\sum_{n=1}^{N} \ln P_n(\beta)/N$, where $P_n(\beta)$ is the probability of the observed outcome for decision maker n, N is the sample size and β is a vector of parameters. At this maximisation point, the first derivative of this function will be equal to zero. The log-likelihood is always negative because the likelihood is a probability between 0 and 1 and the log of any number in this range is negative.

2.2.4 Statistical significance of model estimates

The maximum likelihood procedure allows the calculation of asymptotic standard errors for the β's in discrete choice models. The statistical significance of individual $\beta's$ is determined using the Wald statistic, this being equivalent to the asymptotic t-tests (Hensher et al.

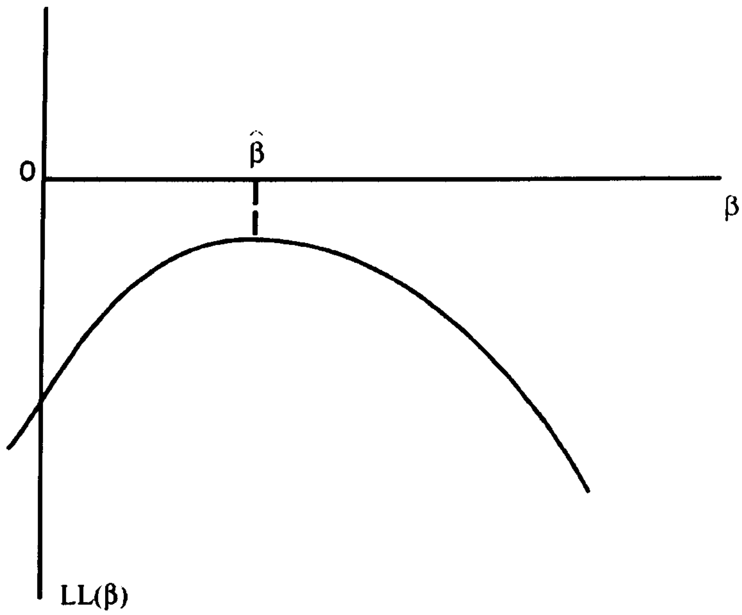


Figure 2.1: Maximum likelihood estimate (Adapted from (Train 2003))

2005a). The Wald statistic is denoted as:

$$\text{Wald} = \beta_i / s_i \tag{2.7}$$

where β_i and s_i are the parameter estimate and standard error for each attribute or alternative. If a 95 percent confidence level is assumed, then the critical Wald value is 1.96. Therefore, if the absolute value of the Wald statistic is greater or equal to 1.96, then the analyst can conclude that the parameter estimate is significant. Conversely, if the absolute value of the Wald statistic is less than the critical Wald value of 1.96, then the analyst can conclude that the explanatory variable is not statistically significant. There are many reasons why an attribute or alternative may not be statistically significant. These include (1) that the attribute may not have been an important influence of the choice under study, (2) the presence of outliers on some observations and (3) the existence of non-normality in the attribute's distribution which limits the usefulness of equivalent t-statistics (such as Wald tests) to establish levels of significance (Louviere et al. 2000).

2.2.5 Overall model significance, goodness of fit and model comparison

The log-likelihood function evaluated at the mean of the estimated utility parameters is a useful criterion for assessing overall goodness of fit when the maximum likelihood estimation method is used to estimate utility parameters of discrete choice models (Louviere et al. 2000). One of the measures which can be used is the likelihood ratio index, which is analogous to R^2 in ordinary regression (*ibid.*). This statistic measures how well the model with the estimated parameters (estimated model), performs compared with a model in which all the parameters are zero (base model). The likelihood ratio index is defined as:

$$\rho^2 = 1 - LL(\beta_e)/LL(\beta_b) \tag{2.8}$$

where ρ^2 is a type of R^2 (also called pseudo R^2) that is equal to 1 minus the value of the log-likelihood function at the estimated parameters $LL(\beta_e)$ and $LL(\beta_b)$ is its value when all the parameters are set to zero. The smaller the ratio $LL(\beta_e)/LL(\beta_b)$, the better the statistical fit of the model and hence the larger ρ^2 would be. Values of $\rho^2 = 0.2$ and 0.4 are considered to be indicative of extremely good model fits (Louviere et al. 2000).

Another statistical test that can be used to determine whether the overall model is statistically significant is the log-likelihood ratio test (LL Ratio test). The LL Ratio test is defined as follows:

$$\text{LLratiotest} = -2[LL(\beta_b) - LL(\beta_e)] \tag{2.9}$$

where $LL(\beta_b)$ is the restricted maximum value of the LL function under the null hypothesis (i.e. when all parameters are set to zero) and $LL(\beta_e)$ is the unrestricted maximum value of the LL function. The statistic is distributed chi-squared with degrees of freedom equal to the difference in the number of parameters estimated between the two models $(K_e - K_b)$, where K is the number of estimated parameters (Ben-Akiva & Lerman 1995, Wilks 1962). If the calculated value of chi-squared exceeds the critical value for the specified level of confidence, then the null hypothesis that the parameters being tested are equal to zero will be rejected (*ibid.*).

As long as the same choice variables are used and the same sample size remains constant, the likelihood ratio test can be used to compare two different discrete choice model specifications (i.e. provided that they are nested models (Cameron & Trivedi 2005, Hensher et al. 2005*a*). The same calculation as that in Equation 2.6 is used except that the log-likelihood of the base comparison model ($LL(\beta_b)$) is replaced by the largest absolute value of the log-likelihood of the two models under comparison. Therefore,

$$\text{LLratiotest} = -2[LL(\beta_{largest}) - (\beta_{smallest})]. \quad (2.10)$$

The degrees of freedom (which is equal to the critical χ^2 statistic) is calculated as the difference between the number of parameters estimated in the two models. Once the critical value of the chi-squared statistic is exceeded, the analyst can reject the null hypothesis that the new model does not statistically improve the LL of the previous model. In the case of non-nested models such as the latent class model, goodness of fit tests based on information criteria (e.g. AIC and BIC) should be used. These are described further in Section 2.5.2.

2.3 The multinomial logit model

The MNL model is the most widely used in the field of discrete choice modelling. Practitioners in discrete choice modelling have stated that the main reason for its popularity is due to the model's closed form specification which allows an increase in the ease and speed at which the model can be estimated[7]. The logit formula was originally derived by Luce (1959), further developed by Marschak (1960) and completed by McFadden (1974). As previously stated in Section 2.2.1, in a discrete choice model a decision maker n is faced with a choice among J alternatives. The utility U_{nj} of the decision maker is assumed to be divided into an observable portion V_{nj} which is estimated by the analyst and an unobserved portion ε_{nj} which is unknown to the analyst and therefore treated as random. This is expressed as:

$$U_{nj} = V_{nj} + \varepsilon_{nj}. \quad (2.11)$$

The multinomial logit model (MNL) is derived by assuming that the individual error terms ε_{nj} are independently and identically distributed and follow a Type 1 extreme value or

[7]See (Louviere et al. 2000) for a more exhaustive list of reasons why the MNL model is the most widely used amongst practitioners.

Gumbel distribution. A Gumbel distributed variable has a number of properties, one of which is that the cumulative distribution function for each unobserved component of utility can be expressed as:

$$F(\varepsilon_{nj}) = e^{-e^{-\varepsilon_{nj}}}. \tag{2.12}$$

Following McFadden (1974) and Train (2003), the logit probabilities are derived as follows: the probability that decision maker n chooses alternative i is:

$$\begin{aligned} P_{ni} &= \text{Prob}(V_{ni} + \varepsilon_{ni} > V_{nj} + \varepsilon_{nj}, \ \forall j \neq i) \qquad (2.13) \\ &= \text{Prob}(\varepsilon_{nj} - \varepsilon_{ni} < V_{ni} - V_{nj}, \ \forall j \neq i). \end{aligned}$$

Since the error terms (ε's) are independent, the cumulative distribution function over all J ($j \neq i$) is the product of the individual cumulative distributions. The final logit probability can be expressed as follows:

$$P_{ni} = \frac{e^{\beta' x_{ni}}}{\sum_j e^{\beta' x_{nj}}} \tag{2.14}$$

Another property of a Gumbel distributed variable is that the variance is $\pi^2/6$. As discussed in Section 2.2.2, the scale of utility should be normalised and the standard way of doing this is to normalise the variance of the error terms. The variance can be expressed as any number which is a multiple of $\pi^2/6$. So, for example, the variance can be also be expressed as $(\pi^2/6 \times \lambda^2)$. In order to normalise this value to $\pi^2/6$, the variance must be multiplied by $1/\lambda^2$ and the variance of the error term changes by $1/\lambda^2$ when the utility is multiplied by $1/\lambda$. Therefore, since normalising in this case requires multiplying the variance by $1/\lambda^2$, this is equivalent to multiplying the utility by $1/\lambda$. The value of λ is called the scale parameter and all β parameters are scaled by this value. Note that the scale parameter can not be separated from the β parameters:

The choice probability therefore becomes:

$$P_{ni} = \frac{e^{V_{ni}/\lambda}}{\sum_j e^{V_{nj}/\lambda}} \tag{2.15}$$

$U_{nj} = V_{nj} + \varepsilon_{nj}$ where variance of the error term can be expressed as $(\pi^2/6).\lambda^2$	$\equiv$ in this case, normalizing the variance of the error term requires multiplying by $1/\lambda^2$	$U_{nj} = 1/\lambda V_{nj} + 1/\lambda\varepsilon_{nj}$ where variance of the error term becomes $\pi^2/6$ which is equivalent to multiplying utility U_{nj} by $1/\lambda$

which is the same as equation 2.14, but with representative utility divided by the scale parameter λ. Assuming V_nj is linear in parameters with coefficients β^*, the choice probabilities become:

$$P_{ni} = \frac{e^{(\beta^*/\lambda)' x_{ni}}}{\sum_j e^{(\beta^*/\lambda)' x_{nj}}} \tag{2.16}$$

where the coefficients β^* have been scaled to reflect the variance of the unobserved component of utility. Since β^* and λ are not separately identified, the logit probability is usually expressed in its scaled form where $\beta = (\beta^*)/\lambda$. This gives the standard logit expression in equation 2.14.

The estimated β parameters indicate the effect of each observed variable relative to the variance of the unobserved factors. The ratio of any two coefficients is not affected by the scale parameter since it drops out of the equation; for example, $\beta_1/\beta_2 = (\beta_1^*/\lambda)/(\beta_2^*/\lambda) = \beta_1^*/\beta_2^*$, where the subscripts refer to the first and second coefficients.

The relation of the logit probability to representative utility is sigmoid or S shaped. This shape has implications for the impact of changes in explanatory variables. For example, if representative utility is very low or very high, compared to others, a small increase in utility of this alternative will not substantially affect its probability of being chosen. The point at which the increase in the representative utility has the greatest effect on the probability of being chosen is close to 0.5. This means that there is a 50-50 percent chance of each alternative being chosen. Therefore, a small increase in the utility of one alternative can 'tip' the balance in people's choices and induce a large increase in the probability of the alternative being chosen.

2.3.1 Limitations of the MNL model

IIA property and substitution

Despite the wide use of the MNL model, there are limitations of this model with respect to representing choice behaviour. One of the most widely known and hence discussed limitations is the independence of irrelevant alternatives (IIA) property which implies that logit models only allow a certain pattern of substitution. This property states that, for an individual, the ratio of the choice probabilities of any two alternatives, for example i and k, as shown in the following equation:

$$\begin{aligned} \frac{P_{ni}}{P_{nk}} &= \frac{e^{V_{ni}/\sum_j e^{V_{nj}}}}{e^{V_{nk}/\sum_j e^{V_{nj}}}} \\ &= \frac{e^{V_{ni}}}{e^{V_{nk}}} = e^{V_{ni}-V_{nk}} \end{aligned} \tag{2.17}$$

is entirely unaffected by the presence of attributes of any other alternative. The basic premise behind this property is that the relative odds of choosing i and k are the same no matter what other alternatives are available or what attributes of the other alternatives are (Train 2003). While the IIA property is an accurate representation of reality in some choice situations, it is implausible for alternative sets containing choices that are close substitutes (Chipman 1960, Debreu 1960, McFadden 1974). Therefore, this may lead to the prediction of counterintuitive and erroneous results.

An example of the effect of IIA property can be illustrated with the classic red bus/blue bus example. A commuter has the choice of going to work by car or taking a blue bus. For simplicity, the assumption is that the representative utility of the two modes are the same, such that the choice probabilities are equal to one:

$$\begin{aligned} P_{car} &= 1/2 \\ P_{bus} &= 1/2 \\ P_{car} + P_{bus} &= 1 \end{aligned} \tag{2.18}$$

Now suppose that another bus service is introduced that is equal in all attributes to the existing bus service except that the buses are painted differently. Under the IIA property, the ratio of choice probabilities is the same and the probabilities add up to one. Therefore the new choice probabilities will be as follows:

$$\begin{aligned} P_{car} &= 1/3 \\ P_{redbus} &= 1/3 \\ P_{bluebus} &= 1/3 \\ P_{car} + P_{redbus} + P_{bluebus} &= 1 \end{aligned} \tag{2.19}$$

This is unrealistic because the commuter will in reality be most likely to treat the two bus modes as a single alternative and behave with the following choice probabilities:

$$\begin{aligned} P_{car} &= 1/2 \\ P_{redbus} &= 1/4 \\ P_{bluebus} &= 1/4 \\ P_{car} + P_{redbus} + P_{bluebus} &= 1 \end{aligned} \tag{2.20}$$

This example shows that using the MNL model would lead to an overestimation of the probability of choosing a bus and an underestimation of the probability of choosing a car. As a result of this property, the model predicts that a change in the attributes of one alternative (or the introduction of a new alternative, or the elimination of an existing alternative) changes the probabilities of the other alternatives proportionately such that the ratios of probabilities remain the same. In general, the IIA property implies a certain pattern of substitution across the alternatives. If the substitution of alternatives actually takes place in the way the MNL model assumes, then the use of this model will be appropriate. On the other hand, to allow for more general patterns of substitution and to investigate which pattern of substitution is most accurate, more flexible models have to be used (such as generalised extreme value (GEV) models). The unifying assumption for this class of models is that the unobserved components of utility are jointly distributed as generalised extreme value. This distribution allows for correlation over alternatives. One of the most widely used GEV models is the nested logit model.

Panel nature of data

In stated discrete choice experiments, respondents are asked a series of questions which the analyst is able to observe. This type of data representing repeated choices is called panel data (Train 2003). The MNL model is able to capture dynamics that are related to observed factors. However, dynamics related to unobserved factors cannot be handled by MNL models since these factors are assumed to be unrelated over choices. This is a limitation of the MNL model since it is expected that if there are dynamics in the observed factors, then the analyst might expect dynamics in the unobserved factors as well (*ibid.*). One way to allow the unobserved factors to be correlated over time is use a probit model or mixed logit model which allows this correlation to be accounted for.

Taste variation

One implication of the IIA property is that the random elements in utility ε_{nj} are independent across alternatives and identically distributed (Louviere et al. 2000). As a result of this, the logit model can only be used to represent systematic taste variation (that is, taste variation that relates to observed characteristics of the decision maker or observed heterogeneity) but not random taste variation (differences in tastes that cannot be linked to observed characteristics or unobserved heterogeneity) (Train 2003). Put differently, unless systematic taste variation is accounted for, the logit model assumes homogeneity in preferences. Homogeneity yields a model where the values of the unknown parameters (β's) is the same for all members of the population represented by the sample. Therefore, this implies that all individuals share a common utility function (Milon & Scrogin 2002).

2.3.2 Taste (preference) heterogeneity

It has recently been highlighted by Louviere et al. (2002) that any variance in the random component of utility (or what many researchers call unobserved heterogeneity) may be better defined as unobserved variability. This is because there are many sources which can cause variance in the random component of utility and, therefore, not all of these sources can be attributed entirely to heterogeneity (observed or unobserved). This had been previously recognised by Manski (1977) who identified four sources of uncertainty[8] when modelling the random component of utility. Only one of these was due to differences in unobserved taste variation, or what is commonly called unobserved (taste) heterogeneity in environmental economics. For example, one source of variability which is scarcely identified by researchers comes from the confounding of the scale parameter with utility parameters[9] (§ Section 2.2.2). Other sources have been identified by empirical studies which systematically vary the random component with respect to a variety of factors under the researcher's control (such as task complexity) and which can therefore be taken into account (Swait & Adamowicz 2001*a*, DeShazo 2002). Chapter 5 reports the results of one such study while Chapter 4 reports the results of a study that captures unobserved heterogeneity due to taste variation. Observed and unobserved heterogeneity arising from taste variation will be discussed next.

As described in the Section 2.3.1, the MNL model assumes homogeneity in preferences (tastes). Incorrectly restricting preferences to be homogeneous when in fact preferences do vary across individuals will lead to biased parameter estimates for any specific individual (Breffle and Morey). Such biased parameter estimates have been shown to lead to different expected compensating variation estimates (*ibid.*). Therefore, accounting for taste heterogeneity can enhance the accuracy and reliability of parameter estimates. Additionally, several practitioners have recently shown that accounting for taste heterogeneity in valuations of public goods leads to an increase in the explanatory power of environmental preference models and provides relevant information to policymakers about the distribution of public preferences (Milon & Scrogin 2002). Examples of studies that show this include Scarpa & Thiene (2005), Scarpa, Willis & Acutt (2005) and Boxall & Adamowicz (2002).

Taste variation may be purely random (unobserved taste heterogeneity), or it may have a systematic nature (observed taste heterogeneity). Observed taste heterogeneity means

[8]These are (1) unobserved attributes, (2) unobserved taste variations, (3) measurement errors and (4) instrumental variables.

[9]One recent exception is a study by Scarpa & Thiene (2006) that identifies sources of variation arising from the scale parameter.

that the decision makers taste variation can be linked to some observed variable such as socioeconomic characteristics. In the case of unobserved taste heterogeneity, even though two decision makers may have identical observed variables, they can make different choices and therefore have different tastes. In the latter case, the most common approach used to capture observed taste heterogeneity is to interact observable socioeconomic characteristics with attributes of choice or an alternative specific constant. As described in Section 2.2.2 this specification allows these variables to enter the utility equation in such a way that they create differences in utility over the alternatives. Therefore, the main advantage of this technique is that the unknown parameters are allowed to vary over individuals in a systematic way according to these specified variables and so utility becomes a function of these specified variables. Examples of studies which use individual specific variables include (Morey 1981, Morey et al. 2002). There are two main limitations of using this method. The first is that they require *a priori* selection of key individual characteristics and can only involve a limited selection of individual-specific variables (Adamowicz et al. 1998). The second is that if too many interactions are specified, then multi-collinearity may occur (Breffle & Morey 2000) which could reduce the precision of the obtained estimates (Greene 1997).

The environmental economics literature has utilised two main approaches[10] for modelling unobserved and observed heterogeneity taste heterogeneity: latent classes (latent class models) and continuous distributions of taste (mixed multinomial logit models). These two modelling approaches are examined in the following sections.

2.4 The mixed multinomial logit model (MMNL)

The mixed multinomial logit model (MMNL) is one of the most flexible discrete choice models available to choice practitioners, thus allowing it to more accurately capture underlying choice behaviour (Gopinath et al. 2004). It addresses the three limitations of the multinomial logit model by allowing for (1) unrestricted substitution patterns, (2)

[10] Probit models can also be used but they only allow taste variation to be specified with a normal distribution

correlations in unobserved factors over time and (3) random taste variation (Train 2003) (Section 2.3.1). MMNL models have been used in a number of environmental valuation studies such as Carlsson et al. (2003), Shrestha & Alavalapati (2004). The MMNL model is used in this thesis primarily to capture unobserved taste heterogeneity (random taste variation) as described in Chapters 4 and 5.

2.4.1 Derivation of the MMNL model

The mixed logit model can be derived under a number of different specifications (as described in Section 2.4.1), each derivation providing a particular interpretation (Train 2003). The derivation presented here is based on Train (2003). MMNL models are based on mixed logit probabilities which are integrals of standard logit probabilities over a density of parameters and can be expressed as follows:

$$P_{ni} = \int L_{ni}(\beta) f(\beta) d\beta \tag{2.21}$$

where $L_{ni}(\beta)$ is the logit probability:

$$L_{ni}(\beta) = \frac{e^{V_{ni}(\beta)}}{\sum_{j=1}^{J} e^{V_{nj}(\beta)}} \tag{2.22}$$

and $f(\beta)$ is the density function. The mixed logit probability is a weighted average of the logit formula evaluated at different values of β, with the weights given by the density $f(\beta)$. The nomenclature underlying MMNL models comes from the statistics literature. In particular, a mixed function is the weighted average of several functions and the density that provides the weights is called the mixing distribution. Therefore, the mixed logit probability is a mixture of the logit function evaluated at different β with $f(\beta)$ as the mixing function. As further described in Section 2.5, the mixing function $f(\beta)$ can be specified to be continuous or discrete.

If the mixing function $f(\beta)$ is specified to be continuous and distributed according to a functional form with a mean b and covariance W as shown in equation 2.23. Examples of typical distributional forms that analysts specify include normal, log normal or triangular (Hensher & Greene 2003). The analyst then estimates the b and W:

$$P_{ni} = \int L_{ni}(\beta) f(\beta | b, W) d\beta \tag{2.23}$$

It should be noted that there are two sets of parameters in a MMNL model. Firstly, there are the parameters which enter the logit formula β_n and have density $f(\beta)$. Secondly, there are the parameters of β that describe this density, for example the mean b and covariance W of the density. For simplicity these parameters will be denoted by θ. Usually the goal is to estimate θ, that is the parameters which describe the distribution. Therefore, an alternative way to denote this density is $f(\beta|\theta)$. The mixed logit probabilities do not depend on the value of the parameters β which enter the logit probability and, like the error terms ε_{nj}'s, are integrated out. However, as described in Section 2.4.2, it is possible to obtain information about those β values for each sampled decision maker as well as the parameters that describe the distribution of β across decision makers by calculating individual-specific β estimates.

Alternative specifications of the MMNL model

The mixed logit formulation can be explored in two mathematically identical, yet conceptually different ways (Bastin et al. 2005, Koppelman & Bhat 2006, Train 2003). In particular, it can be generated from two specifications: (1) the error component specification which allows flexible substitution patterns across the alternatives to be achieved through the relaxation of the IIA property (2) the random parameter specification that accommodates taste heterogeneity (Koppelman & Bhat 2006). The error components specification is used mainly in studies where the goal is to realistically represent substitution patterns by specifying variables that can induce correlations in alternatives in a parsimonious fashion (Train 2003). Studies that adopt this latter approach include those done by Scarpa, Ferrini & Willis (2005), Brownstone & Train (1999) and are more concerned with prediction (*ibid.*). The studies done using the random parameter specification are more concerned with modelling the pattern of tastes by allowing each attribute's coefficient to vary over. These studies include Revelt & Train (1998), Train (1998), Bhat (1997). The MMNL models specified in Chapter 4 and 5 are based on the random parameter specification.

The MMNL model addresses the three limitations of the MNL model as follows. Firstly, it allows taste variation related to the observed attributes of the decision maker to be captured through the use of explanatory variables (observed taste variation) and through the mixing distribution (unobserved taste variation). In particular, observed heterogeneity can be accounted for by introducing an interaction between the mean estimate of a random parameter and a covariate. If the interaction is statistically significant then it can be concluded that there is the absence of observed preference heterogeneity. This does not imply that there is no preference heterogeneity around the mean, but that the analyst has not been able to reveal its presence based on his *a priori* assumptions. This then means that the analyst relies fully on the standard deviation of the parameter estimate, with the latter representing all sources of preference heterogeneity (Hensher & Greene 2003).

Through the relaxation of the IIA property, the MMNL model addresses the two other limitations of the MNL model. Firstly, through its error component specification, it allows correlation between the unobserved components of utility across choice situations or alternatives for the same individuals (Hensher & Greene 2003). As noted in Section 2.3.1, this is important for panel data as correlations are expected to exist over time between the choice situations presented to an individual. It is also important in stated discrete choice experiments since, if the observed components are correlated, then it is expected that the unobserved components are correlated as well. This correlation can stem from many sources including, amongst others, the commonality of socioeconomic variables that do not vary across the choice situations for a sampled individual and the sequencing of choice situations that can result in learning and inertia effects (Hensher & Greene 2003). Secondly, the relaxation of the IIA property also allows flexible substitution patterns as the analyst can draw more from one alternative than another without the limitation of proportional substitution as required by the MNL model.

Random parameter specification

Using the random parameter specification the decision maker n faces a choice among J alternatives. The utility that the decision maker n from alternative j can be specified as:

$$U_{nj} = \beta_n' x_{nj} + \varepsilon_{nj} \tag{2.24}$$

where x_{nj} is a vector of observed variables that relate to alternative j and to decision maker n; coefficient vector β_n is unobserved for each n and represents the decision maker's tastes which varies in the population with density $f(\beta_n)|\theta)$ where θ are the parameters of this distribution, and ε_{nj} is an unobserved random term that is distributed IID extreme value, independent of β_n and x_{nj}. The goal is to estimate θ that is the population parameters which describe the distribution.

The decision maker knows the value of his own β_n and (ε_{nj}'s) for all j and chooses alternative i if and only if $U_{ni} > U_{nj}$ for all $j \neq i$. The analyst observes (x_{nj}'s) but not (β_n) or the (ε_{nj}'s). If the analyst observed β_n, then the probability that decision maker n chooses alternative j could be expressed as the standard multinomial logit model (i.e. the probability would be conditional on (β_n)):

$$L_{ni}(\beta_n) = \frac{e^{\beta_n' x_{ni}}}{\sum_j e^{\beta_n' x_{nj}}} \tag{2.25}$$

However, the researcher does not observe the actual tastes β_n, and so cannot condition the probability values on β. Therefore, an assumption that the decision maker's tastes follow a particular distribution is made in order to estimate β_n with density $f(\beta \mid \theta)$. The unconditional choice probability is therefore the integral of $L_{ni}(\beta_n)$ over all possible values of β_n, which gives the mixed logit probability:

$$P_{ni} = \int \left(\frac{e^{\beta' x_{ni}}}{\sum_j e^{\beta' x_{ni}}} \right) f(\beta) d\beta \tag{2.26}$$

The β values (unknown preference parameters) vary in the population (based on some assumed distribution) as opposed to being fixed as in the MNL models. The variance in β induces correlation in utility over attributes. In particular, the coefficient vector for each decision maker can be expressed as the sum of the population mean b and standard deviation s. The standard deviation of the parameter β represents the individual's tastes relative to the average tastes of the population and thereby accommodates the presence of unobserved preference heterogeneity in the sampled population (Hensher & Greene 2003).

Error components specification

The mixed logit model can also be interpreted as an error components specification. The error components structure partitions the random term associated with utility into two components: one component which allows for unobserved error terms to be non-identical and non-independent across alternatives, and the other which is specified to be IID type 1 extreme value distributed across alternatives. Consider that utility is specified as:

$$U_{nj} \quad = \quad \beta_n' x_{nj} + [\mu_{nj}' z_{nj} + \varepsilon_{nj}] \tag{2.27}$$

where x_{nj} and z_{nj} are vectors of observed variables relating to alternative j; β_n is a vector of coefficients which are fixed over people and alternatives; μ_{nj} is a vector of random terms with zero mean and ε_{nj} is IID extreme value and does not depend on underlying parameters or data and is normalised to set the scale of utility. The term μ_{nj} induces heteroscedasticity and correlation across unobserved utility components of the alternatives. That is, the unobserved (random) component of utility $[\mu_{nj}' z_{nj} + \epsilon_{nj}]$, can be correlated over alternatives depending on the analyst's specification of z_{nj}. In the MNL model, z_{nj} is identically zero which means that there is no correlation in utility over the alternatives leading to restrictive substitution patterns. The emphasis in the error components model is to allow a flexible correlation patterns, and hence substitution patterns among alternatives in a parsimonious fashion (Bhat 2001). This is achieved by the appropriate specification of z_{nj} and μ_{nj}.

2.4.2 Individual-specific estimates

As noted in Section 2.4.1, the MMNL model allows the distribution of tastes in the population to be identified. In addition, the MMNL model also allows the identification of the distribution of tastes in the subpopulation of people who make particular choices (Train 2003). These estimates are called 'individual-specific' or 'conditional' since they are derived based on the individual's known (within-sample) choices (Train 2003).

Denote the random coefficients as vector β. The distribution of β in the population of all people can be denoted by $g(\beta|\theta)$, where θ are the parameters of this distribution. It is known that a choice situation consists of several alternatives which can be described collectively by the variables x. Consider if everyone in the population were to face the same choice situation described by the same variables x. For every alternative, some portion of the population would have chosen that alternative. Consider the portion of the population who chose alternative i. Within this portion of the population, even though all the persons in this subpopulation chose alternative i, their tastes would differ. Therefore, the assumption can be made that there is a distribution of coefficients among subpopulation. This will therefore be a distribution of β which can be denoted by $h(\beta|i, x, \theta)$ which represents the distribution of β in the subpopulation of people who would choose alternative i when facing the choice situation as described by x. $g(\beta|\theta)$ can be used to describe the distribution of β in the entire population.

To allow for consideration of repeated choices made in stated discrete choice experiments, y can be denoted as a *sequence of choices* in a series of situations which are described collectively by variables x. Therefore, the distribution of coefficients in the subpopulation of people who make the sequence of choices y when facing choice situations as described by x can be denoted by $h(\beta|y, x, \theta)$. $h(\cdot)$ conditions y and is called the conditional distribution while $g(\cdot)$ does not and is called the unconditional distribution (§ Figure 2.2). Since it has been observed that the person made choice y when facing choice situations described by x, then it is known that the decision maker's coefficients are in the distribution $h(\beta|y, x, \theta)$. Since h represents a narrower range than g, the analyst has obtained better information about the person's tastes by conditioning on his past choices and thus producing

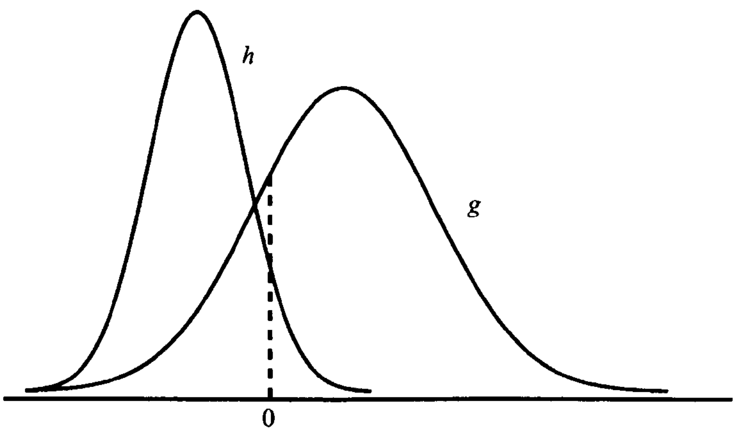


Figure 2.2: Unconditional (population) distribution (g) and conditional (subpopulation) distribution (h) (Train 2003)

individual-specific estimates.

The derivation of the conditional distribution is described following Train (2003). Considering a choice among alternatives $j = 1, \ldots, J$ in choice situations $t = 1, \ldots, T$. The utility that decision maker n obtains from alternative j in situation t is:

$$U_{njt} = \beta_n' x_{njt} + \varepsilon_{njt} \tag{2.28}$$

where ε_{njt} is distributed IID extreme value, and β_n is distributed $g(\beta|\theta)$ in the population. The variables (x_{njt}) can be denoted collectively for all alternatives and choice situations as x_n. Let $y_n = \langle y_{n1}, \ldots, y_{nT} \rangle$ denote the decision makers's sequence of chosen alternatives. Since we do not know β_n, the probability of the decision maker's sequence of choice is the integral of $P(y_n|x_n, \beta)$ over a distribution of β. This is the mixed logit probability described in Section 2.4.1 with respect to the subpopulation who chose y_n.

$$P(y_n|x_n, \theta) = \int P(y_n|x_n, \beta) g(\beta|\theta) d\beta \tag{2.29}$$

Bayes' rule is used in order to derive the conditional estimates which represents the distribution of coefficients in the subpopulation of people who would have made the sequence of choices y when facing situations described by x $h(\beta|y_n, x_n, \theta)$, Bayes' rule states that the conditional probability of A given B $[P(A|B)]$ (that is the probability of A depends on a specified value of B) is equal to the conditional probability of B given A $[P(B|A)]$ multiplied by the marginal or prior probability of A $[P(A)]$ (it does not take into account any information from B). This is divided by the probability of B $[P(B)]$ which is the marginal probability or prior and acts as a normalizing constant. This conditional probability $[P(A|B)]$ is proportional to the likelihood of A, given fixed B:

$$P(A|B) = \frac{P(B|A)P(A)}{P(B)} \propto L(A|B)P(A) \tag{2.30}$$

Following this rule, the density of β in the subpopulation (of people who would choose y_n, when facing x_n) is proportional to the density of β in the entire population multiplied by the probability that y_n would be chosen if the person's coefficients were β.

$$h(\beta|y_n, x_n, \theta) = \frac{P(y_n|x_n, \beta)g(\beta|\theta)}{P(y_n|x_n, \theta)} \tag{2.31}$$

The mean β in the subpopulation of people who would choose y_n when facing x_n is:

$$\bar{\beta}_n = \int \beta \cdot h(\beta|y_n, x_n, \theta)d\beta \tag{2.32}$$

Substituting the formula for h and using equation 2.31 and 2.29

$$\begin{aligned}\bar{\beta}_n &= \frac{\int \beta \cdot P(y_n|x_n, \beta)g(\beta|\theta)d\beta}{P(y_n|x_n, \theta)} \\ &= \frac{\int \beta \cdot P(y_n|x_n, \beta)g(\beta|\theta)d\beta}{\int P(y_n|x_n, \beta)g(\beta|\theta)d\beta}\end{aligned} \tag{2.33}$$

The integrals in equation 2.33 do not have a closed form and has to be estimated using simulation. These estimates can be used to calculate individual-specific WTP values as described in section 2.6.2

2.4.3 Estimation

The choice probability in equation 2.26 cannot be calculated exactly because the integral does not have a closed form. The integral is therefore estimated through simulation.

Consider that the analyst specifies the functional form $f(\cdot)$ and wants to estimates the parameters θ. In order to approximate the probabilities through simulation for any value of θ, first a value of β is drawn from $f(\beta|\theta)$, and this is labelled as β_r referring to the first draw. Secondly, the logit formula $L_{ni}(\beta^r)$ is calculated with this draw. Finally, the first and second steps are calculated many times and the results are averaged. This average is the simulated probability:

$$\check{P}_{ni} = \frac{1}{R}\sum_{r=1}^{R} L_{ni}(\beta^r) \tag{2.34}$$

where R is the number of draws; $\check{P}_{ni}$ is an unbiased estimator of P_{ni} by construction. The simulated probabilities are inserted into the log likelihood function to give a simulated log likelihood (SLL):

$$\text{SLL} = \sum_{n=1}^{N}\sum_{j=1}^{J} d_{nj}\ln\check{P}_{nj} \tag{2.35}$$

where $d_{nj} = 1$ if n chose j and zero otherwise. The values of the maximum likelihood estimator is the value of θ that maximises the SLL. This description does not include the simulation process for individual-specific WTP estimates. The simulation for the individual-specific estimates is achieved by weighting draws from the distribution dependent on the alternative chosen by the subpopulation. This is described in further detail in Train (2003).

2.4.4 MMNL model specification issues

There are a number of important issues which were considered when estimating the mixed logit models in Chapters 4 and 5. These are discussed in the following sections.

2.4.5 Selecting the random parameters

The selected random parameters define the degree of unobserved taste heterogeneity through the standard deviation of the parameters and observed taste heterogeneity (if they are specified) through interactions between mean parameter estimates and deterministic segmentation criteria (e.g. socioeconomic variables) (Hensher et al. 2005*a*). They are also the basis for accommodating correlation across alternatives and across choice situations (*ibid.*). To assist in the establishment of candidate random parameters, two methods have been suggested. The first method utilises the Lagrange multiplier tests (Brownstone & Train 1999) whereby artificial variables associated with each attribute are introduced in an MMNL model. The model is then re-estimated and the artificial variables that have estimates significantly different from zero will have their associated attribute specified as random. The second method is to assume all parameters are random and then examine their standard deviations using a t-test for the individual parameters or a likelihood ratio test to establish the overall contribution of the additional specification of the random parameters (Hensher et al. 2005*a*). However, as noted by Revelt & Train (1998), when all the coefficients are allowed to vary in the population, identification of the random parameters tends to be difficult since the MMNL model does not converge within a reasonable number of iterations. The latter method was used in selecting the random parameters in Chapters 4 and 5.

2.4.6 Distribution of the random parameters

The choice of the distributional assumptions of the random parameters is not straightforward (Kjaer 2005). The selected random parameters can take a number of predefined functional forms, the more popular being the normal, triangular, uniform and lognormal distributions (Hensher & Greene 2003). The distribution most commonly used in MMNL models is the normal distribution. The normal distribution is symmetrical around the mean and specifying a given coefficient to follow a normal distribution is equivalent to making an *a priori* assumption that both positive and negative values for this coefficient may exist in the population (Hess et al. 2005). The lognormal distribution, is the most common choice of distribution for coefficients with an explicit sign assumption. One such attribute is cost which is known to be negative for everyone (Train 2003). In the uniform distribution, β is distributed uniformly between $b - s$ and $b + s$, where the mean b and spread s are estimated. The triangular distribution has a positive density that starts at $b - s$, rises linearly to b, and then drops linearly to $b + s$, taking the form of a triangle. In the uniform distribution, the mean b and spread s are also estimated but the density is flat instead of peaked.

In practice, each distribution has strengths and weaknesses (Hensher et al. 2005*a*). The weakness is usually associated with the standard deviation of the distribution at its extremes including behaviorally unacceptable sign changes for the symmetrical distributions (*ibid.*). The lognormal has a long upper tail while the normal, triangular and uniform may give the wrong sign for some parameters (*ibid.*). These densities for the triangular and uniform distributions have the advantage of being bounded on both sides, thereby avoiding the problem that can arise with normals and lognormals having unreasonably large coefficients for some share of decision makers (Train 2003). In addition, constraining a uniform or triangular distribution so that $s = b$ enables the analyst to ensure that the coefficients have the same sign for all decision makers (*ibid.*). The random parameters presented in Chapters 4 and 5 are specified with normal distributions and constrained triangular for the cost attributes.

2.4.7 Selecting the number of points for simulation

The numerical methods used to evaluate multi-dimensional integrals can be categorised into three broad groups: (1) multi-dimensional polynomial-based cubature methods, (2) Monte Carlo simulation methods and (3) quasi-Monte carlo simulation methods (the Halton method) (Bhat 2001). Bhat (2001) showed that the latter method has outperformed the polynomial-based cubature methods and Monte Carlo simulation methods for a mixed logit model estimation. The basic idea behind the Monte Carlo simulation method is that evaluating multidimensional integrals entails computing the integrand at a sequence of 'random points' and computing the average of the integrand values. The Halton method is similar to the Monte-Carlo method in that it evaluates a multi-dimensional integral by replacing it with an average of values of the integrand computed at discrete points. However, rather than using pseudo random sequences for the discrete points, the Halton method uses 'cleverly' crafted non-random and more uniformly distributed sequences within the domain of integration. The result is that the Halton method achieves more precise results with fewer draws (Train 1999). This is illustrated in Figures 2.3 where even with 1000 draws, the pseudo random sequences leave noticeable holes in the unit square, while the Halton sequence gives very uniform coverage.

The number of draws required to secure a stable set of parameter estimates varies (Hensher

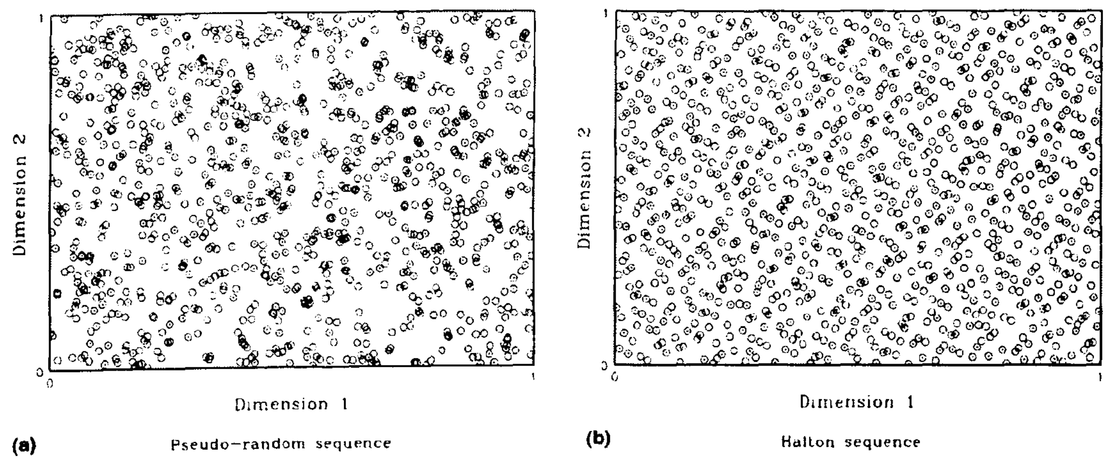


Figure 2.3: 1000 draws in two dimensions from the uniform distribution (Bhat 2001)

et al. 2005*a*). In general, it appears that model specification becomes more complex in terms of the number of random parameters and the number of required draws increases for a given type of draw (*ibid.*). The best test however is to estimate models over a range of draws (e.g. 25, 50, 100, 250, 1000 and 2000) for confirmation of model stability and precision of estimates (*ibid.*). For the MMNL models in Chapters 4 and 5, 300 Halton draws provided the most stable models.

2.5 The latent class model (LCM)

As noted in section 2.4.1 a mixing distribution can also be discrete, with β taking a finite set of distinct values. In this case, the mixed logit model becomes the latent class model (Train 2003). The latent class model simultaneously classifies decision makers into segments and predicts their choice behaviour conditional on segment membership (Swait & Sweeney 2000, Swait 1994). Each latent class is unique, therefore accounting for the variation in taste (unobserved or observed heterogeneity) across the population. Researchers in the marketing field have long recognised that the ability to estimate choice probabilities based on market segments produces results which are actionable and directly relevant to decision making (Swait & Sweeney 2000, Swait 1994). In turn, researchers in environmental economics have applied this principle and used latent class models to determine if public preferences for non-market goods can also be characterised by segmentation. To date there have been several studies which have shown that this segmentation helps to provide more relevant information to policy makers to improve the management of environmental resources (see studies by (Scarpa & Thiene 2005, Kemperman & Timmermans 2006, Milon & Scrogin 2006)). The results reported in Chapter 4 are an example of the usefulness of the latent class model to formulate policies based on the preferences of the identified segments within the subsample of beach recreationists.

2.5.1 Derivation of the latent class model

In the latent class model, an assumption is made that there are S (unknown) classes or segments in the population, $(s = 1, \ldots, S)$. Each segment is characterised by its own unique and homogeneous-within-segment tastes (β_s) (Train 2003, Swait 2006). The assumption here is that observed or unobserved taste heterogeneity (taste variation) is accounted for and adequately captured by the discrete classes (Dillon et al. 1994, Sarbo et al. 1997). The decision maker's choices are observed but their class membership is not observed (i.e. it is latent (Swait 2006)). As a result of this, the latent class model is comprised of two components. The first is a choice model conditional on class membership and the second is a class membership model (*ibid.*). The derivation of the latent class model following (Swait 1994, 2006) follows.

The utility function for decision maker n's choice, among J alternatives, given that the decision maker belongs to segment s can be expressed as:

$$U_{nj|s} = \beta_s x_{nj} + \varepsilon_{nj|s} \tag{2.36}$$

where x_{nj} is comprised of the attributes that appear in the utility functions, and β_s is a segment specific parameter vector. The $\varepsilon_{nj|s}$ represents the random variation for decision maker n. Under the assumption that decision makers are utility maximisers and conditional on segment membership, decision maker n will choose alternative j if and only if $U_{nj|s} \geq U_{ni|s}$, $j \neq i$. By assuming that the random error terms ε_{nj} are IID and follow a Type 1 extreme value distribution[11], the probability that decision maker n belonging to segment s

[11]Any random utility model that assumes a Gumbel error terms will have an embedded scale factor. The

will choose alternative j is therefore given by:

$$P_{nj|s} = \frac{e^{\beta_s x_{nj}}}{\sum_J e^{\beta_s x_{nj}}} \tag{2.37}$$

This gives the first choice model which is conditional on class membership where within class choice is characterised by the IIA property inherent to the MNL model.

Secondly, the class membership model is developed. In order to predict an individual's membership in a segment, an unobservable latent segment membership likelihood function (Y^*_{ns}) is used and can be defined as follows:

$$Y^*_{ns} = \Gamma'_s Z_n + \nu_{ns}, s = 1, \ldots, S \tag{2.38}$$

where Z_n is a vector of individual decision maker variables (such as socioeconomic, attitudinal, perceptions) that affect classification probabilities; Γ'_s is a segment-specific parameter vector; and ν_{ns} is a stochastic error term. A conceptual definition of Y^*_{ns} is that it is a latent factor score that determines the likelihood of decision maker n being in segment s. The rule for class membership assignment is to place decision maker n in segment s iff Y^*_{ns} is larger than the factor scores for all other classes :

$$Y^*_{ns} \geq \max\{Y^*_{ns'}\}, s' \neq s, s' = 1, \ldots, S \tag{2.39}$$

Since membership likelihood functions are random terms, a distribution must be specified in order to make probabilistic statements concerning the occurrence of an event involving the functions. Assuming that the error terms (ν_{ns}) are independent across segments and identically distributed Gumbel, the probability function for segment membership Q_{ns} becomes:

$$Q_{ns} = \frac{e^{\Gamma'_s Z_n}}{\sum_S e^{\Gamma'_s Z_n}} \tag{2.40}$$

scale factor is not identifiable and set to 1 in order to estimate the taste parameters (β_s) (Swait & Adamowicz 2001*b*).

where Z_{ni} is the aforementioned set of observable characteristics such as psychometric (i.e. responses to attitudinal and perceptual survey questions) or sociodemographic variables. These variables are indicators (observable to the analyst) of latent factors (unobservable) that can enter the membership likelihood function Y_{ns} and be used to classify individuals into segments (Ben-Akiva et al. 2002). Studies which used psychometric and socioeconomic variables in the specification of their latent class models, and thereby capturing observed taste heterogeneity, include those by Boxall & Adamowicz (2002), Morey et al. (2006), Milon & Scrogin (2006). In the latent class model specified in Chapter 4, no such observed characteristics enter the model and therefore only unobserved taste heterogeneity was captured here. As explained by Hensher & Greene (2003), this means that the only elements in Z_i would be the constant term, 1, and the latent class probabilities would be simple constants which, by construction, sum to one.

In order to derive a model that accounts for choice and segment membership, the two components in equations 2.37 and 2.40 are estimated simultaneously via the latent class model:

$$P_{njs} = P_{nj|s}.Q_{ns} \tag{2.41}$$

which gives the joint probability P_{njs} that decision maker n belongs to segment s and chooses alternative j is:

$$P_{njs} = \left[\frac{e^{\beta_s x_{nj}}}{\sum_J e^{\beta_s x_{nj}}}\right]\left[\frac{e^{\Gamma_s' Z_n}}{\sum_S e^{\Gamma_s' Z_n}}\right] \tag{2.42}$$

Therefore, the marginal probability of observing decision maker n in segment s choosing alternative j is:

$$P_{nj} = \sum_{s=1}^{S}\left[\frac{e^{\beta_s x_{nj}}}{\sum_J e^{\beta_s x_{nj}}}\right]\left[\frac{e^{\Gamma_s' Z_n}}{\sum_S e^{\Gamma_s' Z_n}}\right] \tag{2.43}$$

where the probability of selecting alternative j is equal to the sum over all latent classes s of the class-specific membership model conditional on class $P_{nj|s}$, multiplied by the probability of belonging to that class Q_{ns}. The values of β for each segment and the probability of membership are estimated by simulation as described by Swait (1994).

Two additional points relevant to the latent class model are worth highlighting here. Firstly, as noted by Swait (1994), it is not possible to simultaneously estimate the β values and the scale factors for each segment. Instead, the scale parameter is normalised for every segment (typically to 1) and the β parameters are estimated. This essentially reflects the hypothesis that taste parameters differ between latent segments, but that they have equal variances of the error terms. An alternative hypothesis is that taste is homogenous across the groups, but they are heterogeneous in terms of error variance. In this case, this heterogeneity is captured in the different variances of the error terms, and hence the different scales.

The second noteworthy point is that the IIA property is not assumed across segments, even though this property applies to the error terms of the two multiplied factors of equation 2.41. Recall from equation 2.17 that the ratio of two choice probabilities in the MNL is independent of the probabilities of other alternatives. However, in the LCM model, the ration of two choice probabilities does not cancel out the $\sum_J e^{\beta_s x_{nj}}$ term from the numerator and denominator as a summation over both the numerator and denominator is required for each segment. Therefore, the c hoice probability of choosing an alternative is no longer independent of the probability of choosing another alternative.

2.5.2 Determining the number of segments

In a latent class model, successive models are estimated with varying numbers of segments and statistical tests based on information criteria are used to help compare different models. Such tests include Akaike Information Criterion (AIC), Akaike Information Criterion three (AIC-3) and Bayesian Information Criterion (BIC) where the model with the smallest information criterion is preferred. These statistics are based on the principle that there exists tension between the model fit, which is measured by the maximised log likelihood value, and the principle of parsimony that favours a simple model. The fit of the model can be improved by increasing model complexity (Cameron & Trivedi 2005). However, parameters are only added if the resulting improvement in fit sufficiently compensates for loss of parsimony (*ibid.*). Different information criteria vary in how steeply they penalise model complexity. The AIC, AIC-3 and BIC Criteria are calculated as follows:

$$\begin{aligned} AIC &= -2(LL - K) \\ BIC &= -LL + (K/2) * \ln(N) \\ AIC - 3 &= -3(LL - K) \end{aligned} \tag{2.44}$$

where K is the number of estimated parameters, N is the number of individuals in the sample and LL is the log likelihood of the model. All such tests (AIC, AIC-3 and BIC) are useful guides, but often suggest different values for each model estimated against a different number of segments (Sarbo et al. 1997). As there is no clear answer as to which criterion should be preferred, the number of segments should be determined through a combination of statistical information and interpretation of the model results (Walker & Jieping 2007). In Chapter 4, the results of the AIC-3 and AIC suggested that the 3-segment model was superior for the given data, while the BIC suggested that the 2-segment model was superior. The 2-segment model was selected because in examining the estimation results it was found that in the 3-segment model, the fee parameter was negative for one of the classes and the parameter estimates were insignificant.

2.5.3 Individual-specific estimates from the LCM model

The β estimates and probability of membership derived in the LCM model assume homogeneity within each segment and heterogeneity across segments. It is possible to calculate the probability of an individual being in a segment conditional on the particular choices made by that individual. Given the probability of class membership Q_{ns} and the observed (sequence) of choices of an individual, Bayes' theorem can be used to derive an individual-specific set of probabilities ($Q*_{ns}$) (*Nlogit 3.0 reference guide* 2002, Scarpa & Thiene 2005). This is an $(n \times s)$ matrix of probabilities that describes the probability of each n belonging to segment s based on the choices made by n.

2.6 Economic welfare measurement in discrete choice models

The parameter estimates derived from discrete choice models can be used to give a measure of welfare, that is, the amount that individuals are willing to pay for quality or quantity changes (Louviere et al. 2000). This is important since the main objective of discrete choice experiments in the field of environmental valuation is to understand the economic impact of changing attributes and/or alternatives and their associated policy implications. In Chapter 4, the welfare measures calculated give an indication of: (1) the marginal WTP values for each attribute (2) the individual-specific WTP values for each attribute and (3) the compensating variation (CV), that is the WTP per day for a beach visit after a quality improvement. These will be discussed in the following sections.

2.6.1 Marginal WTP

The parameter on the cost attribute can be interpreted as the marginal utility of income and therefore dividing any attribute parameter by this value gives an 'implicit price', which can be interpreted as a marginal WTP value (Hanley et al. 2003). The WTP for a unit change in a certain attribute j can therefore be computed as the negative of the ratio of j's β coefficient divided by the coefficient on the cost variable β_{cost} (marginal utility of income):

$$WTP = \beta_j / \beta_{cost} \tag{2.45}$$

2.6.2 Individual-specific WTP

Using the individual-specific or conditional estimates described in Section 2.4.2 and 2.5.3 for the MMNL and LCM models respectively, individual-specific WTP estimates can also be calculated. As shown in the previous section, the estimation of WTP values can be done by taking the ratio of a non-price attribute and the price attribute.

Individual-specific WTP estimates from the MMNL model

In MMNL models, if the two parameters used in deriving WTP are estimated as non-random parameters, then equation 2.45 can be used. However, if one of the parameters to be estimated is random, then the WTP calculations must take this into account. The distribution obtained in calculating the ratio of these parameters may be discontinuous. In particular, if the distribution in the denominator has a zero value, then this ratio will have a singularity and therefore an infinite variance and mean. Therefore, the WTP estimates are usually calculated using simulated values from the chosen distributions. If X_1 is a random draw from the distribution of an attribute with mean β_i and standard deviation σ_i and X_2 is a random draw from the cost distribution C with mean β_c and standard deviation σ_c, then the WTP for that draw is calculated as $(\beta_i + X_1\sigma_i)/(\beta_c + X_2\sigma_c)$. This is repeated for several draws with the resulting set of WTP values having their own mean and standard deviation.

Sillano & Ortuzar (2005), Greene et al. (2005), Scarpa et al. (2007) adopt an alternative procedure to estimate WTP based on individual-specific level parameters. This approach could be seen as more accurate as the distribution of taste is identifiable in the data for a particular individual rather than being an averaging of all the population as would be done when deriving the unconditional WTP values (Hensher et al. 2005a). This approach is also used in Chapters 4 and 5 for calculating the WTP estimates. Using equation 2.33, the estimator for the WTP for an attribute is obtained by finding the ratio of that attribute's distribution and the cost distribution weighted by the likelihood function:

$$E[WTP^n_{att}] = \frac{\int \frac{\beta^n_{att}}{\beta^n_{cost}} \cdot P(y_n|x_n,\beta)g(\beta|\theta)d\beta}{\int P(y_n|x_n,\beta)g(\beta|\theta)d\beta} \tag{2.46}$$

This can be approximated by simulation using R draws, this thereby ensuring the WTP estimates are obtained conditional on the sequence of observed responses y_n and observed attribute values x_n for each decision maker:

$$E[WTP^n_{att}] = \frac{\frac{1}{R}\sum_R \frac{\beta^n_{att}}{\beta^n_{cost}} \cdot L(\bar{\beta}^n_r|y_n,x_n)}{\frac{1}{R}\sum_R L(\bar{\beta}^n_r|y_n,x_n)} \tag{2.47}$$

where $L(\cdot)$ is the logit probability conditional on the individual set of responses.

Individual-specific WTP estimates from the LCM model

The marginal WTP estimates in the LCM model are calculated using the individual-specific probabilities of membership described in Section 2.5.3. The individual-specific posterior estimates of the marginal WTP (as derived in (Scarpa & Thiene 2005)) are calculated as:

$$WTP_{n,att} = \sum_{S} Q^{*}_{ns}\left(-\frac{\beta_{s,att}}{\beta_{s,cost}}\right) \tag{2.48}$$

where Q^{*}_{ns} is the probability of membership for of decision maker n in segment s and $\beta_{s,att}$ and $\beta_{s,cost}$ are the β estimates for attribute (att) and the cost respectively in class s. Individual-specific estimates from an LCM model specification are calculated in Chapter 4 for a snorkeller group.

2.6.3 Compensating variation

To examine the monetary impact of a quality change, one could compare the situation before and after the change following Louviere et al. (2000), Train (2003):

$$V_n^0 = \beta(x_n^0) + \alpha(C) = \beta(x_n') + \alpha(C + CV) = V_n^1 \tag{2.49}$$

where V_n^0 is the representative component of utility before the change, V_n^1 is the representative component of utility after the change of attribute x from level x_n^0 to x_n^1 and α is the coefficient of the cost attribute (C) interpreted as the marginal utility of income. The economic welfare impact of change from x_n^0 to x_n^1 is the price increase or compensating variation[12] (CV) that makes a decision maker (n) as well off in the original situation as they will be under the quality improvement. Therefore, the analyst has to find the value of CV that solves this expression. If the decision maker is known to definitely choose an alternative, then the CV can be calculated from the attribute changes to this alternative. The choice of an alternative is probabilistic in a discrete choice model as there is a component of utility (U_{nj}) that is not observed (ε_{nj}). From the analyst's perspective an assumption on the distribution of (ε_{nj}) can be made and therefore the expected value of the compensating variation can be calculated (Train 2003, Louviere et al. 2000, Bockstael & McConnell

[12] Compensating Variation in discrete choice models is defined as the amount of money taken from income that will equate the utility of the preferred choice after the change in quality with the utility of the preferred choice before the change (Bockstael & McConnell 2007).

2007)[13]:

$$E(CV_n) \;=\; \frac{1}{\alpha_n} E[\max(V_{nj} + \varepsilon_{nj}\ \forall j)] \tag{2.50}$$

where the expectation is over all possible values of ε_{nj} and α_n is the marginal utility of income. As noted Train (2003), it was previously shown by Small & Rosen (1981) and Williams (1977) that if each error term (ε_{nj}) is IID extreme value and utility is linear in income (so that α_n is constant with respect to income), then this expectation becomes:

$$E(CS_n) \;=\; \frac{1}{\alpha_n} \ln\left(\sum_{j=1}^{J} e^{V_{nj}}\right) + K \tag{2.51}$$

where K is the unknown constant that represents the fact that absolute utility cannot be measured and $E(CS_n)$ is the average consumer surplus in the population who have the same representative utilities as decision maker n. The total consumer surplus in the population is calculated as the weighted sum of $E(CV_n)$ over a sample of decision makers, with the weights reflecting the numbers of people in the population who face the same representative utilities as the sampled decision maker. Therefore, a change in the initial conditions of V^0 to new conditions V^1 can be expressed as:

$$\Delta E(CV_n) \;=\; -\frac{1}{\alpha_n}\left[\ln\left(\sum_{j=1}^{J^1} e^{V^0_{nj}}\right) - \ln\left(\sum_{j=1}^{J^0} e^{V^1_{nj}}\right)\right] \tag{2.52}$$

where $E(CV_n)$ is calculated twice: first under the conditions, before the change and again under the conditions after the change. The number of alternatives or attributes of the alternatives can change. In Chapter 4, V^0 represented the level of utility of the attributes in their current state and V^1 is the level of utility after the attributes were changed to the maximum improvement possible as defined in this survey. The unknown constant K drops out of equation 2.52 because it enters expected consumer surplus before and after the change. The marginal utility of income α_n can be derived from the discrete choice model

[13]Expected value of CV is the expected value of CV conditioned on an event, weighted by the probability that the event occurs, and summed over all possible events (Bockstael & McConnell 2007).

where a cost variable enters representative utility.

The CV can also be calculated conditional on the choices made by the decision maker using the individual-specific estimates calculated for the LCM and MMNL models. The CV in the LCM model based on the conditional estimates from this model is calculated by weighting equation 2.52 with the choice probabilities of segment membership as described in Section 2.5.3:

$$\Delta E(CV_n) = -\sum_{S} Q^*_{ns} \frac{1}{\alpha_{ns}} \left[\ln \left(\sum_{j=1}^{J^1} e^{V^0_{nj}} \right) - \ln \left(\sum_{j=1}^{J^0} e^{V^1_{nj}} \right) \right] \tag{2.53}$$

The CV in the MMNL model based on the conditional estimates from this model is calculated using the same equation as equation 2.52 but the values of β for an attribute are obtained by taking random draws from the chosen random distribution associated with that attribute. Therefore, for each decision maker, several CV values are obtained that are dependent on the mean and standard deviation of the attribute estimates specific to that individual. The mean of these CV values therefore defines the overall CV for that particular decision maker. The final CV for the whole population is then found by calculating the mean of these individual-specific CV values. Chapter 4 reports the results of the CV values conditional on choice for the LCM and MMNL models in a snorkeller and nonsnorkeller population respectively.

2.6.4 Summary

This chapter presented an overview of the discrete choice models used in this thesis. This included a discussion on some of the common properties of these models and the relevance of these properties to the analyses undertaken in Chapters 4 and 5. One of the important properties discussed was the scale parameter and its role in testing equality between parameter estimates when datasets are combined. The derivation of the workhorse of discrete choice modelling, the MNL model, was also discussed and its limitations highlighted. One of these limitations was noted to be its inability to account for unobserved taste heterogeneity. This was followed by the derivation of two of the more flexible econometric models which allow the researcher to account for unobserved taste heterogeneity, namely the LCM and MMNL models. Finally, a discussion on the use of parameter estimates to derive WTP values followed. More specifically, measures of compensating variation, marginal and individual-specific WTP for the MNL, LCM and MMNL models concluded this chapter.

Chapter 3

Design of discrete choice experiment surveys and data collection

Abstract

The adminstration of the three choice experiment surveys for (1) snorkellers (2) non-snorkellers and (3) the respondent-selected respondents are described in this chapter. The common objective of all three experiment surveys was to determine the non-market value of the recreational benefits of attributes linked to improved coastal water quality for beach users. The main design stages of the three surveys were: (1) selecting attributes and levels for the choice sets, (2) choosing the experimental design and constructing the choice sets and (3) developing of the questionnaires. The three surveys were designed to minimise any biases that may have existed. The final version of each survey was a product of a number of revisions informed by the use of three qualitative research methods: focus groups, one-on-one interviews and pilot tests. The results obtained from applying these research methods are described in Section 3.1. The feedback from this research was used to construct a list of attributes and levels that were scientifically linked to coastal water quality and behaviourally linked to the recreational use of beaches. A description of these attributes and levels is presented in Section 3.2. Having defined the attributes and levels, a statistical design identifying the main effects was generated using SPSS® . As described in Section 3.3, the alternatives were obtained by cycling of this design. A blocking strategy was employed for the snorkellers and non-snorkellers choice experiments in order to reduce the number of choice tasks given to each respondent. Finally, a detailed description of the

final versions of the three surveys is presented in Section 3.4.

3.1 Research methods used in the design of choice experiments

Three qualitative research methods, interviews, focus groups and pilot tests, were used in this study to help in the design and refine the choice experiment surveys. It has become common practice to employ qualitative methodologies in order to aid survey design and to improve the quality and meaning of the results from valuation studies (Powe et al. 2005). The use of these methods is popular in surveys relating to non-market valuation because these surveys tend to involve topics which respondents may not be familiar with (Champ 2003). They thereby allow researchers to develop an understanding of the respondents' baseline knowledge of the survey topic as well as the complexity of factors which may affect their choice behaviour.

One of the main objectives of the qualitative research carried out in this study was to generate a list of attributes and levels which adequately described and portrayed improvement and deterioration changes to coastal water quality. The challenge here was to ensure that the list did not only take into consideration the changes to the coastal water quality but also captured the public perception of what constituted various levels of improvement or deterioration. The use of a combination of these qualitative methods was crucial in ensuring that attributes and levels used to describe the alternatives were not only in line with the requirements of the policy makers but that they also were meaningful to respondents (Adamowicz et al. 1998, Bennett & Blamey 2001).

The one-on-one interview method was the main technique used to gather information from scientists and policy makers, the main objective of which was to collect enough information to generate a preliminary list of attributes. This interview format (1) allowed for more detailed information to be relayed about each attribute; (2) gave the researcher an opportunity to elaborate on specific attributes tailored to the knowledge and experience of the specialist[1]; (3) allowed the researcher to tailor the questions of each subsequent

[1]For example, some specialists were more knowledgeable of water quality issues while others were more

interview based on the previous responses; (4) provided a better setting for the discussion of more sensitive environmental issues, especially with local policy makers. The focus groups sessions were also key in helping to reveal the participants' views and attitudes on issues relating to coastal water quality. Most importantly, they helped to verify and clarify the list of attributes which was generated with the specialists and shed light on how people thought about the choices they made. This thereby allowed the researcher to verify whether they were communicating the hypothetical scenario created by the survey instrument adequately. Finally, the use of the pilot tests was key in ensuring that all elements of the survey were understandable to respondents and in identifying any amendments which were needed that were not discovered or overlooked during the focus groups.

3.1.1 Consultation with specialists through one-on-one interviews

In order to derive a preliminary list of attributes before the first interview sessions, research was carried out using various sources of secondary information. These included government reports, brochures and the limited published studies that were available on aspects relating to coastal water quality, beach recreation and tourism in Tobago. Discussions with other researchers who carried out studies on similar aspects in the Caribbean region also helped with compiling this list. A literature review of studies incorporating any aspect of the preliminary list of attributes helped with the definition of levels of the attributes.

In order to further define the preliminary attribute list, a number of structured interviews were held with scientists and policy makers who were based in Trinidad and Tobago or based internationally but who had relevant working experience in Tobago and the wider Caribbean region. This two pronged approach was used to ensure that the perspectives gathered from the specialists were extensive and as broad as possible.

One of the main challenges in compiling the list of attributes was the limited availability of secondary information, this being even more pronounced with respect to the characterisation of the baseline levels for certain attributes. For example, a limited amount

knowledgeable of issues relating to coral reefs.

of information was available on the baseline levels present at certain beach sites for the attributes representing the level of coral cover and fish abundance. As a result, discussions with local scientists in Tobago were key in characterising these levels. In addition, discussions with policy makers helped to reveal potential plans for improvement of coastal water quality. This provided information which helped to define the level of attributes representing the higher level of environmental improvement. For example, one of the proposed policy plans was to build a sewage treatment plant which would improve the quality of effluent that was pumped out to sea. The scope of the improvement expected by the implementation of the sewage treatment plant gave insights into the expected effect this would have on other potential attributes such as the vertical visibility of the sea-water column. The consultations also yielded important background information on the effects of coastal water quality degradation and how various stakeholders contributed to or alleviated this problem. The feedback from each consultation was used to generate a more advanced list of attributes and levels which was then used in the focus group sessions.

3.1.2 Focus group discussions

Focus group research is useful for revealing, through interaction, the beliefs, attitudes, experiences and feelings of participants, in ways which are not feasible using other methods such as individual interviews, observation or questionnaires (Gibbs 1997). The focus groups used in this study had the dual objective of refining the list of attributes and seeking feedback on an early version of the questionnaires. The aim of the first objective was to determine the relevance of these attributes to potential groups of respondents and to ensure that the perspectives of the policy makers coincided with those of the respondents (Bennett & Blamey 2001). The aim of the second objective was to determine whether the individuals were interpreting the information and questions in the early version of the questionnaire as intended by the researcher. The moderator paid particular attention to the degree of difficulty encountered by focus-group participants in understanding and interpreting the presentation format of the various valuation scenarios. In addition, the focus group discussions in this study were valuable in determining, for the various groups, how effectively the information was being communicated through the questionnaires.

Structure of the focus group discussions

Four focus group sessions were carried out on both islands of Trinidad and Tobago in August 2005. Two of the sessions consisted of participants who were snorkellers while the other two consisted of those who were non-snorkellers. In order for the participants in the discussions to be as representative as possible, the sessions were designed to include the main segments of users who were target respondents. The composition of these groups included nationals who resided in Trinidad, nationals who resided in Tobago, non-nationals residing in Tobago and non-nationals who were visiting the island. The first focus group session was held in Trinidad while the remaining three were held in Tobago. Due to budget limitations, local contacts were used to help identify participants and the sessions were conducted in offices of governmental and non-governmental organisations as well as at the private premises of volunteers.

The structure of the focus group discussions were divided into three main stages. The first stage involved a warming-up exercise during which participants were given handouts which would accompany the discussion and invited to introduce themselves. This was done so that participants could start feeling comfortable about disclosing and responding to information (Litoselliti 2003). The second stage involved a guided discussion on an early version of the questionnaire which began with questions on their preferences relating to coastal water quality and ended with the completion of choice sets. Visual aids were distributed to gauge opinions on whether the illustrations and photographs used to portray various attribute levels matched textual descriptions. The final stage involved the use of more open ended questions which allowed the participants to give general feedback on any of the topics which had been covered. Follow-up and probing questions were used to clarify the participants' responses. All of the questions were kept as simple as possible and free of any technical jargon.

Recording the focus group discussions

All the focus groups sessions were recorded. This allowed the moderator to fully concentrate on the group discussion and ensure that it remained balanced with contributions from all participants. This also allowed the moderator to take note of how the group members were reacting through their non-verbal communication and ensure that the discussions kept to the agenda of the meeting. The observations from the recordings and group sessions were collated, analysed and reported with recommendations to be made for improvements to the surveys. This information also contained a record for inclusion and exclusion of information within the survey so that the other researchers could make an assessment of the recommendations for changes to the final survey instrument.

Moderating the focus group discussions

In accordance with the suggestions in (Morgan & Krueger 1997) and (Litoselliti 2003) on how best to moderate focus groups, participants were advised of a number of points at the start of the sessions. For instance, they were informed that even though the sessions were being recorded, all their responses would be completely confidential. The moderator informed the participants that the main reason the sessions were being recorded was to ensure that comments and opinions were not overlooked. They were also advised that there were no wrong or right answers and that all opinions they had were valuable, whether they were positive or negative. They were reminded that the role of the moderator was to learn from their discussions and thoughts on the subject matter. Finally, they were given an indication of how long the focus group session would last. Participants were told at the start of the focus group sessions that the results of the discussions would be used to design questionnaires which would elicit values on changes to coastal water quality in Tobago. The results of these questionnaires would in turn be used to inform policy making which would impact upon the recreational use of the beaches in Tobago. This was done to ensure that the participants did not view the discussions as entirely hypothetical and therefore behave strategically or inconsequentially when answering choice questions (Carson & Groves 2007).

Information on beach use and attitudes

The focus group discussions began with a number of questions regarding the participants' beach use and attitudes towards coastal water quality. This was done to determine the factors which motivated participants' beach use and the importance they attributed to the characteristic of water quality. One of the first discussion points involved asking participants if they had visited the beach in the past year for recreational purposes. Feedback from the session indicated that almost all of the nationals had visited the beach within the past year while the non-nationals had also visited the beach during the duration of their short term visits. In the two non-snorkeller focus group sessions and one of the snorkeller sessions, participants asked the moderator to clarify the words 'recreational purposes'. The use of the word recreation in this context seemed to be linked to involvement of a sport or a specific activity. Therefore, the word 'leisure' was used in addition to 'recreation' to improve the understanding of 'recreation' in this context. The focus group sessions revealed that swimming was the most popular activity which was closely followed by walking and relaxing. Participants also suggested two additional beach uses: nature watching and beachcombing. Most of the participants in the focus group indicated that water quality was the most important factor which influenced their decisions as to which beach to visit. This was followed by other tested factors which included the availability of facilities such as changing rooms, amenities such as the availability of a jetty and watersports, and the proximity of the beach to their location. This provided evidence that the respondents would indeed trade off attributes associated with coastal water quality.

Participants were given a location map[2] of Tobago's beaches and asked to determine whether the names and locations of the beaches were familiar to them. This exercise proved very useful as it revealed a number of beaches that were not included on the map. In addition, the participants indicated that some of the beaches were better known to locals by different names. This information on the official and local names of all beaches was included in the final questionnaire as shown in Figure 1.2 on page 3.

Information on attributes and levels

Participants in all sessions suggested several changes to the photographic and written descriptions of the levels of attributes. For example, the words used to describe the health risk associated with swimming in poor coastal water quality was initially described as an attribute defined as 'health risk'. This was the risk associated with the chance of

[2]The map which was used in the sessions was obtained from the Ministry of Planning of Trinidad and Tobago in 2005.

contracting a stomach infection from swimming in polluted water. It was noted that there were several problems with this definition of this attribute. The first was that it was difficult to come up with representative and plausible levels of the chance of contracting a stomach infection since no epidemiological studies had been carried out in Tobago or even in the wider Caribbean region. Secondly, it was discovered that most of the participants were using this attribute to eliminate an alternative without considering the other attributes of that alternative. Thirdly, the local participants indicated that stomach infections were not very common and more persons suffered from ear infections. This was later confirmed in discussions with the county medical officer in Tobago (Weeks 2005). As a result of these discussions this attribute was redefined as 'chance of contracting an ear infection'. Participants agreed that using this definition, the health risk attribute was no longer being used as a dominating attribute to avoid consideration of all attributes in the alternative. Changes were also made to the photographs representing the level of plastic litter. Finally, participants indicated that the initial photographs of the high level and low level policy actions were too similar. These were therefore adjusted accordingly.

The description of the scenario used to introduce the choice sets were also tested in these sessions. Feedback from these discussions revealed that participants preferred the improvement levels of the attributes to be described in terms of a generic level of policy improvement, rather than a more detailed explanation of how each attribute could be improved. This would also reduce the amount of time required for the researcher to explain the levels of improvement when in the field. It was also decided that the researcher should present all levels of policy improvement using the visual aids before presenting the choice sets to respondents.

Information on payment mechanism

In order to determine an appropriate payment mechanism, the focus group sessions included discussions on how payment would be best described. This revealed the snorkellers' and non-snorkellers' attitudes and opinions on paying for coastal water quality improvements. Most of the participants in all focus groups agreed that the coastal water quality needed to be improved. However, some of them disagreed on who should pay for these improvements. For example, most locals did not agree that visitors should be made to pay for improvements and believed that the government was responsible for this. Visitors also thought that locals should not have to pay to visit a beach. Most of the participants were willing to pay for levels of improvement if they thought that the levels of improvement were guaranteed.

The term 'entrance fee' was initially used to describe the payment mechanism. Most local participants did not agree with using this term because of the past contentious issues associated with paying for beach access (Potts 2003). Local participants were also very suspicious of the government's use of funds for environmental projects because of past issues associated with the Green Fund[3]. As a result of these responses, the term 'entrance fee' was changed to 'contribution fee' which would be described as a monetary contribution to be given to a non-governmental organisation that would be responsible for improving the coastal water quality. Almost all of the participants in the focus group sessions were willing to pay to visit the beach when presented with the choice sets with the new payment mechanism as well as an explanation that the money would be used to guarantee improvements of attribute levels.

Information on the number of attributes

To explore the effect of the number of attributes on the choices made, participants were asked whether they considered all attributes presented to them. Feedback from the sessions revealed a greater percentage of participants considered all attributes presented to them in the choice card with 6 attributes as opposed to the choice cards with 9 attributes. This provided preliminary evidence that participants may have been employing simplifying strategies when making their choices. The participants were also asked whether they considered all attributes when presented with 2, 3 and 4 attributes in each choice set. Here, participants indicated that they considered all the attributes. The attribute which

[3]The Green Fund was established by the Finance Act 2000. This Act introduced a 0.1 percent tax on the gross sales or receipts of all companies conducting business in Trinidad and Tobago. The purpose of the fund is to enable grants to be made to community groups and organisations engaged in activities to remediate, reforest, and conserve the environment. There is still debate to date on whether these funds are being used for environmental purposes.

received the most attention in both groups was that representing the chance of contracting an ear infection. Other popular attributes included vertical visibility and the presence of a marine protected area. The attributes associated with snorkelling were not ranked very high by the participants. This could have been because most of the participants revealed themselves to be occasional snorkellers and not real enthusiasts of this activity.

3.1.3 Pilot tests

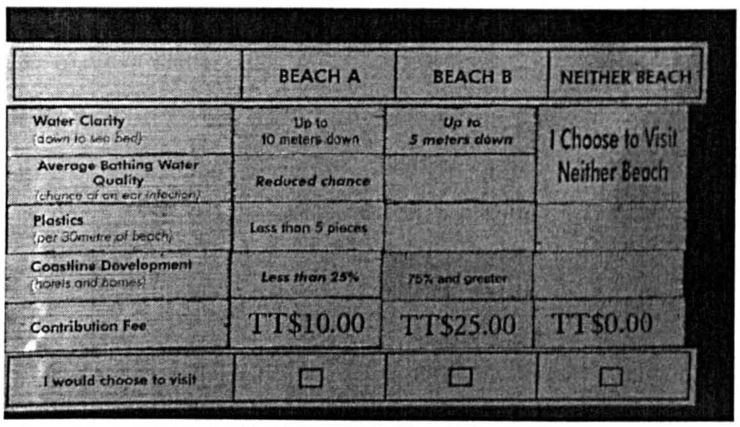
A pilot study is a small scale implementation of preliminary survey procedures with an acknowledgement that these procedures may be modified based on the results of the study (Champ 2003). The overall objective of the pilot studies that were carried out was to test how well the three discrete choice experiments worked as a whole and to determine if any part of the survey needing redesigning. Recommendations from the focus group discussions were incorporated in later versions of the questionnaires to be tested in the pilot studies. In particular, the use of wording and the description of the choice scenarios were examined to determine if they needed to be reworded.

Pilot surveys were undertaken at the Crown Point International airport in Tobago. Forty pilot surveys were conducted in total for the snorkeller and non-snorkeller experiments while 30 were conducted for the respondent-selected experiment. The choice responses from all the pilot surveys were analysed using the MNL model specification to determine if the choice responses were producing result consistent with *a priori* expectations. The majority of those approached at the airport were willing to volunteer for the survey as they were waiting for their flights and therefore found participation in the surveys a useful way to pass the time. The average time taken to complete the non-snorkeller experiment was 20 minutes while 30 minutes was the average for the snorkeller experiment. The respondent-selected survey took an average of 40 minutes to complete. Of the 20 snorkellers, 17 rated the questionnaire as interesting, 2 rated it as educational while 1 person rated it as too long. Of the 20 non-snorkellers, 12 rated it as interesting and 8 rated it as educational. Eleven respondents rated the respondent-selected experiment as interesting, 5 rated it as educational and 4 said that the survey took too long to complete.

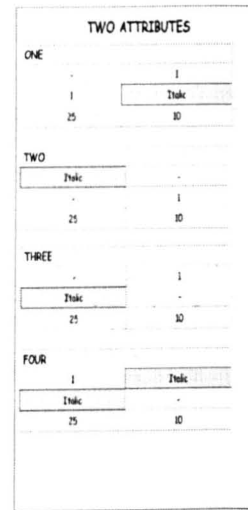
One of the main objectives of the pilot tests for the respondent-selected survey was to determine the best way to tailor each choice card based on the attributes the participants chose. This proved to be challenging and therefore a variety of methods were designed and tested. These methods all required the manual transfer of the experimental design in order to create choice cards in an efficient way. The first method involved printing blank choice cards so that the enumerator could fill in the levels of the design based on the attributes chosen. A preprinted design sheet similar to the one in Figure 3.1 was used to help differentiate the various levels of the attributes. There were two problems with this method. The first was that it took on average an extra 16 minutes for each choice card to be written out. The second was that the choice cards were not very clear as they being filled in by hand. The second method tested was the use of a board lined with velcro onto which individual velcro stickers representing the attribute and levels could be attached. Labels were printed to ensure that they were more legible. The design sheet shown in Figure 3.1 was used here as well. This was tested on 5 persons and, although the labels were more legible, the removal and attachment of the velcro still required about 12 minutes. In addition, this process seemed to distract the respondents. The final version involved the use of a magnetic board and magnetic labels on which the attribute levels were pre-printed. This proved to be the most efficient out of all three, and took 10 minutes to complete. It is acknowledged that computer-assisted technology such as that used in studies by (Hensher 2006*b*) would have been the most efficient method to administer the sample-survey experiment. Unfortunately, budgetary limitations made this impossible.

All three sets of pilot interviews confirmed that the use of a worked example was very important as this illustrated how respondents should be thinking about making their choices. In addition, respondents confirmed that the use of visual aids used in the survey helped them to complete the survey more efficiently. The enumerator simultaneously asked the questions while displaying the relevant visual aids. For example, the visual aids were used to display the possible answers of a close-ended question or to present a statement which the respondent had to form an opinion on. With the exception of the choice cards, the enumerator recorded the answers from all sections of the questionnaire. This helped to

Step 1 - Enumerator creates choice sets using design sheet and labels

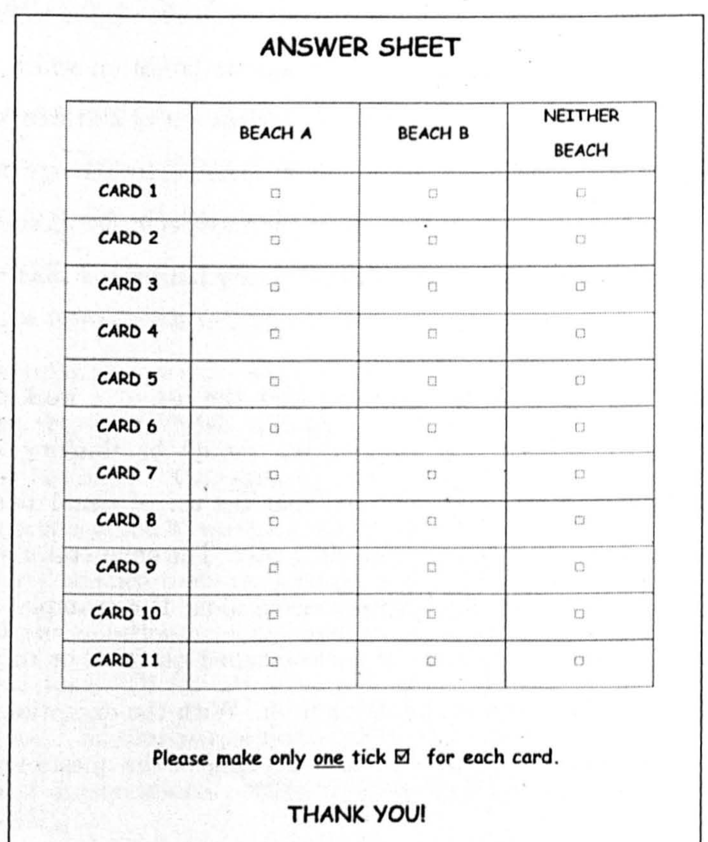


Magnetic board and labels used to create choice sets



Sample design sheet for two attributes

Step 2 - Respondent records answers after considering each choice set



ANSWER SHEET

	BEACH A	BEACH B	NEITHER BEACH
CARD 1	□	□	□
CARD 2	□	□	□
CARD 3	□	□	□
CARD 4	□	□	□
CARD 5	□	□	□
CARD 6	□	□	□
CARD 7	□	□	□
CARD 8	□	□	□
CARD 9	□	□	□
CARD 10	□	□	□
CARD 11	□	□	□

Please make only one tick ☑ for each card.

THANK YOU!

Figure 3.1: Steps in respondent-selected discrete choice experiment

reduce the time it took to complete each survey since the enumerator was more familiar with the material presented in the survey. In addition, this allowed the respondent to focus fully on their thoughts and formulate their answers.

3.2 Choice of attributes and levels

Each attribute and its levels were chosen to satisfy scientific understanding about their environmental impact on coastal water quality and also the public perception as perceived from the background work, consultations with specialists and focus groups. Improvements to coastal water quality were described in terms of 9 attributes for the snorkeller experiment and 6 attributes for the non-snorkeller and respondent-selected experiments, exclusive of the fee attribute (§ Table 3.1). All attributes with the exception of that representing the chance of contracting an ear infection were described in quantitative terms in order to maximise the valuation potential and ease of interpretation (Bennett & Blamey 2001).

The different levels were chosen to be realistic and represent possible future values if policy measures were to be implemented (Bennett & Blamey 2001). Three levels were used to represent each attribute according to the intensity of the proposed improvement. To maintain clarity in communication, after an initial detailed description, the three levels were referred to as high level policy action, low level policy action and no level of policy action (that is the status quo). The high level represented the greatest amount of policy intervention which implied a high level of environmental quality while the low level represented a reduced amount of intervention and hence a lower level of environmental quality. The status quo option represented the situation as it was currently on the island. The fee attribute was included to determine the WTP for the attribute levels. The underlying expectation for all attributes was that the presence of an attribute representing a higher level of environmental policy action would increase the probability of beach visitation while that representing a low level would decrease it. A description of the 10 attributes used in the three discrete choice experiments follows.

Table 3.1: Attribute definitions, levels and variable names

Attribute	Definition	Variable Names and Levels	
Number of boats	Number of recreational and fishing boats near the coastline	BTS1_Low_Policy	Up to seven boats allowed near coastline
		BTS2_High_Policy	Up to 2 boats allowed near coastline
Marine protected area	Presence of type of marine protected area	MPA1_Low_Policy	A marine protected area where you can (tour, swim, snorkel, dive) and fish.
		MPA2_High_Policy	A marine protected area where you can (tour, swim, snorkel, dive) but no fishing
Coastline development	Percentage of coastal development on the coastline	DEV1_Low_Policy	Up to 75% development allowed on the coastline
		DEV2_High_Policy	Up to 25% development allowed on the coastline
Average bathing water quality	Risk of contracting an ear infection from swimming in polluted water	WQ1_Low_Policy	Increased chance of contracting an ear infection from swimming in polluted water
		WQ2_High_Policy	Reduced chance of contracting ear infection from swimming in polluted water
Clarity	Level of Vertical Visibility	CLAR11_High_Policy	Vertical Visibility of up to 10 metres
		CLAR2_Low_Policy	Vertical Visibility of up to 5 metres
Plastic debris	Number of plastics per 30 metres of coastline	PLAS11_Low_Policy	Up to 15 pieces per 30 metres of coastline allowed
		PLAS2_High_Policy	Less than 5 pieces allowed per 30 metres of coastline allowed
Number of snorkellers	Number of snorkellers allowed per group	SNO1_Low_Policy	Up to 15 snorkellers allowed per group or per instructor
		SNO2_High_Policy	Up to 5 snorkellers allowed per group or per instructor
Coral Cover	Percentage of coral cover available for viewing while snorkelling	CORAL1_High_Policy	Can view up to 45% coral cover while snorkelling
		CORAL2_Low_Policy	Can view up to 15% coral cover while snorkelling
Abundance of Fish	Number of fish available for viewing while snorkelling	FISH1_High_Policy	Can view up to 60 fishes while snorkelling
		FISH2_Low_Policy	Can view up to 10 fishes while snorkelling
Fee	Contribution Fee to Beach Authority	FEE	TT$10, TT$20, TT$25

BOATS NEAR COASTLINE

This is the number of recreational boats and fishing boats near the coastline.

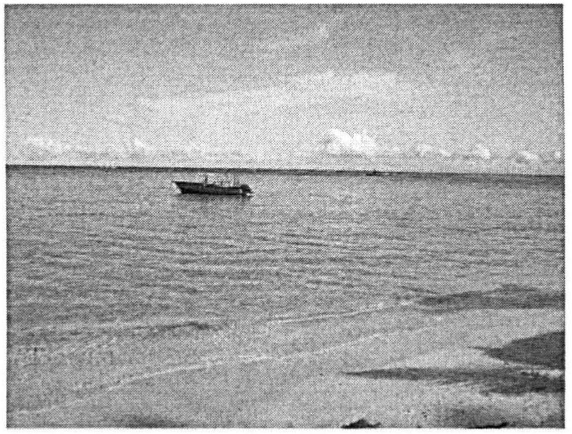
1. No Program Present	2. Program One	3. Program Two
–		
No program for monitoring number of boats.	Only up to 2 boats allowed	Up to 7 boats allowed

Figure 3.2: Number of boats

3.2.1 Number of boats

This attribute was described as the number of recreational and fishing boats moored along the coastline of a beach. Boats in Tobago are used for a number of purposes, including local commercial fishing, recreational fishing and recreational trips such as snorkelling, scuba diving and glass bottom boat tours. The three main types of boats used for these purposes are motorboats, pirogues and yachts. With the exception of a few beaches with marinas, most of the beaches do not have launching sites which can be used by boat operators. This forces local fishermen to use the beach to moor and launch their boats. As the number of boats increases near the coastline at each beach site, there is an increase in the potential for oil and fuel spills, noise (Vasconcellos & Latorre 2001), offensive odours from boat engines and habitat disturbance such as sea grass trampling.

Varying numbers of boats were used to portray different degrees of congestion from boats along the coastline. During the initial focus groups, a photograph depicting 5 boats and representing the low policy option was presented to the respondents while a photograph depicting 2 boats was used to represent the high policy option. The photograph depicting the low policy option was later changed to one showing 7 boats since the participants were not perceiving this to be very different to the high policy option (§ Figure 3.2). The no policy option was described in terms of the current policy situation, this being that there are no regulations in Tobago which control the number of boats that can be moored along the coastline. The expectation is that a reduction in the number of boats near the coastline will have a positive impact on visitation to a beach.

3.2.2 Marine protected area

This attribute represents the presence of a marine protected area off the coastline of a beach. The Buccoo Reef Marine Park (BRMP)[4] is the only designated marine park on the island. It is located on the south-west of the island as shown in Figure 3.3. It has also been designated an environmentally sensitive area. However, as is true of many marine protected areas in the Caribbean, protected area management is not enforced, nor is incentive-based

[4]This area was declared a marine protected area in 1973 under the Marine Preservation and Enhancement Act of Trinidad and Tobago.

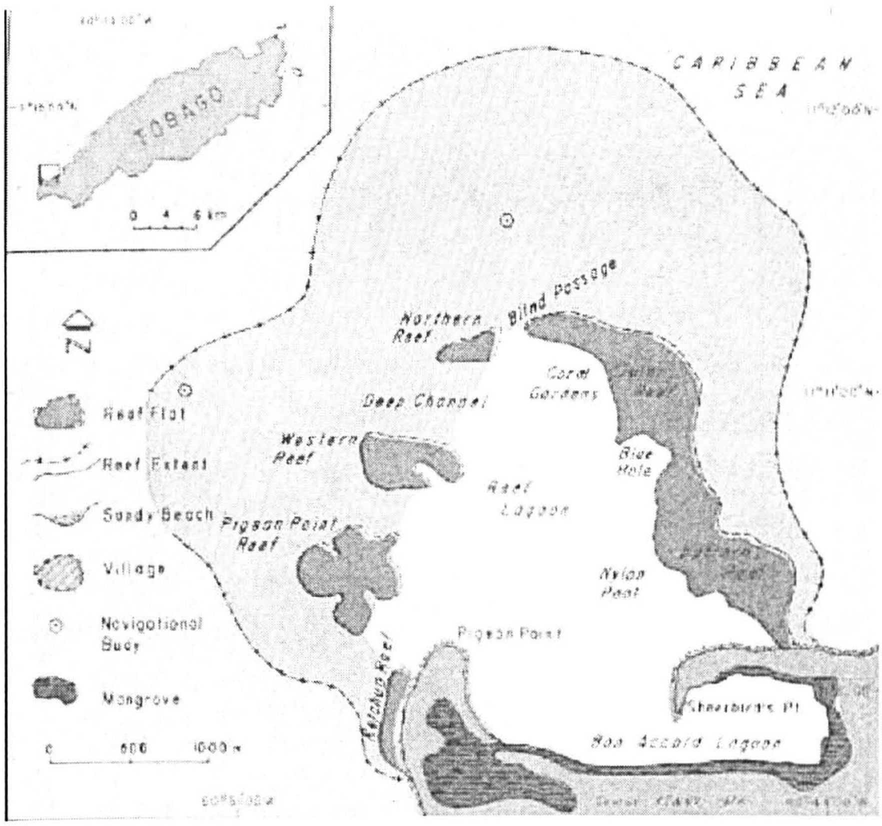


Figure 3.3: Detailed map of Buccoo Reef Marine Park

management used to help compliance with the rules of the BRMP (Mascia 1999). Threats to the reef include reef walking, boat anchoring, collection of species, over exploitation of fisheries and the discharge of untreated domestic waste water. Despite the lack of enforced management, there are plans to designate another marine park in the Speyside area. While numerous studies have shown that persons are willing to pay to visit a marine protected area in the Caribbean (Thur 2004, Williams & Polunin 2000), none of these studies have investigated whether the presence of a marine park would increase beach visitation.

In this study, two types of marine parks were considered. Both parks allow recreational activities which do not harm the habitat or impact significantly on fish populations or ecological processes. The reason for allowing recreation is because the income generated from an MPA is economically important, particularly for glass-bottom tours that have been operated since the 1930's. The main difference between the two parks is the type

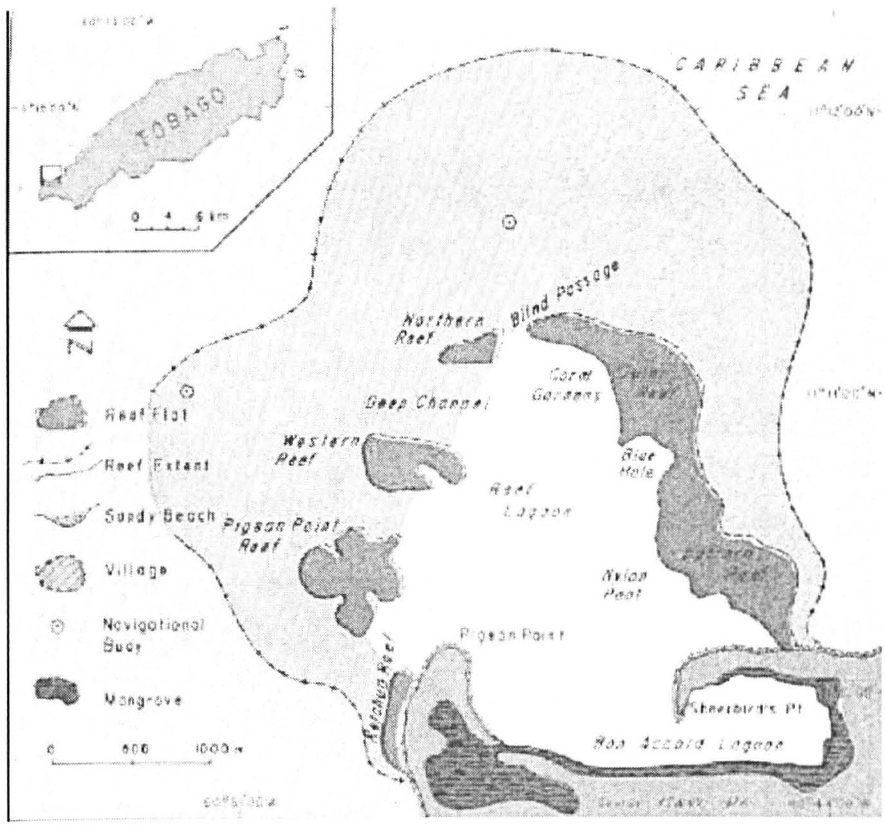


Figure 3.3: Detailed map of Buccoo Reef Marine Park

management used to help compliance with the rules of the BRMP (Mascia 1999). Threats to the reef include reef walking, boat anchoring, collection of species, over exploitation of fisheries and the discharge of untreated domestic waste water. Despite the lack of enforced management, there are plans to designate another marine park in the Speyside area. While numerous studies have shown that persons are willing to pay to visit a marine protected area in the Caribbean (Thur 2004, Williams & Polunin 2000), none of these studies have investigated whether the presence of a marine park would increase beach visitation.

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In the initial focus group sessions, pictures of the marine parks were included together with a textual description of whether fishing was allowed or not. Feedback from the focus groups indicated that a picture of an individual fishing would improve the distinction between the two types of parks. Therefore, low and high policy options were depicted with a photograph of the Buccoo reef marine park and an individual either being allowed to fish or not (§ Figure 3.4). The no policy option was described as the absence of a marine protected area off the coastline of the beach. The expectation for this attribute is that snorkellers will be more willing to visit a beach once a marine park is designated at that beach. This is because they would perceive its presence as improving the opportunity to view marine life. Since there is little information on how recreationists would react to a no take zone, no *a priori* expectations could be specified for this attribute.

3.2.3 Coastline development

This attribute represents the level of development as a percentage of buildings along the coastline. There is a considerable amount of development along the coastline in Tobago, especially on the southern half of the island (§ Figure 3.5). As the level of development increases on the coastline, there is a greater chance that the quality of the coastal waters would decrease due to runoff from the land.

In order to capture the different levels of coastline development, pictures were taken at sea (§ Figure 3.6). The high policy option representing development of up to 25 percent was illustrated using a picture showing one building amongst undeveloped land. The low policy option representing development of up to 75 percent was illustrated using a picture

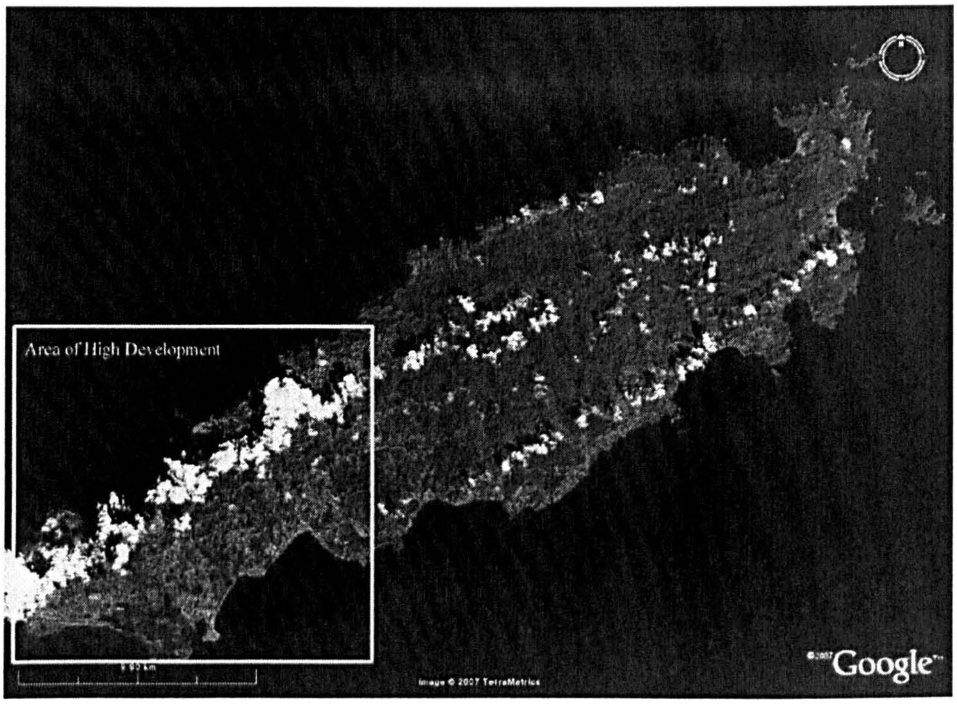


Figure 3.5: Area of high development in Tobago

showing numerous hotel buildings along the coastline. The no policy option was described as a situation where no plans were in place to restrict the amount of development. The expectation here is that as development increases, coastal water quality would decrease and lead to decreased beach visitation.

3.2.4 Average bathing water quality

The attribute representing the average bathing water quality was used to describe the health risk associated with a degradation in coastal water quality. This was expressed as the chance of contracting an ear infection from swimming in polluted waters. It has been noted in research by EFTEC (2002) that very few studies done in Europe have considered explicitly the health risks of bathing in polluted marine waters. This is even more pronounced in the Caribbean region and this is therefore one of the first studies to do so. The expectation here is that an increased chance of contracting an infection will mean that the level of water quality is poor and will lead to a consequent decrease in visitation to a beach. To depict

COASTLINE DEVELOPMENT

The amount of built up environment like hotels and homes near the coastline.

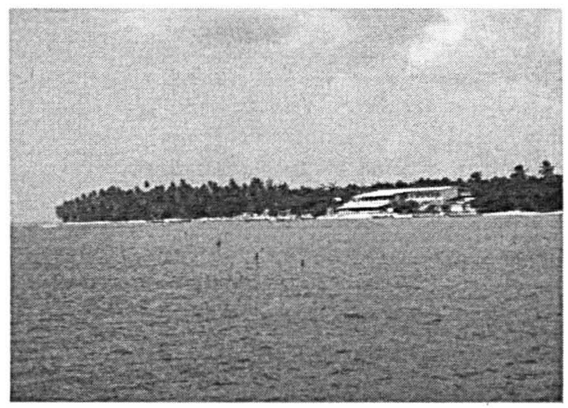
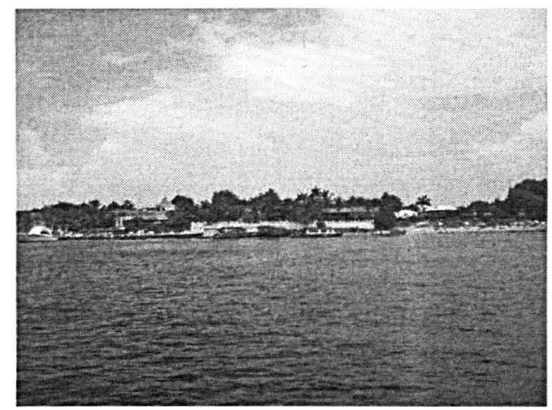
1. No Program Present	2. Program One	3. Program Two
-		
No program for restricting coastline development.	Up to 25% development allowed	Up to 75% development allowed

Figure 3.6: Coastline development

the high policy option, an illustration of an individual lounging on a beach was used. As shown in Figure 3.7, a picture of an infected ear was used to depict the low policy option. The no policy action was described in terms of the absence of information on the quality of the coastal waters with respect to the chance of the individual contracting an ear infection.

3.2.5 Plastic debris

This attribute was defined by the number of pieces of plastic found along a 30 metre stretch of coastline. Plastic is one of the most common types of marine litter and has been identified as a major issue for coastal managers (Santos et al. 2005). Larger amounts of plastic litter are found on the more popular beaches in Tobago, coming from two main sources: marine litter being washed up on the shore and plastics left behind after people have visited the beach. As shown in Figure 3.8 the high policy option was described as a beach containing up to 5 pieces of plastic per 30 metres of coastline while the low policy option was described as one with up to 15 pieces of plastic. The no policy option was described in terms of not having any regulations ensuring that plastic litter was cleaned up. Photographs were taken at different times of the day to show very clean beaches and beaches that were less clean. A variety of photographs were taken to ensure that the different levels of plastic were easily discernible. The expectation here is that as the number of pieces of plastic increases, beach visitation will decrease.

3.2.6 Clarity of water

This attribute was used to describe the level of vertical visibility. Poor coastal water quality can reduce the level of vertical visibility due to an increase in the suspension of solids in the water. In addition to the aesthetic appeal of good vertical visibility, this also serves as a prime regulator of biological and ecological functions in both benthic and aquatic systems (Lloyd et al. 1987). As shown in Figure 3.9, the high policy option was depicted using underwater photographs showing a high level of clarity of approximately up to 10 metres while the low policy option was depicted with one showing a low level of clarity of approximately up to 5 metres. The no policy option was described as the situation where there is no assurance that a certain level of clarity would be provided. The photographs used were taken on the Caribbean island of St. Lucia. The expectation for

AVERAGE BATHING WATER QUALITY

Risk of getting an ear infection from swimming or 'bathing' in polluted water

No Policy	Policy One	Policy Two
–		
No program for monitoring bathing water quality.	Water is BELOW Standard Greater Chance of Ear Infection	Water is ABOVE Standard Reduced Chance of Ear Infection

Figure 3.7: Average bathing water quality

PLASTIC DEBRIS

This is the amount of plastic debris you can see on the beach and in the water per 30 meters.

1. No Program Present	2. Program One	3. Program Two
–		
No program for monitoring and cleaning plastics on the beach.	Less than 5 pieces per 30 meters	Up to 15 pieces per 30 meters

Figure 3.8: Plastic debris

this attribute is that as vertical visibility increases, beach visitation will also increase.

3.2.7 Abundance of fish

This attribute represents the amount of fish one can view while snorkelling. The coastal zone of Tobago is important for supporting recreational and commercial fisheries. Excessive nutrients found in water of poor quality can affect the abundance of fish. Consultations with experts revealed that the population of fish in Tobago has decreased significantly in recent decades. The high policy option was depicted with a photograph which showed high fish abundance of up to approximately 60 fishes while the low policy option was depicted with lower abundance of up to approximately 10 fishes. The no policy option was described as a state where no intervention would be taken to improve the abundance of fish. The photographs as shown in Figure 3.10 are of the blue tang fish (*Acanthurus coeruleus*) and were also taken in St. Lucia. This species of fish is one of the three that are commonly seen while snorkelling in the Caribbean region. The expectation for this attribute is that as the abundance of fish decreases beach visitation will also decrease.

3.2.8 Coral cover

This attribute was used to describe the amount of coral cover one can see while snorkelling. The level of coral cover in Tobago and the Caribbean region as a whole is decreasing due to a number of factors such as poor water quality, increased incidence of diseases and overfishing (Burke & Maidens 2004). Discussions with coral reef specialists revealed that 100 percent coral cover was extremely rare in the Caribbean region and that 45 percent was a realistic and representative level of good coral cover. As shown in Figure 3.11 the high policy option was depicted with a photograph showing approximately up to 45 percent coral cover. The photograph depicting high coral cover shows a good selection of corals including finger coral (*Porites porites*), yellow pencil coral (*Madracis mirabilis*), sponges and gorgonians. The low policy option was depicted with a photograph showing approximately up to 15 percent coral cover. The photograph depicting low coral cover shows a reef that has very sparse amounts of yellow pencil coral left but is dominated by green and red algae. The no policy option was described as a state where no intervention would be taken to improve coral cover. The expectation here is that less coral cover will reduce snorkelling opportunities

CLARITY OF WATER

This is how far down to the bottom of the sea bed you can see or the level of vertical visibility

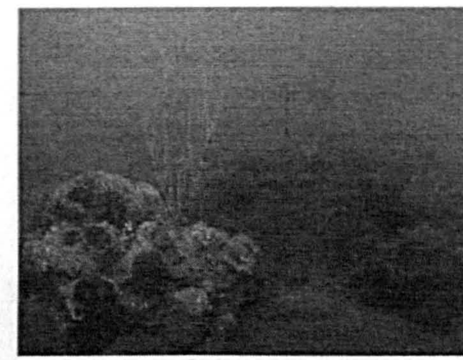
1. No Program Present	2. Program One	3. Program Two
-		
No program for ensuring clarity of water on beach.	Up to 10 meters.	Up to 5 meters.

Figure 3.9: Clarity

ABUNDANCE OF FISH

This is the amount of fish you can see.

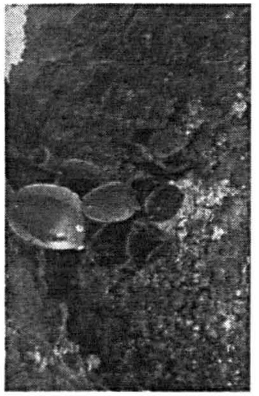
1. No Program Present	2. No Program Present	3. No Program Present
		
There is no program for ensuring fish populations.	Up to 60 fishes	Up to 10 fishes

Figure 3.10: Abundance of fish

and lead to reduced beach visitation.

3.2.9 Number of snorkellers per group

This attribute represents the number of snorkellers allowed to snorkel per group or per instructor. Research has shown that the intensity of snorkelling can lead to a degradation in the quality of marine life (Epstein et al. 1999, Barker 2003). However, this is the first study to investigate people's perception of restricting the number of snorkellers that are allowed in a group. The expectation here is that as the number of snorkellers increases, the probability of damage to marine life will also increase with a consequent reduction in beach visitation. The high policy option was defined as a restriction where up to 5 snorkellers would be allowed per group or per instructor. The low policy option was defined as a restriction where up to 15 snorkellers would be allowed per group or per instructor. The photographs representing these two policy levels are shown in Figure 3.12. There are currently no restrictions in Tobago on the number of snorkellers per group and this was used to represent the no policy option.

3.2.10 Contribution fee

As described in Section 3.1.2, the focus group sessions revealed that the payment mechanism should be described in terms of a contribution fee which would be given to a non-governmental beach authority. The beach authority would then use the money for coastal water quality improvements which would benefit beach visitors. The expectation is that the implementation of a fee-based system would decrease beach visitation. The focus group discussions also revealed an upper bound of TT$30.00 for this payment vehicle (Bennett & Blamey 2001). The contribution fee for the snorkellers was initially set at TT$10.00 and TT$25.00 and that for the non-snorkellers was also set at TT$10.00 and TT$25.00. The experimental design was updated to increase its efficiency as described in Section 3.3. This resulted in a change in the fee levels to TT$20.00 and TT$10.00 for the snorkellers and TT$25.00 and TT$10.00 for the non-snorkellers.

CORAL COVER

This is the amount of coral cover while snorkelling.

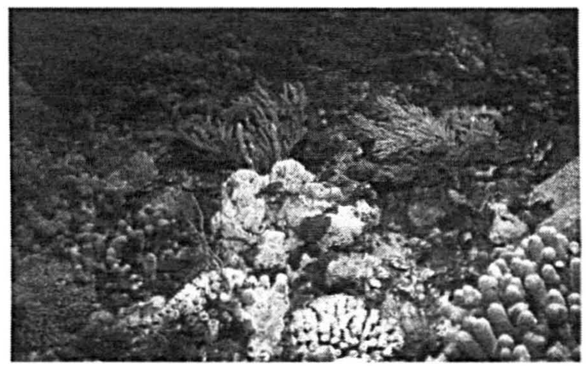
1. No Program Present	2. Program One	3. Program Two
-		
No program for ensuring coral cover	Up to 45% coral cover	Up to 15% coral cover

Figure 3.11: Coral cover

NUMBER OF SNORKELLERS

This is the amount of snorkellers allowed per group instructor.

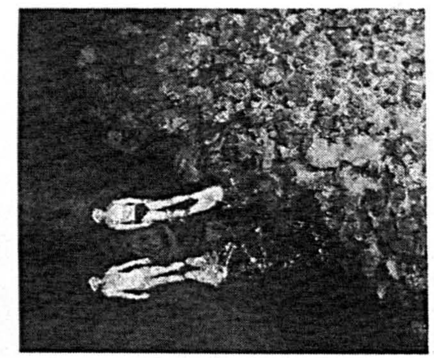
1. No Program Present	2. Program One	3. Program Two
–		
There is no program for restricting snorkellers per group.	Up to 15 Snorkellers allowed.	5 or less allowed

Figure 3.12: Number of snorkellers

3.3 Experimental design

Having identified the relevant attributes and levels to be used in the discrete choice experiment, an experimental design was constructed from which the choice sets could be derived. The key to a successful stated preference survey is to ask questions in such a way that this generates the maximum amount of information from each respondent given other constraints such as complexity for the respondent, the length of the questionnaire and the cost of the survey (Carlsson & Martinsson 2003). An experimental design used in a discrete choice experiment allows researchers to control and manipulate attributes and levels, thus allowing hypotheses on what influences utility to be tested. As a consequence, the number of attributes and levels used in a discrete choice experiment has an effect on model parameters and statistical efficiency of the experiment.

A common goal when choosing an experimental design for a discrete choice experiment is to maximise orthogonality and balance (Lusk & Norwood 2005). Perfect orthogonality requires that the attributes are uncorrelated with one another across the design. Balance requires that each level of each attribute occurs with equal frequency and therefore has the same statistical power. To achieve perfect orthogonality and balance, a full factorial design can be used which consists of all possible combinations of attributes and levels. The quality of a design is often described in terms of its D-efficiency. Despite its statistical advantages, it has been established that it is not practical and cost effective to administer the large amount of surveys required of a full factorial design (Louviere et al. 2000). In order to reduce the number of choice sets in a discrete choice experiment, various design strategies therefore have been developed. For example, one of the more popular methods is the use of orthogonal fractional factorial designs. These designs involve the selection of a fraction of the full factorial so that particular effects of interest can be estimated as efficiently as possible (*ibid.*). In general, all fractional factorial designs involve some loss of statistical information (*ibid.*). Other design strategies used for reducing the complexity for respondents include the blocking of a design or using a fractional factorial combined with a blocking strategy (Hensher et al. 2005*a*).

Researchers have recently developed a new class of designs which are referred to as optimal or statistically efficient designs. The main difference between orthogonal fractional factorial designs and optimal designs is that, in the former, the objective is to ensure that all the attributes of the design are uncorrelated. On the other hand, the objective of an optimal designs is to create a design that optimises the amount of information obtained from the derived choice sets. Therefore, optimal designs will be statistically efficient but will likely have correlations between attributes whereas orthogonal fractional factorial designs will have no correlations but may not be the most statistically efficient design available [5] (Hensher et al. 2005*a*). Various construction strategies have been explored by a number of authors in order to come up with optimal designs (Bunch et al. 1994, Huber & Zwerina 1996, Sandor & Wedel 2001, Kanninen 2001). One of the shared constraints of creating an optimal design is that knowledge of the utility parameters is required which is not usually known prior to the study. This constraint has led to the commonly used assumption that good linear designs are also good for non-linear models such as discrete choice models (Kuhfeld 2000).

Research into the development of optimal experimental designs for discrete choice models continues to evolve. To date, there have been few studies which have investigated the impact of the various optimal design strategies on WTP estimates. The few studies which have done so have investigated the effect on WTP of using different types of optimal design strategies. Using a health economics application, Carlsson & Martinsson (2003) found that D-optimal designs based on prior information generated more accurate welfare estimates than orthogonal fractional factorial designs. Another study, from the agricultural economics field, Lusk & Norwood (2005) found that designs which incorporated attribute interactions generated more precise valuation estimates. In addition, it was also found that larger experimental designs did not perform better than those which minimised an efficiency criterion. The suggestion by Lusk & Norwood (2005) is that a manageably sized experimental design can be implemented without sacrificing the accuracy of WTP estimates. The most recent work done in the field of environmental economics was by Ferrini & Scarpa (2007), Scarpa et al. (2007) who showed that the use of Bayesian algorithms can be used to improve the efficiency of the design for non-linear models. The

[5] Optimal designs are also known as D-optimal designs, a term which is inversely related to D-efficiency.

authors also noted that this only holds true when good *a priori* information is available and that if this was not the case then practitioners were better off with shifted designs built from conventional fractional factorial designs.

3.3.1 Description of experimental design strategy for three discrete choice experiments

In each of the three discrete choice experiments, three unlabelled alternatives were listed on each choice card. The first two alternatives described beaches with varying levels of attributes and the third alternative was a 'stay at home' alternative. All attributes were depicted using three attribute levels. In the snorkeller experiments, each choice set contained 9 attributes, exclusive of the fee attribute. In the non-snorkeller experiments each choice set contained 6 attributes, exclusive of the fee attribute. The respondent-selected choice cards contained choice sets with 2, 3 or 4 attributes exclusive of the fee attribute.

Since it was not possible for respondents to choose from the full factorial of designs, an orthogonal fractional factorial design was created using SPSS® which incorporated only the main effects[6]. In the snorkeller and non-snorkeller discrete choice experiments, one complete design was made up of 27 and 17 choice sets respectively. A blocking strategy was employed in order to reduce the number of choice sets given to each respondent. Blocking involves introducing another orthogonal column to the design, the attribute levels of which are then used to segment the design (Hensher et al. 2005*a*). In the snorkeller discrete choice experiment, the 27 choice sets were blocked into three versions containing 9 choice sets, each of which was given to a different respondent. In the non-snorkeller discrete choice experiments, the 17 choice sets were blocked into two blocks of 9 and 8 choice sets, each of which was also given to different respondents. In the respondent-selected experiment, it was required that one person complete one entire design, since the design was being tailored to that respondents' choice of attributes. Therefore the maximum number of attributes which could be chosen by one respondent was 4 attributes, this thereby producing a design consisting of 10 choice sets. Similarly, respondents who were allowed to choose 2 and 3

[6]An assumption was made that there were no significant interaction effects. This is justified following the results of Dawes & Corrigan (1974) who found that main effects typically account for 70 to 90 percent of explained variance (Louviere et al. 2000)

attributes were given 7 and 8 choice sets to complete respectively. If the respondents would have been allowed to choose 5 or 6 attributes, then this would have meant they had to complete 16 and 17 choice sets respectively. This was deemed too be cognitively burdensome.

The alternatives for each choice set were generated using a cycled[7] design from the original fractional factorial design. This process involves first allocating each of the alternatives from the fractional factorial design into different choice sets and then constructing the alternatives by cyclically adding alternatives into the choice set based on the attribute levels. The attribute level in the new alternative is the next higher attribute level and, if the highest level is obtained, then the attribute level is set to its lowest level in the new alternative. By construction, this design has balance, orthogonality and minimal overlap. Hence it satisfies the principles of an optimal design except for utility balance (Carlsson & Martinsson 2003). This type of design was originally proposed by Bunch et al. (1994) and recent applications include those by Carlsson & Martinsson (2003), Ferrini & Scarpa (2007).

In total, responses from 200 snorkellers, 90 non-snorkellers and 50 of the sample-selected respondents were collected. Of these collected responses, 198, 86 and 42 were usable surveys for the snorkellers, non-snorkellers and sample-selected respondents respectively. In order to determine the appropriate sample size, the minimum suggested guideline of 50 respondents was used (Louviere et al. 2000, Bennett & Blamey 2001). In addition, *a priori* information was used to calculate choice probabilities. This was done to determine if the information collected was adequate based on the statistical power required to estimate the discrete choice models. Another guideline to determine adequate sample sizes is based on the number of levels of attributes ($NLEV$), the number of alternatives per choice set ($NALT$) and the number of choice questions per individual ($NREP$) as follows (Johnson et al. 2006):

$$N = 500 \cdot \frac{NLEV}{NALT \cdot NREP} \tag{3.1}$$

Based on this guideline the minimum sample size for the non-snorkellers and snorkellers was 88 and 83 respondents respectively. This guideline could not be applied to the

[7] A cycled design is also known as a shifted design.

sample-selected respondents because the number of choice questions per respondent varied based on the number of chosen attributes per respondent.

Although the sample sizes collected for all three discrete choice experiments were adequate based on the above guidelines, a more statistically efficient experimental design was implemented for the snorkellers and non-snorkellers. This was done by dividing the snorkeller and non-snorkeller respondents so that information on the parameter estimates collected in the first phase could be used to increase the efficiency of the experimental design in the second phase. This was done following the numerical optimisation technique described by Kanninen (2001). This involves the maximisation of the D-optimal criterion by manipulation of the first experimental design. In this experiment, the maximisation procedure involved keeping all attribute levels except the fee attribute as they were in the first phase and allowing the levels of the fee to change. The information collected on the parameter estimates was used to balance the probabilities of choices across the alternatives in the choice sets which resulted in the fee attribute being updated. In the snorkeller discrete choice experiment, parameter estimates from 93 respondents were used to update the fee attribute from levels of TT$10.00 and TT$25.00 to the levels of TT$25.00 and TT$10.00 to be given to 105 respondents. In the discrete choice experiment done with the non-snorkellers, parameter estimates from 60 respondents were used to update the fee attribute from levels of TT$25.00 and TT$10.00 to the levels of TT$20.00 and TT$10.00 and given to a further 26 respondents.

In order to evaluate the benefit of updating the fee parameter, the D-efficiency of the experimental designs from the two phases were calculated as described in (Ferrini & Scarpa 2007). Given a design, the objective function to be maximised can be based on the information matrix **I**:

$$\mathbf{I}(\mathbf{X}|\beta, N) = N \sum_{s=1}^{S} \mathbf{X}_s'(\mathbf{P}_s - \mathbf{p}_s\mathbf{p}_s')\mathbf{X}_s \tag{3.2}$$

where s denotes choice situations (27 for the snorkellers design and 17 for the non-snorkellers design), N is the number of individuals, X_s is one choice situation in the design matrix

((19 × 3) for the snorkellers design and (13 × 13) for the non-snorkellers design) and $\mathbf{p}_s$ is a vector of 3 choice probabilities from choice situation s. Finally, $\mathbf{P}_s$ is obtained by creating a diagonal matrix from the three choice probabilities in $\mathbf{p}_s$. The resulting information matrix is a (19 × 19) matrix for the snorkellers design and a (13 × 13) matrix for the non-snorkellers design. The D-error is used to calculate a scalar value from this information matrix in order to compare designs using a single number. The D-error is defined as:

$$D\text{-error} \quad = \quad \{\det[\mathbf{I}^{-1}(\beta)]\}^{1/k} \tag{3.3}$$

where k is the number of attributes (19 for the snorkellers design and 13 for the non-snorkellers design). The D-efficiency is defined as the inverse of the D-error ((D−efficiency = 1/D−error)).

Calculating the D-error allowed the analyst to note whether an improvement could be observed in the updated designs. The changes in the price levels resulted in a choice set with a D-error of 0.276 for the snorkellers compared to a D-error of 0.275 in the experimental design. This shows that there was only a marginal improvement in the design with these changes. However, the changes in D-error were significant for the non-snorkellers. Here, a D-error of 0.487 in the original choice set reduced to a D-error of 0.464 with the updated experimental design.

3.4 Sections of questionnaires for three discrete choice experiments

All surveys for the three discrete choice experiments were done using in-person surveys which were administered face-to-face by the enumerator at the Crown Point International airport in Tobago between the period September - November 2005. The use of this location provided a sample of foreign non-nationals and nationals who lived both in Trinidad or Tobago. The surveys were carried out between 8:00 a.m. and 9:00 p.m. on each weekday depending on the scheduling of flights and the availability of persons to be interviewed.

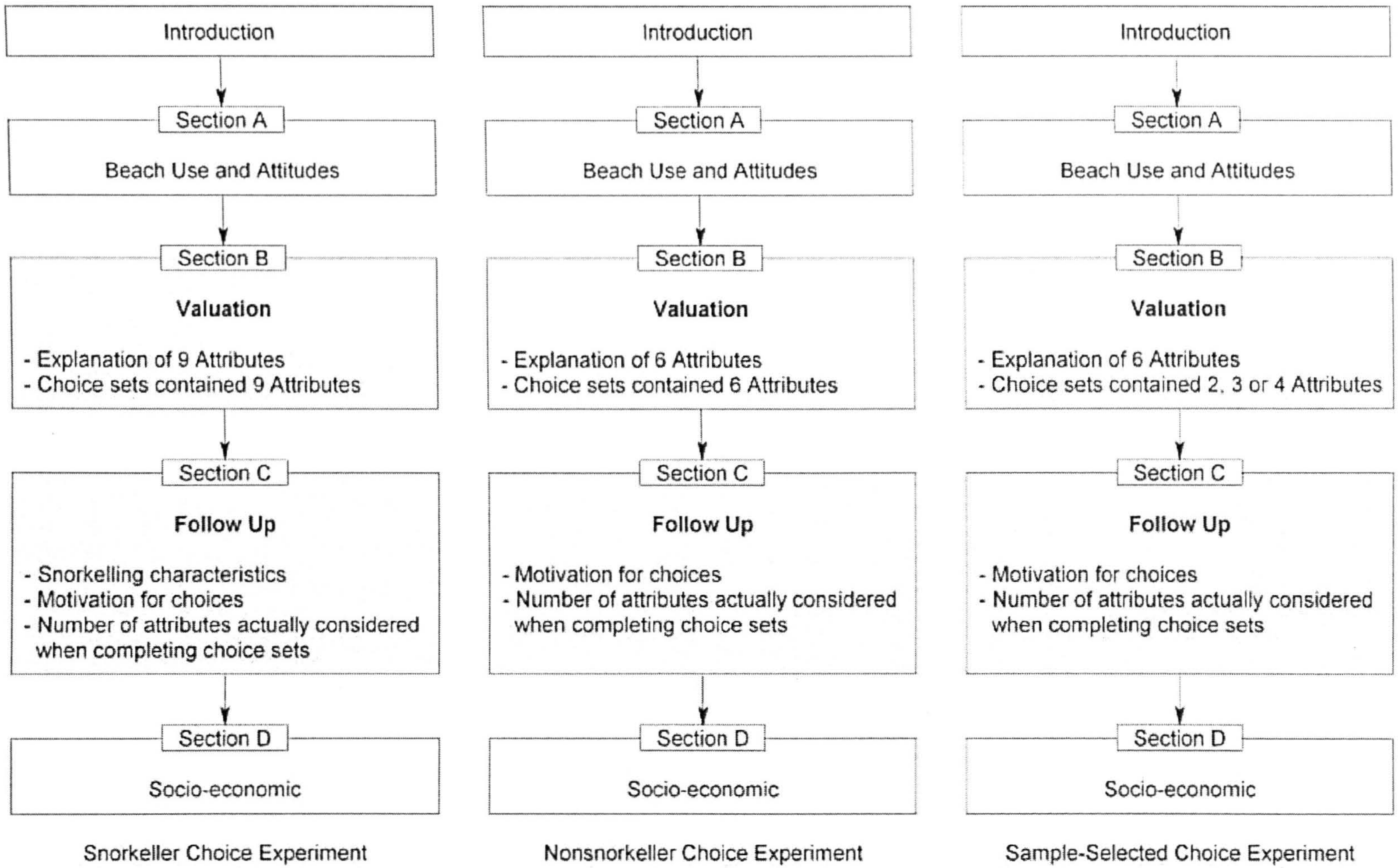


Figure 3.13: Three discrete choice experiments

In this section, a description of the three questionnaires (snorkellers, non-snorkellers and respondent-selected) will be presented together with the efforts made to reduce sources of bias within the data (§ Appendix A, B and C for full versions of the three questionnaires). Each questionnaire consisted of four main sections. The questions in Sections A and D of all three questionnaires were the same while the questions in Section B and C varied depending on whether the discrete choice experiments was targeted at respondents of the snorkellers, non-snorkellers or respondent-selected experiments (§ Figure 3.13).

- Introduction: The enumerator introduced herself and provided preliminary information to determine whether the respondent would be willing to participate in the survey.
- Section (A): The first section comprised of questions which sought to ascertain whether the respondent was an international visitor or a national of Trinidad and Tobago. It also consisted of questions regarding the respondents' frequency of use of beaches in Tobago, frequency of activities enjoyed at the beach, attitudes towards improving coastal water quality and preferences for beach characteristics.
- Section (B): The second section began with an explanation of the hypothetical scenario. This entailed asking respondents to imagine a choice situation where they have a day out in Tobago. The attributes used in the discrete choice experiment were explained with the aid of photographs to help respondents visualise what each attribute would look like on a beach in Tobago. The choice sets varied based on the number of attributes in each discrete choice experiment. For example, the non-snorkellers and respondent-selected respondents were presented with 6 attributes and the snorkellers were presented with 9 attributes.
- Section (C): The third section contained debriefing questions on whether respondents were or were not willing to pay for improvements for the choice scenarios. It also contained questions to determine whether the respondents were employing any strategies to simplify their choice tasks.
- Section (D): The fourth section contained questions which gathered information on socio-economic characteristics such as education, income and work status.

3.4.1 Introduction

The enumerator approached respondents by first introducing herself. They were then informed that she was a student from the University of York and was carrying out research on the beaches of Tobago. She also indicated that this information would be used to help improve the quality of coastal water quality at beaches in Tobago. The respondents were also informed that the reason they had been approached in the airport was to gain an opinion of visitors who may have recently completed their vacation or nationals who were travelling. They were also informed that the surveys were voluntary and that all their responses would be kept confidential. Respondents were also given the approximate time it would take to complete the survey. Finally, respondents were asked if they would be would be willing to participate. Information such as date, time and identification numbers for each completed survey were recorded in this part of the survey.

3.4.2 Section A - Beach use and Attitudes

The first questions in this section were used to categorise respondents into one of the three categories (1) international visitors (2) local visitors who resided in Trinidad and (3) locals who resided in Tobago. This allowed the enumerator to determine which questions to ask in the remaining sections. An objective of this section was to determine whether the respondent visited a beach and, if so, the frequency with which he or she engaged in particular recreational activities. It was important for the reliability of the valuation estimates that the majority of the sampled population were beach users.

Questions in this section were also asked to determine the characteristics of a beach which were most important to each respondent. This was done using ranking by elimination which allowed the respondent to choose the beach characteristics which were most important and less important to him or her. Respondents were also asked to rank beach characteristics other than coastal water quality, such as the presence of amenities and availability of facilities. This allowed the issue of coastal water quality to be placed in the wider context of characteristics which may affect their beach visitation. Therefore, the environmental good of coastal water quality was embedded in an array of substitute and complementary goods which helped to establish an appropriate frame of reference for the respondents Bennett &

Blamey (2001), Adamowicz et al. (1998).

Other important questions involved determining the respondents attitudes towards improvements to coastal water quality, determining who they thought should be responsible for improvements, and their opinion on whether particular groups of users or the government should give monetary contributions for improving water quality. These questions also helped respondents to explore their thoughts and attitudes towards coastal water quality. This helped to reveal the underlying factors driving respondents answers and was therefore helpful in the interpretation of the valuation results.

3.4.3 Section B - Valuation

In order to introduce the valuation scenarios for all three discrete choice experiments, a statement explaining the decision to improve the coastal water quality was given together with an explanation of why this was important. The details provided on this decision included some measures which could be implemented to ensure that water quality would be improved. The solutions were explained in terms of the high level and low level of policy action and the 'no level' of policy action (or status quo). Visual aids were used to help differentiate between the status quo and the alternatives presented and to make respondents feel that the solutions that were being offered were believable. The respondents were also told that their contributions to a non-governmental authority would be used to help achieve the levels of environmental improvement.

The snorkeller respondents were presented with choice sets consisting of 9 attributes while the non-snorkeller respondents were presented with those consisting of 6 attributes (§ Appendix A and II for sample choice sets). In the respondent-selected experiment, the respondents were asked to choose the number of attributes that were most important to them on their day out at the beach. If they chose more than 4 attributes they were asked to rank the attributes. If they chose less than 4 attributes, they were given choice sets which incorporated the number of attributes which were important to them (§ Appendix C for sample choice task material).

Once the attributes and their levels had been explained, respondents were presented with a worked example of a choice set. This allowed the enumerator to explain the choice task. A sample answer was given. Respondents were asked to imagine having the option of a day of leisure and that there were only three options available on this day. Respondents were informed that in making this choice, it was important to consider all attributes and levels inclusive of the cost attribute presented to them. The enumerator explained each level present in each alternative in order to help the respondent understand what they should consider when making their choices. Respondents were asked to consider whether they thought that the coastal water quality policies offered value for money when taking into account their budgets. They were then told to consider all three alternatives and choose their most preferred option. Once the example choice card had been explained, respondents were presented with all the choice cards and asked to complete all of them in the same way. At the beginning of each choice set, an extra choice set was inserted to test for monotonic preferences and at the end stability of preferences were tested for. Respondents who were snorkellers and non-snorkellers were presented with 9 and 6 choice cards respectively.

Respondents who participated in the respondent-selected experiment were given a varying number of choice cards depending on the number of attributes chosen. For example, those who chose 2 attributes had to complete 7 choice cards while for those who chose 3 and 4 attributes had to complete 8 and 9 choice cards respectively. This was exclusive of the two extra choice sets that were included to test for monotonicity and preference stability. Sample choice cards for the snorkellers and non-snorkellers are presented in Figures 3.14 and 3.15. The choice sets for the respondent-selected respondents were presented on a magnetic board and the respondents were given an answer sheet where they could record their answers. The design sheet as depicted in Figure 3.16 was used to help the enumerator to create the choice sets.

A DASH (-) represents that there is no program to control the levels of this factor at the beach

	BEACH A	BEACH B	NEITHER BEACH
Boats (near coastline)	-	2 Boats or less	I Choose to Visit Neither Beach
Marine Protected Area (absence or presence)	-	YES, TO VISIT ONLY, NO FISHING	
Coastline Development (hotels and homes)	Less than 25% developed	-	
Average Bathing Water Quality (chance of an ear infection)	Reduced chance	Increased chance	
Water Clarity (down to seabed)	Up to 10 meters	-	
Plastics (per 30meters of beach)	Less than 5 pieces	Up to 15 pieces	
Number of Snorkellers (per group)	-	Up to 15 per group	
Level of Coral Cover	Up to 45% coral cover	15% coral cover	
Abundance of Fish	Up to 60 fishes	-	
Contribution Fee (TT$)	TT$10.00	TT$25.00	TT$0
I would choose to visit	☐	☐	☐

TT$10.00 = US$1.40 = £0.90 **TT$25.00 = US$4.00 = £2.27**

Figure 3.14: Sample choice set for snorkellers experiments

DASH (-) represents that there is no program to control the levels of this factor at the beach

	BEACH A	**BEACH B**	**NEITHER BEACH**
Boats (near coastline)	-	Up to 7 boats	
Marine Protected Area (absence or presence)	-	YES, TO VISIT ONLY, NO FISHING	
Coastline Development (hotels and homes)	Less than 25% developed	-	
Average Bathing Water Quality (chance of an ear infection)	Reduced chance	Increased chance	I Choose to Visit Neither Beach
Water Clarity (down to seabed)	Up to 10 meters	-	
Plastics (per 30 meters of beach)	Less than 5 pieces	-	
Contribution Fee (TT$)	TT$10.00	TT$25.00	
I would choose to visit	☐	☐	☐

TT$10.00 = US$1.40 = £0.90 **TT$25.00 = US$4.00 = £2.27**

Figure 3.15: Sample choice set for non-snorkellers experiments

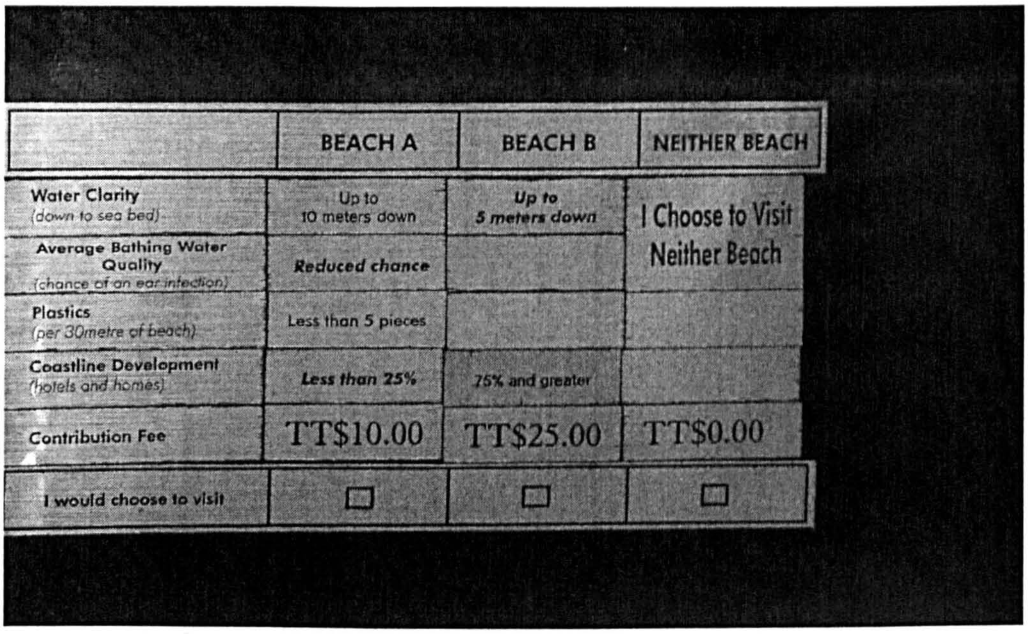


Figure 3.16: Sample choice set on magnetic board and labels for respondent-selected experiment

3.4.4 Section C - Follow-up

Following the completion of the choice cards, respondents in all three discrete choice experiments were asked whether they considered all attributes presented to them while making their choices. This was done to determine whether respondents had been ignoring attributes presented to them (Louviere & Islam 2004, Campbell et al. 2006, Hensher 2006*a*). Other questions in this section were included to determine why the respondents were or were not willing to pay for improvements. In the case of a respondent who chose the status quo alternative, a question was designed to detect protest bids from people who genuinely were not willing to pay for improvements. In the case of persons who did choose to pay for improvements, questions were asked to determine what the main rationale behind their choices was. This was also done to obtain an indication of whether persons may have been exhibiting behaviour which created the 'warm glow' effect. In the snorkellers discrete choice experiment, an additional section included questions on locations at which the respondents snorkelled and their motivations for snorkelling. These were designed to obtain information which could help characterise the type of snorkeller.

3.4.5 Section D - Socioeconomic

This section contained questions which helped to identify the socioeconomic characteristics of the individuals. All respondents were asked questions on their income, the number of persons in their household, age, work status, education, place of residence and involvement in environmental groups. Visitors were asked additional questions, in particular the length of their stay, type of accommodation and the purpose of their visits. All respondents were also asked their general opinion on the survey to determine whether the general feedback on the survey was positive or negative.

3.4.6 Limitations of survey design

One of the main limitations of this survey was the limited available financial resources to interview a larger and more representative sample of respondents. For example, in addition to the airport, visitors could have been interviewed at the main harbour. This is another entry point for domestic and international visitors who use inter-island ferry services or cruise ships. In addition, the use of a stratified random sampling covering all geographical counties could have been used to achieve a more representative sample of preferences of the local beach users.

Another limitation of the design of the respondent-selected treatment was the manual construction of the choice sets in the field by the administrator. Computer technology could be used to automatically construct the choice cards based on each respondent's choice and number of attributes. This could have been implemented using public computer stations or in-person portable touch screen computers. These methods of survey administration could have reduced the time taken to complete each survey as well as minimise the incidence of human error in manual construction of the choice sets.

Despite these limitations every attempt was made to ensure that the design and adminstration of the survey was undertaken in such a way that biases were minimised and sampling efficiency was maximised.

3.4.7 Summary

This chapter described the design and development of the three discrete choice experiment surveys carried out in this thesis. The use of one-on-one interviews, focus groups and pilot studies guided the development of the three surveys. The qualitative research began with the use of one-on-one interviews with policy makers and scientists in order to derive a preliminary list of attributes and levels. This list was refined using four focus group sessions with different segments of target respondents. Opinions on all aspects of the survey were sought in these sessions with the aim of ensuring that the survey instrument was easily understandable to the targeted respondents. The final stage of the qualitative research involved the use of pilot surveys to test the final survey instruments in the field.

The final attribute list was chosen so as to reflect the results of the qualitative research. Each attribute was also chosen so as not only to adequately describe changes to coastal water quality but also to be able to characterise aspects which recreational beach users considered when making their choice to visit the beach. The non-snorkeller and respondent-selected surveys contained 6 attributes while the snorkeller survey contained 9, exclusive of the fee attribute. The attributes included: number of boats along a coastline, presence of a marine protected area, level of vertical visibility, number of plastic debris per 30 metres of coastline, chance of contracting an ear infection, level of coastline development, abundance of fish, level of coral cover and number of snorkellers per group. Each attribute was represented under three levels of policy action to improve the quality of the coastal waters: high policy, low policy and no policy.

The choice sets were constructed using a statistical design which identified only the main effects. Numerical optimisation procedures were employed to improve the efficiency of the design by altering the fee attribute for the snorkellers and non-snorkellers. To evaluate the improvement, the D-error was calculated for the improved designs. It was found that, for both groups of respondents, there was an increase in the D-efficiency of the design after implementation of the numerical optimisation technique.

The three final questionnaires contained four main sections. The first section was designed to elicit information on the respondent's use of the beach and attitudes towards coastal water quality. The second section contained the valuation scenarios and explanation of the choice tasks. The third section contained follow-up questions which helped to explain why respondents made their choices and also to determine if they had excluded any attributes from their consideration. The final section contained questions designed to gather socioeconomic information to help with interpretation of the choices made in the discrete choice experiments.

Chapter 4

Valuation estimates for snorkellers and non-snorkellers

Abstract

This chapter reports the results of a discrete choice experiment designed to determine the willingness to pay (WTP) for an improvement in coastal water quality for two types of beach recreationists: snorkellers and non-snorkellers. As described in Chapter 3, two separate surveys were designed and administered by one interviewer to locals, domestic and international visitors. The responses of 284 beach recreationists were analysed and the results are presented.

This chapter begins in Section 4.1 by describing the significance of categorising beach recreationists into two systematic groups in the context of the study site. This is followed in Section 4.2 by the specific research questions addressed and a review of the related literature and methods used to derive the recreational benefits of coastal water quality. A brief description of the survey adminstration is presented in Section 4.3. In Section 4.4, the descriptive findings of the two surveys are presented and the results of socio-economic questions, attitudinal and follow-up questions from snorkellers and non-snorkellers are discussed and compared. The parameter estimates of alternative discrete choice models are then presented and discussed in Section 4.5. These include the results of the MNL model under two specifications and the MMNL and LCM models. The latter two models are used to investigate the presence of unobserved taste heterogeneity within snorkeller and non-snorkeller groups. In this section, the explanatory power of each model is also

compared using a number of statistical criteria.

The rationale for choosing the most appropriate discrete choice model specification is discussed in Section 4.6. The parameter estimates from the chosen model specifications are then used to calculate marginal WTP estimates. Following this, the results from the individual-specific WTP values are calculated and presented using kernel density graphs for each attribute in Sections 4.6.1 and 4.6.2 for the snorkellers and non-snorkellers respectively. The cost per beach visit is presented in Section 4.7 by calculating compensating variation estimates using the individual-specific estimates for each model specification. Prioritised policy recommendations for each attribute are discussed in Section 4.8. Finally, the chapter concludes with a summary of the main results in Section 4.9.

4.1 Introduction

Beach recreation is an important contributor to welfare in Tobago for both local and tourist populations. There are now over thirty thousand visits to the beaches of Tobago every year (CSO 2001)[1]. This increase in visitation in combination with pollutants from land based activities causes coastal water pollution and degradation problems. Within the past ten to fifteen years, coastal water pollution has become an important concern in Tobago and in the wider Caribbean region (Siung-Chang 1997). Deterioration in coastal water quality has not only made many beaches unsuitable for swimming, but it has also damaged ecological systems such as coral reefs, mangroves and seagrass communities (IMA 2006). The source of deterioration has been identified as nutrient pollution leading to a series of environmental issues such as eutrophication, harmful algal blooms, loss of seagrass and coral reefs and marine diseases (Lapointe et al. 2004). Nutrient pollution of Tobago's coastal waters is likely to have a direct impact on the tourism industry. While the environmental impacts of degraded costal water quality have been described and documented, no study has yet been undertaken to estimate the recreational benefits of improving coastal water quality on the island.

[1]The average number of beach visits per year is based on the author's calculation and done by using data from The Central Statistical Office of Trinidad and Tobago.

Environmental valuation studies provide information which policy makers and managers require to manage the coastal environment. As in other developing areas of the world, there is a paucity of environmental valuation studies in the Caribbean region, primarily because of the limited use of these tools in decision and policy making. However, in the small number of economic valuation studies which have been undertaken on marine recreational activities, the emphasis has been on valuing the benefits accrued to recreational users who engage in scuba diving and snorkelling (Williams & Polunin 2000, Thur 2004, Barker 2003). This could be because marine protected areas (MPA) have become highly advocated as a form of marine conservation and management. Hence, valuation studies have tended to focus on recreational activities which could fund the management of these parks. While snorkelling and scuba diving are commonly undertaken by visitors to the Caribbean, most of the local population do not regularly engage in these activities.

The systematic categorisation of the two recreational groups, snorkellers and non-snorkellers or general beach users, was instrumental in allowing a specific investigation into the preferences of visitors and local beach users. This is important to resource managers as it provides them with information on the preferences of both local and visitor populations.

Even within systematic groups there can be diverse preferences, particularly when investigating a quality aspect of a natural resource. Therefore, in addition to identifying systematic heterogeneity, it is important that studies also account for any unobserved taste heterogeneity within groups in the measurement of preferences (§ Section 2.3.2). Homogeneity is commonly assumed in theoretical enquiries into the general properties of environmental problems (Milon & Scrogin 2002). However, to make a better informed case for protection, and thereby to improve policy making, it is important that environmental policy decisions allow for any taste heterogeneity. This is achieved in this chapter by addressing the following research questions:

1. Are there differences in the WTP values for beach access due to an improvement in attributes linked to better coastal water quality for two groups of beach recreationists, snorkellers and non-snorkellers?

2. Can unobserved taste heterogeneity be accounted for using latent class and mixed multinomial logit model specifications? If so, what are the differences in WTP values after accounting for unobserved taste heterogeneity?

3. Based on the derived valuation estimates, what are the recommendations for policy initiatives in order to improve attributes associated with better coastal water quality on Tobago?

4.2 Related literature

Several studies have estimated the marine recreational benefits of improved coastal water quality. This can be attributed to two factors. The first is the wide range of public policy issues associated with protecting this natural resource, such as balancing extractive and non-extractive uses, disposal of biodegradable wastes and multiple uses of marginal lands. The second is the large number of marine recreational activities which the public can engage in. The basic premise of all these studies is that improved coastal water quality should improve the experience of the marine recreational activity, which in turn should lead to measurable economic benefits.

In 1995, Freeman produced a review of the empirical literature on the economic value of marine recreational activities (Freeman 1995). Freeman indicated that the recreational activities which have received the most attention are fishing, swimming and related beach activities and boating. His analysis also revealed that in comparison to marine recreational activities such as boating or fishing, the number of studies undertaken on swimming and beach-related activity remains small. Today, just over a decade later, the number of beach applications still remains small in comparison to marine recreational activities such as boating or fishing (Massey 2002).

The literature on the demand for recreational beach services can be categorised into two main streams of research. The first describes studies which have estimated the recreational value of beach access due to a change in a site characteristic linked to water quality. The second describes studies which address characteristics which are not directly linked to water quality. This second category can be further subdivided into two parts. The first gives the recreational value of beach access due to a change in site quality characteristics which are unrelated to water quality. Studies in this area include those on congestion (McConnell 1977) and beach nourishment (Silberman & Klock 1988, Huang & Poor 2004, Landry et al. 2003). The second calculates an economic value for beach access and does not link directly to any site quality attributes (Bell & Leeworthy 1990, Leeworthy & Wiley 1991, Parsons et al. 2000, Bin et al. 2004).

The study described in this chapter falls into the first of the aforementioned categories. Therefore, this review will focus on the methods and studies used for (1) estimating the economic value of beach access for swimming beach-related activity and (2) investigating how these are affected by variations in attributes linked to water quality. The majority of these studies were undertaken using systems of demand equations, travel cost models, random utility models and the contingent valuation method. More recently, a small number of studies which use choice experiments to produce value estimates have been carried out.

The earliest studies which valued quality dimensions of coastal waters for beach recreation were carried out in the 1980s, at which time there was a shift in focus (in recreational demand modelling) from just valuing access to a beach sites to valuing changes in the quality of the beach environment. Additional quality attributes addressed included turbidity and secchi disk readings (Bockstael et al. 1991).

The first applications to show the benefits of improving coastal water quality were carried out by Feenberg & Mills (1980), Vaughn et al. (1985), Freeman (1979), Bockstael, Hanemann & Kling (1987). In order to accommodate the valuation of site characteristics, Vaughn et al. (1985) used a varying parameter model. This was the first study which attempted to determine how participation in swimming at marine beaches was influenced by the pollution. However, Vaughn et al. (1985) could not detect a significant link between pollution and beach use (Freeman 1995). The same dataset was used for the study by Feenberg & Mills (1980) and Bockstael, Hanemann & Kling (1987) but Feenberg & Mills (1980) study used the random utility methodology (RUM) while Bockstael, Hanemann & Kling (1987) compared and contrasted the RUM model with the hedonic travel cost model. This literature reflects the fact that whilst researchers were trying to value changes in environmental quality, they were also paying increasing attention to the details of the models which were being derived (Bockstael et al. 1991). For example, the studies by Bockstael, Hanemann & Kling (1987), Bockstael et al. (1989), Bockstael, Strand & Hanemann (1987), all used the same dataset to examine varying methodological issues surrounding the recreational benefits of improving coastal water quality in Chesapeake Bay. Earlier studies which also focused on methodological work applied to estimating water quality benefits include those studies by Smith & Desvousges (1985), Smith et al. (1983). The travel cost and the RUM site choice methods were the two most prominent methods used at this time. Both require that the consumer visit the site to consume its services. The popularity of contingent valuation (CV) grew from the 1990s onwards because it freed analysts from their reliance on observations of behaviour in order to make inferences of value. The earliest study using the CV method was that on Chesapeake bay carried out by Bockstael et al. (1989). Other more recent applications include (Zylick et al. 1995, Barton 1998, Machado & Mourato 1999, Goffe 1995).

Although discrete choice experiments have become increasingly prevalent in environmental economics, few have focused on coastal water quality in the context of beach recreation. To date only two studies exist in the latter category, that of EFTEC (2002) and that of Eggert & Olsson (2005). In the study by EFTEC (2002), 6 attributes (water quality, advisory note system, litter or dog mess, safety and additional water charges per year) were examined and related to the implementation of a revised European Commission Bathing Water Quality Directive. In the study by Eggert & Olsson (2005), water quality was described using 4 attributes: fish stock level, bathing water quality, biodiversity level and cost. Both studies linked the levels of their attributes to changes in coastal water quality.

This research represents only the third application of the discrete choice experiment method to examine the effect of varying levels of beach visit attributes on beach users' WTP for beach access. It therefore contributes to the literature in 3 ways:

1. This study provides valuation estimates for 9 attributes linked to coastal water quality and beach recreation which have not previously been explored in the literature. This

study is also the first discrete choice experiment application in the context of beach recreation that has been undertaken in a developing country.

2. In order to value changes in coastal water quality, this study systematically categorises beach recreationists into two groups (snorkellers and non-snorkellers) and examines their preferences separately by using different choice experiment designs. The study also accounts for unobserved taste heterogeneity in the respondents using the LCM and MMNL models.

3. The results of this study are use to provide policy recommendations for attributes linked to improvements in coastal water quality in Tobago.

4.3 Survey administration

The results presented in the following sections are from two discrete choice experiment surveys that were administered. The first was designed for non-snorkellers and comprised of choice sets with 6 attributes each having 3 levels. The second was designed for snorkellers and comprised of 9 attributes, also with 3 levels. All respondents were interviewed in the Crown Point International airport in Tobago. Further details on the design and adminstration of these surveys are detailed in Chapter 3.

4.4 Descriptive results

This section provides a summary of the socioeconomic characteristics as well as responses from attitudinal and follow-up questions for the two sampled populations. In total, 305 surveys were administered. Of these, 15 persons refused to participate in the survey, representing a 7 percent refusal rate; 6 surveys were unusable. In all, 284 surveys were collected with usable responses. Of these, 198 were completed by snorkellers while 86 were completed by non-snorkellers.

4.4.1 Distribution of visitors and residents

Most of the non-snorkellers (64 percent) were residents of Tobago or local visitors from Trinidad while 36 percent were made up of international visitors. In the group of snorkellers,

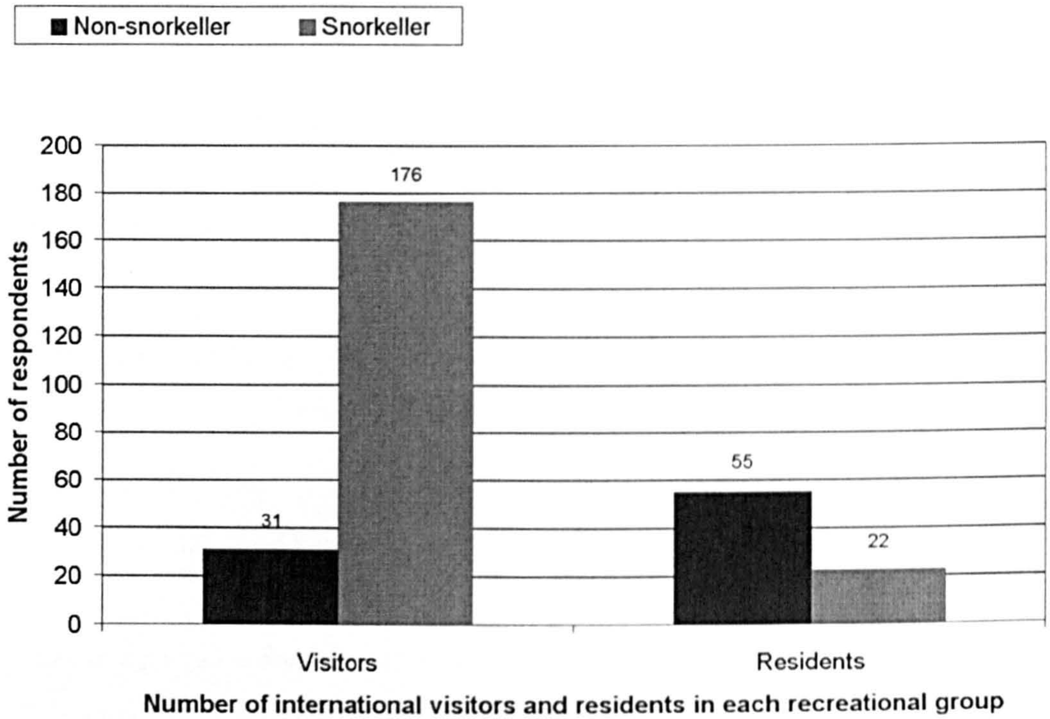


Figure 4.1: Distribution of visitors and residents

just 11 percent were local visitors and residents while 89 percent were international visitors. Therefore, the majority of international visitors engage in snorkelling while most of the local visitors and residents of Tobago do not. Figure 4.1 shows the breakdown of each group of respondents.

4.4.2 Age, sex and household size

As shown in Table 4.1, the majority of snorkellers belong to the 31-40 age group (33 percent) closely followed by the 18-30 age group (32 percent). The majority of non-snorkellers belong to the 18-30 age group (31 percent) while 26 percent belong to the 31-40 age group. Both groups of respondents contained an almost equal distribution of males and females. The non-snorkeller group was made up of 48 percent males and 52 females, while the snorkeller group was made up of 54 percent males and 46 percent females. Of the 86 non-snorkellers, 34 percent have a household size of 2 persons, while 70 percent of the snorkellers had a household size of 2 persons.

Table 4.1: Age, sex and household size of respondents

	Non-snorkellers		Snorkellers	
	Percent	Frequency	Percent	Frequency
Age				
18-30	31.40	27	31.82	63
31-40	25.58	22	32.83	65
41-50	18.60	16	15.15	30
51-64	20.93	18	17.68	35
65+	3.49	3	2.53	5
Total	100	86	100	198
Sex				
Male	47.67	41	53.54	106
Female	52.33	45	46.46	92
Total	100	86	100	198
Household size				
1	16.28	14	4.04	8
2	33.72	29	70.20	139
3	12.79	11	9.09	18
4	13.95	12	10.10	20
5	10.47	9	3.54	7
6	8.14	7	1.01	2
> 6	4.65	4	2.02	4
Total	100	86	100	198

Table 4.2: Employment types of respondents

	Non-snorkellers		Snorkellers	
Employment	Percent	Frequency	Percent	Frequency
Self employed	22.09	19	7.07	14
Employed full time (40 hours plus per week)	61.63	53	72.73	144
Employed part time (less than 40 hours per week)	5.81	5	7.07	14
Student	3.49	3	3.03	6
Housewife	2.33	2	1.01	2
Retired	2.33	2	7.58	15
Unemployed	2.33	2	0.51	1
Unable to work due to sickness of disability	0.00	0	1.01	2
Total	100	86	100	198

4.4.3 Employment, income and education

As shown in Table 4.2, 62 percent of the non-snorkellers worked full time (40 hours plus per week), while 22 percent were self-employed. 73 percent of snorkellers worked full time while only 7 percent were self employed. Most of the snorkellers (89 percent) were from developed countries and, as expected, the average income level was higher for the snorkellers than the non-snorkellers (§ Table 4.3). Median income fell within the range of TT$36,000-TT$60,000 per year for the non-snorkellers[2] (20 percent). The median income range for the snorkellers was TT$204,00-TT$375,030 (77 percent). Tables 4.3 and 4.4 also show the distribution of income and educational attainments of both groups of respondents. For both snorkellers (46 percent) and non-snorkellers (30 percent), the most common level of eduction was a Bachelor's degree.

4.4.4 Attitudes

Respondents from both groups were asked a number of questions to determine their opinion about coastal water quality and its protection and use by visitors and locals. Most of the respondents agreed that the quality of coastal waters is affected by activities on the land and that everyone would benefit from its improvement. Most people also agreed that everyone should pay for environmental improvement and an even larger percentage of persons were of the opinion that responsibility for improving coastal water quality rests with the government (§ Figures 4.2 and 4.3).

For both groups of respondents, the most important amenity at a beach was the provision of good water quality followed by the presence of facilities such as food outlets and changing rooms. A larger percentage (67 percent) of the snorkellers thought that water quality was the most important attribute compared with the non-snorkellers (56 percent). More of the non-snorkellers also thought that the presence of facilities was important (26 percent) compared with the snorkellers (17 percent). Figures 4.4 and 4.5 shows that both groups of respondents had similar ratings for the presence of amenities such as water sports and jetties (2 percent for snorkellers and 3 percent for non-snorkellers) as well as the convenience of location (17 percent for snorkellers and 16 percent for non-snorkellers).

[2]The currency reported is Trinidad and Tobago dollars (TT$). Approximately GBP1.00 is equal to TT$12.67

Table 4.3: Income of respondents

	Non-snorkellers		Snorkellers	
Total Gross Income per Year (TT$)	Percent	Frequency	Percent	Frequency
Under 12 000	7.32	6	0.53	1
12 000 - 36 000	12.20	10	1.59	3
36 000 - 60 000	19.51	16	6.35	12
60 000 - 84 000	13.41	11	9.52	18
84 000 - 108 000	3.66	3	2.12	4
108 000 - 121 000	4.88	4	0.53	1
121 000 - 156 000	1.22	1	2.65	5
156 000 - 180 000	4.88	4	1.59	3
180 000 - 204 000	7.32	6	4.76	9
204 000 - 375 030	12.20	10	40.74	77
375 030 - 525 042	1.22	1	16.40	31
525 042 - 675 054	3.66	3	3.70	7
675 054 - 756 310	1.22	1	3.70	7
756 310 - 975 078	2.44	2	1.06	2
975 078 - 1 125 090	1.22	1	2.12	4
1 125 090 - 1 275 102	3.66	3	0.00	0
Over 1 275 102	0.00	0	2.65	5
Total	100	82*	100	186*
Average Income	204 723		339 431	

*12 respondents (housewives and students) were removed from the snorkellers and 4 were removed from the non-snorkellers because they did not have an income.

Table 4.4: Education level of respondents

	Non-snorkellers		Snorkellers	
Level of Education	Percent	Frequency	Percent	Frequency
Primary	3.49	3	1.01	2
G.C.S.E O Levels/C.X.C	19.77	17	15.66	31
Advanced Levels or Advanced Vocational Training	9.30	8	7.58	15
Professional qualification of degree levels	13.95	12	13.13	26
College Degree/ University Undergraduate degree	30.23	26	45.96	91
Postgraduate Education	23.26	20	16.67	33
Total	100	86	100	198

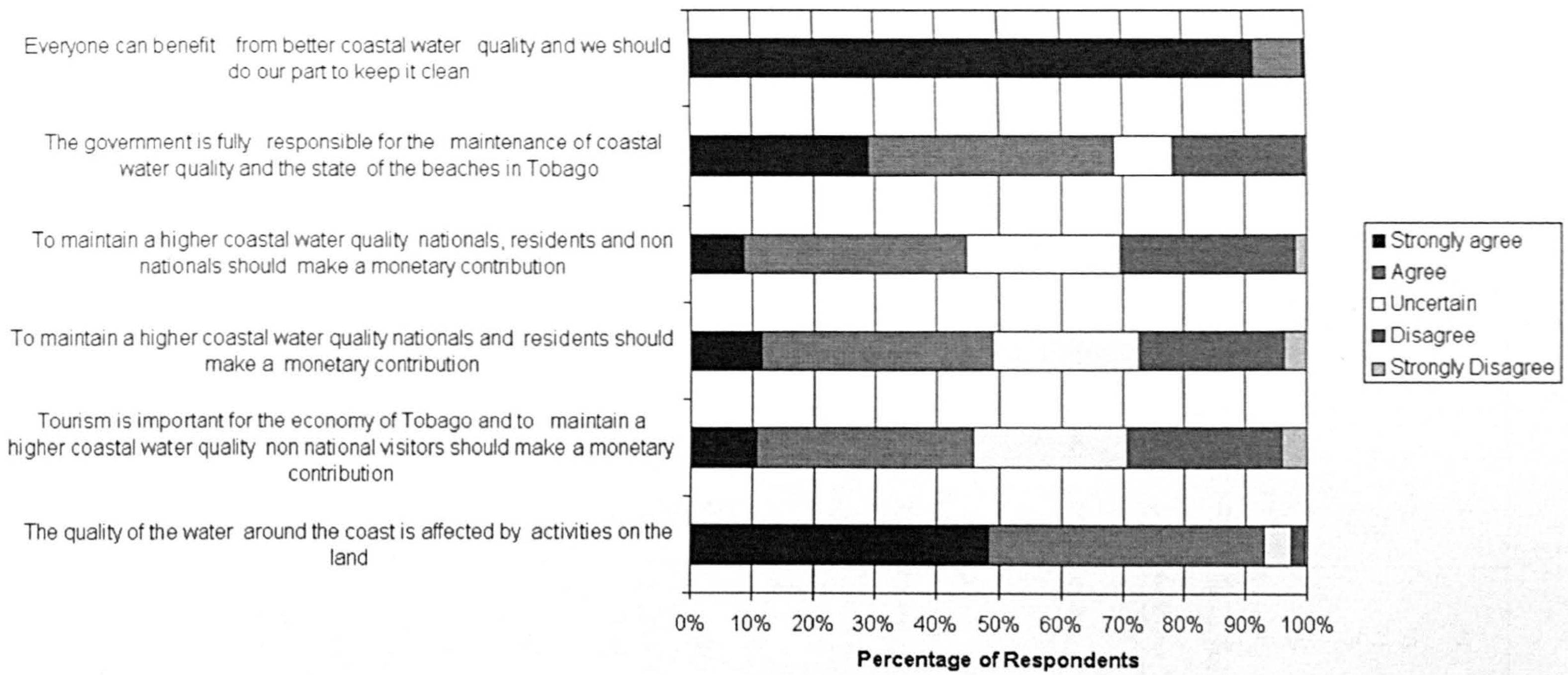


Figure 4.2: Attitudes of snorkellers towards coastal water quality

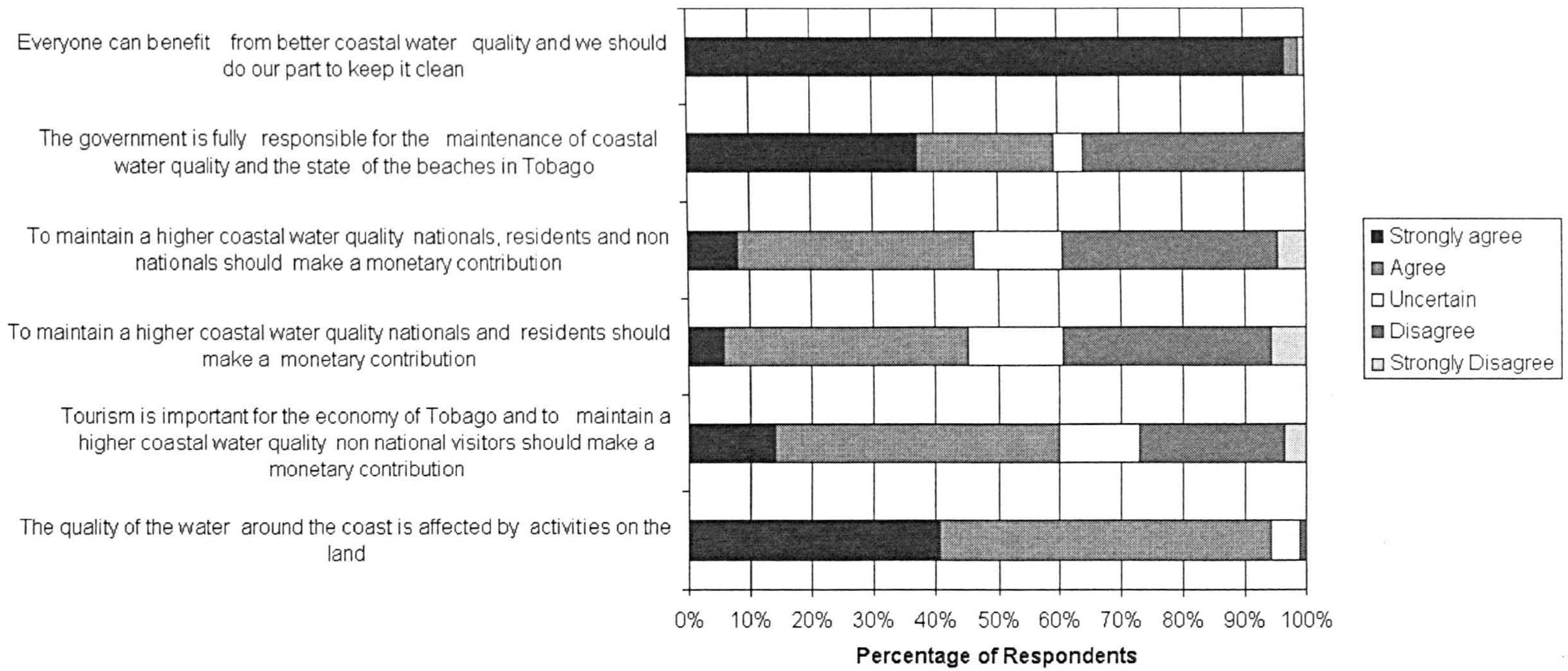


Figure 4.3: Attitudes of non-snorkellers towards coastal water quality

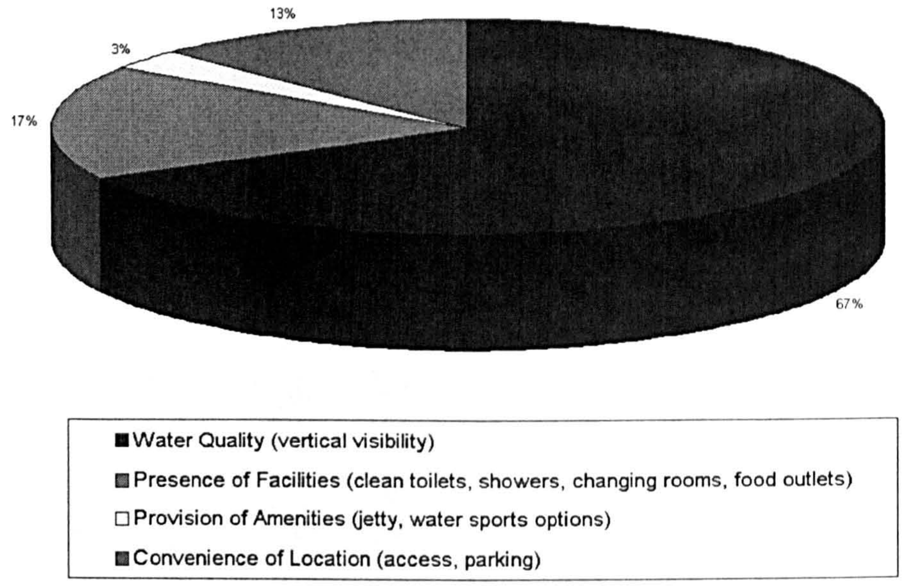


Figure 4.4: Attitudes of snorkellers towards availability of beach amenities

Even though the majority of the respondents in the two groups were not members of environmental groups, they still cared about the quality of coastal waters. A greater proportion of snorkellers were members of an environmental group in comparison to non-snorkellers (20 percent compared to 8 percent respectively).

4.4.5 Follow-up questions

A summary of reasons explaining why respondents might be prepared to pay for improvements in coastal water quality is presented in Figures 4.6 and 4.7. Respondents from both groups would be most prepared to pay for coastal water quality improvements if this would allow future generations to enjoy the beach (48 percent for snorkellers and 39 percent for non-snorkellers). The second most popular reason for non-snorkellers would be to allow themselves and their family to enjoy the beach (29 percent) while the second most popular reason for the snorkellers would be to improve the quality of the beach for everyone to enjoy (19 percent).

For both groups of respondents, 62 percent of respondents found that the questionnaire

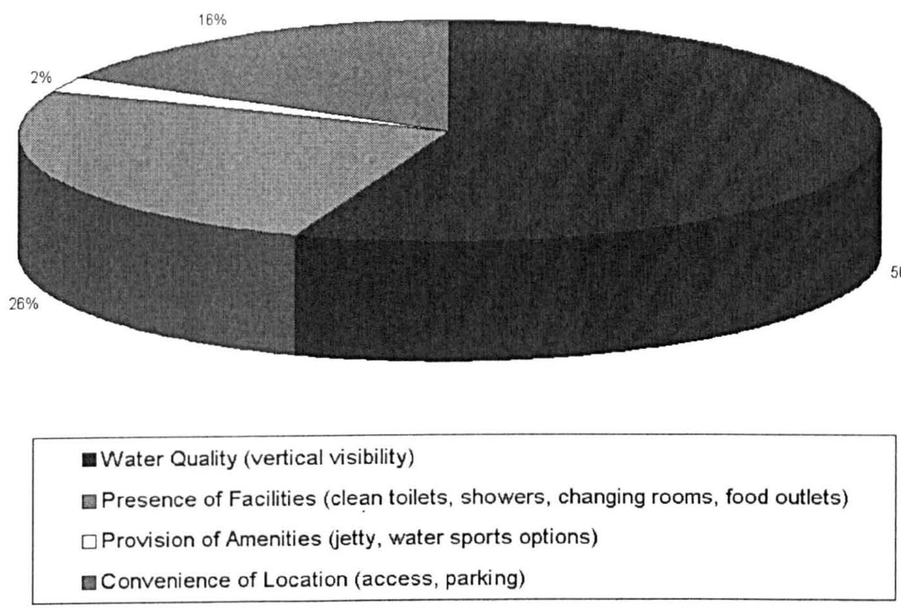


Figure 4.5: Attitudes of non-snorkellers towards availability of beach amenities

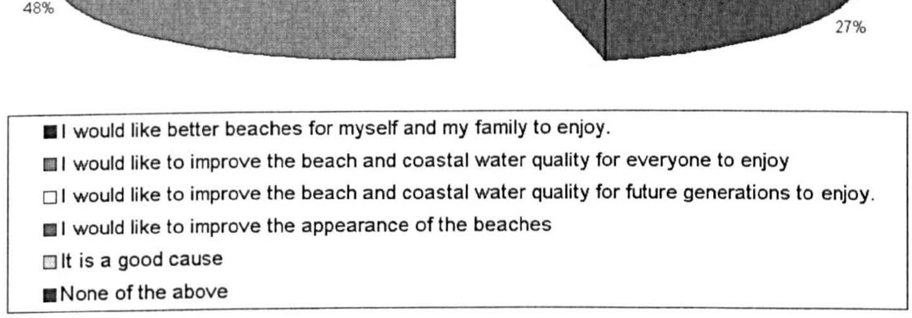


Figure 4.6: Snorkellers' rationale for choices

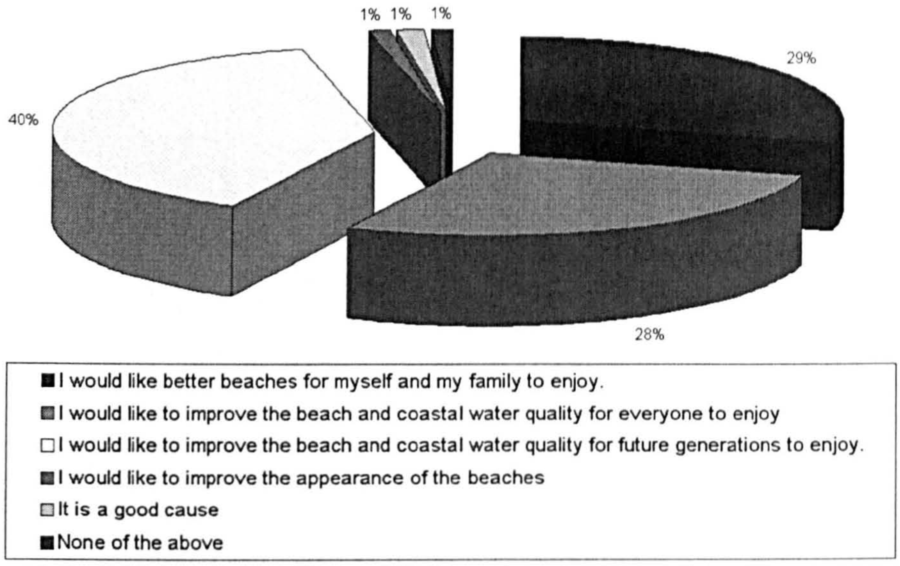


Figure 4.7: Non-snorkellers' rationale for choices

was interesting. A larger percentage of the non-snorkellers found that the questionnaire was educational and informative (21 percent compared with 19 percent for snorkellers). In contrast a larger percentage of snorkellers thought that it took a long time to think about the answers (12 percent compared with 7 percent for non-snorkellers). This could however be due to the difference in the number of attributes in the choice sets for the two groups of respondents.

4.4.6 Beach visitation, use and purpose

Amongst the snorkeller respondents, 87 percent of visitors went to the beach while only 13 percent did not visit during their last trip to the island. Amongst non-snorkellers, 54 percent of visitors went to the beach while 46 percent did not. Of the residents living in Tobago, both snorkellers and non-snorkellers, over 90 percent had visited the beach in the past 12 months.

Swimming is the most popular activity which both snorkellers (66 percent) and non-snorkellers (50 percent) *always* participate in at the beach. More than half (67 percent) of the snorkellers identified that the purpose of their visit was for a vacation followed by

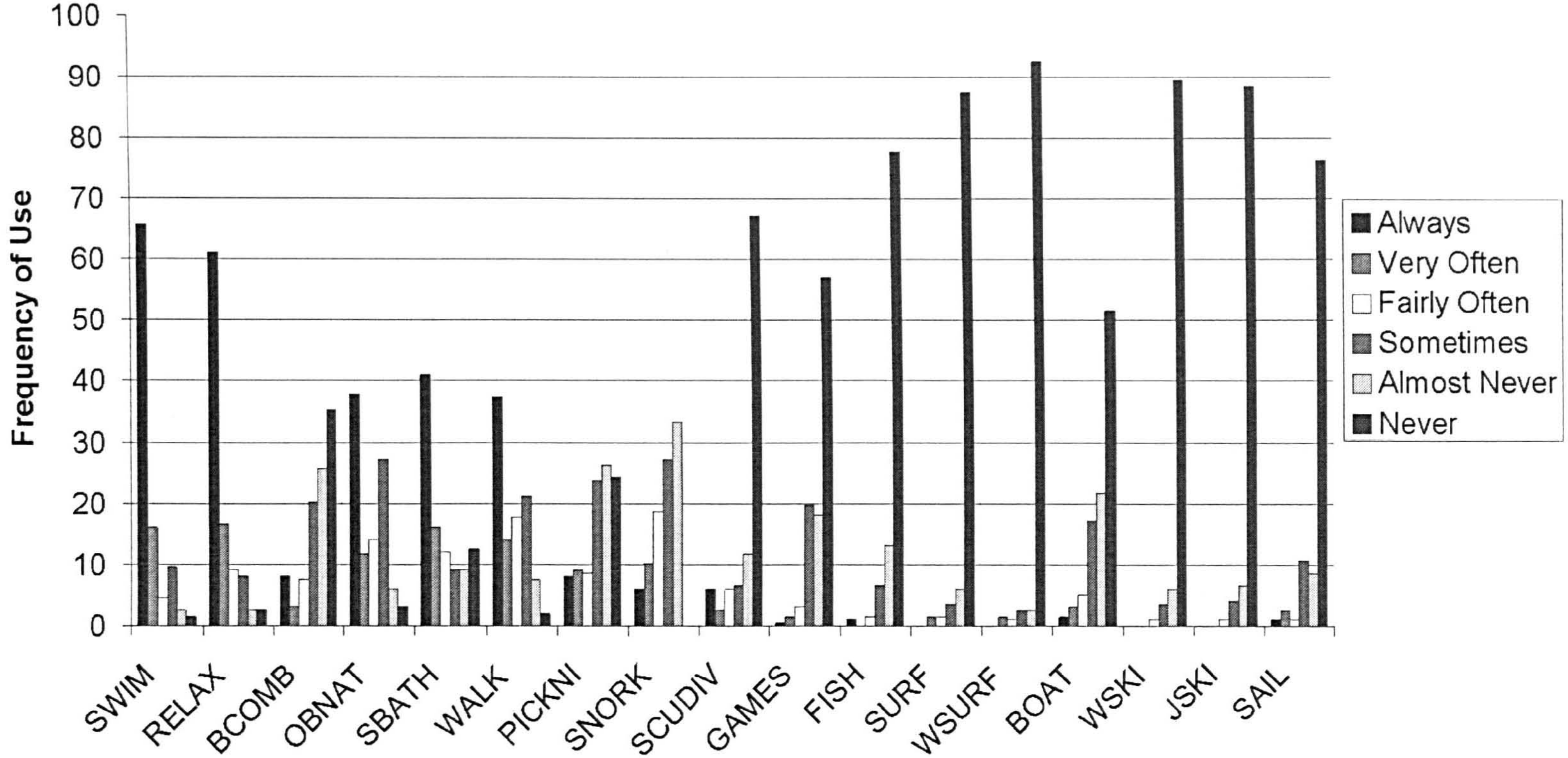


Figure 4.8: Snorkellers' frequency of beach use

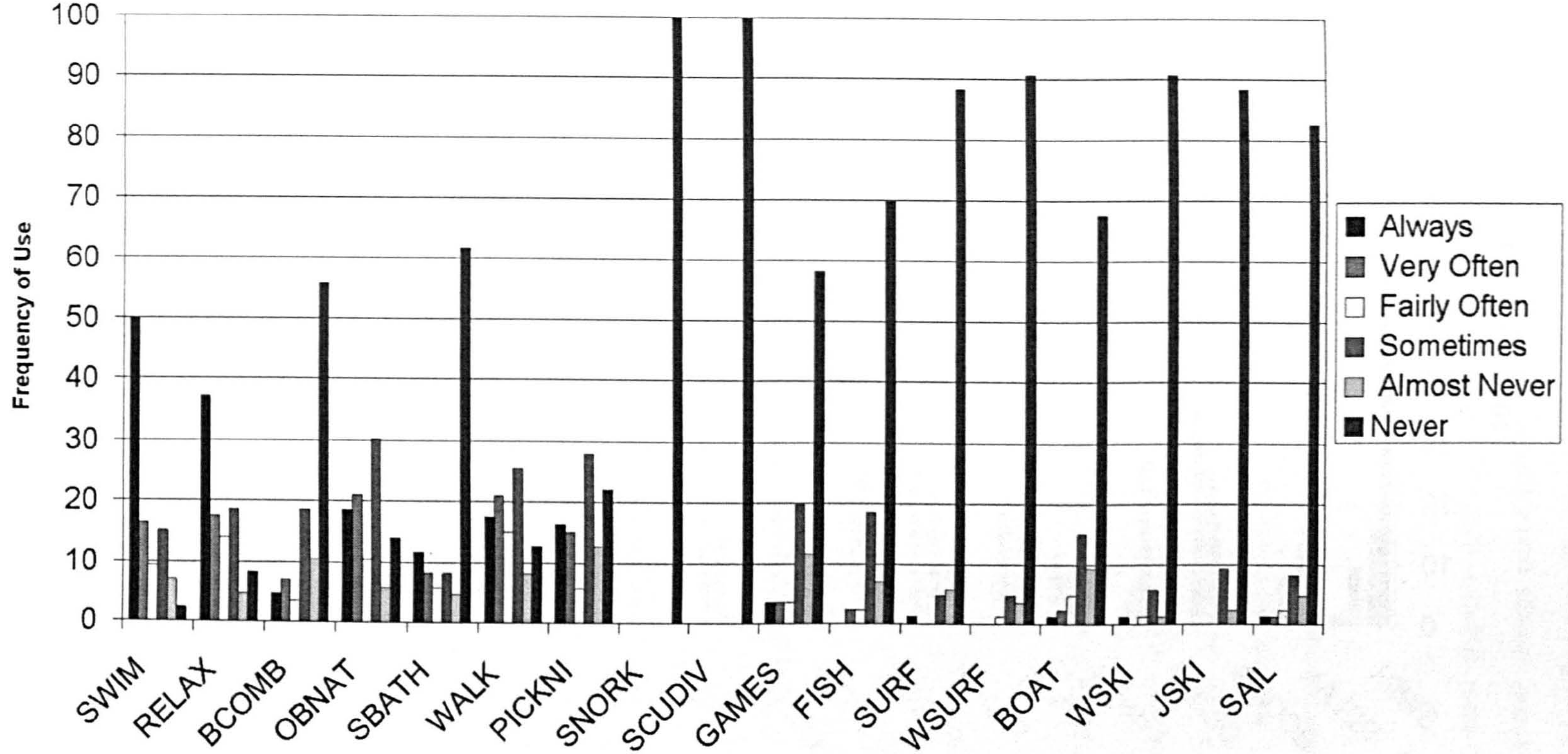


Figure 4.9: Non-snorkellers' frequency of beach use

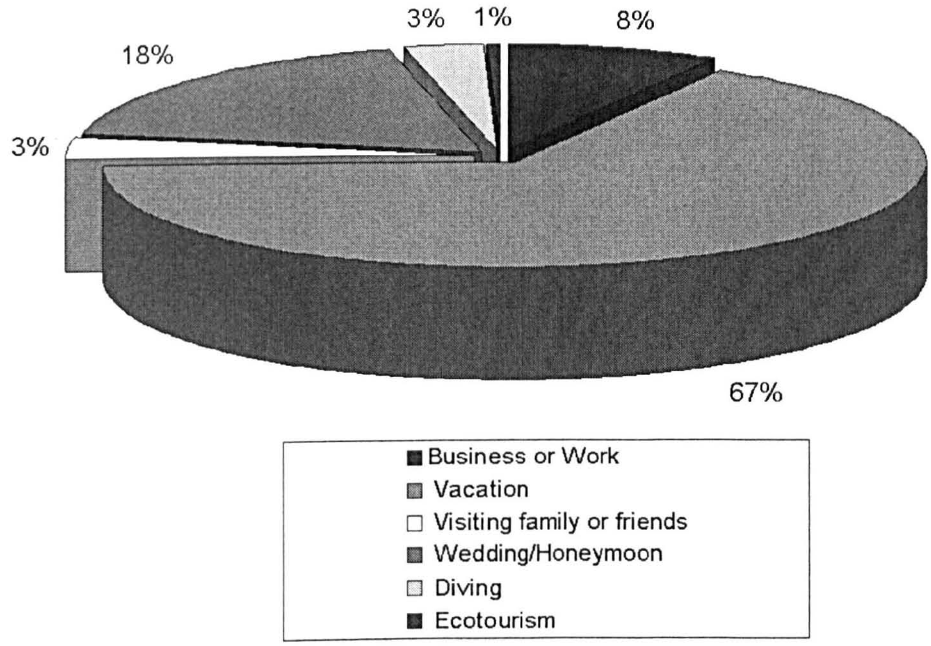


Figure 4.10: Snorkellers' purpose of visit

18 percent who visited to attend a wedding or were on a honeymoon. Less than half the non-snorkeller sample (44 percent) stated that the purpose of their visit was for a vacation. The second most popular reason for non-snorkellers' visits was for business (26 percent) followed by attending a wedding or being on honeymoon (17 percent). In the snorkellers, only 3 percent visited Tobago solely for diving while, as expected, no non-snorkeller visited solely for diving. Despite only 3 percent out of the snorkellers sampled stating that they visited solely for diving, 33 percent had actually participated in scuba diving to some degree over their lifetime. Even though Tobago has been recently acclaimed as the World's best eco-tourism destination, only 1 percent voted eco-tourism as the sole purpose of their visit. These low percentages may be because only enthusiasts of eco-tourism and diving are likely to report either activity as the main purpose of their visit.

The statistics show that the majority of snorkellers and non-snorkellers tend to participate in a number of recreational activities. It is clear however that for the local and visitor population sampled here, swimming is by far the most popular activity that they engage

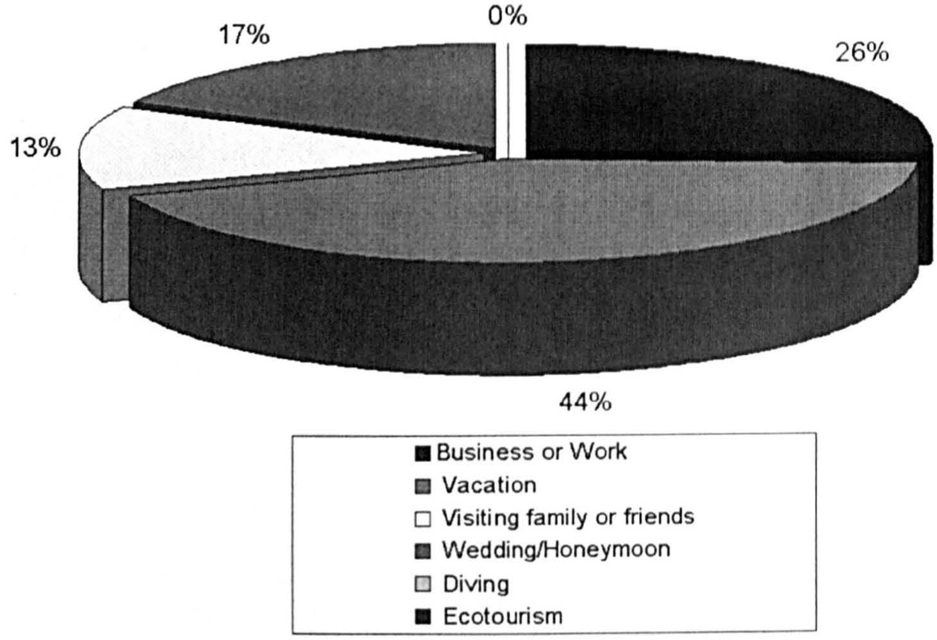


Figure 4.11: Non-snorkellers' purpose of visit

in. This would be expected as swimming is the least expensive and non-specialised activity one can participate in. Figures 4.8, 4.9, 4.10 and 4.11 depict these results.

4.4.7 Choice consistency

Choice consistency[3] was checked for in both discrete choice experiments by inserting extra choice sets within the choice cards. The two aspects which were examined were the presence of non-monotonic and/or unstable preferences. Monotonicity was tested by including a choice task with a dominant alternative while preference stability was checked by including the same choice task at the beginning and end of the choice cards. If the respondent preferred the dominant alternative, then they were considered to have monotonic preferences. If the respondent chose the identical alternative at the beginning and end of the choice cards, then they were considered to have stable preferences.

[3]Choice consistency is the consistency of observed choices under the assumption of rationality.

Table 4.5: Incidence of monotonic and stable preferences

		Monotonic		Non-monotonic		Stable		Non-stable	
Subsamples	Number of Attributes	Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
Non-snorkellers	6	59	68.60	27	31.40	55	63.95	31	36.05
Snorkellers	9	178	89.90	20	10.10	137	69.19	61	30.81
Total		**237**	**83.45**	**47**	**16.55**	**192**	**67.61**	**92**	**32.39**

Table 4.6: Percentage of respondents who considered a subset of attributes

	Snorkeller 9 attributes		Non-snorkeller 6 attributes	
	Frequency	Percent	Frequency	Percent
Considered a subset of attributes	114	59.69	45	54.88
Considered all attributes	77	40.31	37	45.12
	191**		82*	

* 4 chose the no option alternative for non-snorkellers
** 7 chose the no option alternative for snorkellers

Table 4.5 shows the breakdown of results for the consistency tests for both groups of respondents. Of the 86 non-snorkelling respondents, 59 (69 percent) selected the dominant alternative and 55 (65 percent) had stable preferences. Of the 198 snorkelling respondents, 178 (90 percent) selected the dominant alternative and 137 (61 percent) had stable preferences. In the entire sample of 284 respondents, there was a higher incidence of respondents displaying unstable preferences (32 percent) in comparison to non-monotonic preferences (17 percent).

4.4.8 Incidence of respondents not attending to all attributes

After respondents from both groups of respondents completed the choice cards, those who did not choose the no action alternative were asked if they took into consideration all attributes as advised by the survey administrator. Those respondents who indicated that they did not take all attributes into consideration were asked to identify the attributes which they did consider when undertaking the choice experiment.

Of the 198 snorkellers, 7 respondents chose the no action alternative. Of the remaining 191, 114 (60 percent) focussed on a subset of attributes while 77 (40 percent) indicated that they considered all 9 attributes. Of the 86 non-snorkellers, 4 chose the no action alternative while 45 (55 percent) respondents indicated that they focussed on a subset of attributes. The remaining 37 respondents (45 percent) indicated that they considered all 6 attributes (Table 4.6). These results show that in the choice experiment which contained a greater number of attributes (9), a greater percentage of respondents indicated that they focussed on a subset of attributes (60 percent), while for the choice experiment with 6 attributes, 55 percent indicated they focussed on a subset of alternatives.

In both groups of respondents, the attribute which respondents attended to most was that representing the risk of contracting an ear infection from swimming in polluted water (WQ1 and WQ2). The second most popular attribute which respondents in the snorkellers attended to was that representing the number of plastics per 30 metres (PLAS1 and PLAS2) (66 percent) while for non-snorkellers this was the attribute representing the level of vertical visibility (15 percent) (CLAR1 and CLAR2). In both groups, respondents indicated that the average number of attributes they attended to was 3 (Table 4.7).

Table 4.7: Types of attributes considered as part of subset

	9 attributes		6 attributes	
Attribute	Frequency	Percent	Frequency	Percent
Number of recreational and fishing boats near the coastline	11	2.96	6	11.54
Presence of a marine protected area	14	3.76	7	13.46
Level of development on the coastline	49	13.17	9	17.31
Risk of contracting an ear infection from swimming in polluted water	81	21.77	12	23.08
Level of vertical visibility	56	15.05	10	19.23
Number of plastics per 30 meters of coastline	66	17.74	8	15.38
Number of snorkellers allowed per group	7	1.88		
Level of coral cover	48	12.90		
Abundance of fish	40	10.75		
TOTAL	372	100.00	52	100.00

These results seem to indicate that respondents are not attending to all attributes presented to them in the choice experiments. This means that, in effect, attributes are being ignored and this violates the continuity axiom on which the theory of choice experiments is built. Researchers have been investigating reasons as to why persons may not attend to all attributes (Hensher 2006*a*, Campbell et al. 2006). Two main reasons identified are the complexity of the choice experiment and the relevance of attributes. Further investigations on the relevancy of attributes are conducted in Chapter 5.

4.5 Parameter estimates of discrete choice models

The basic workhorse of discrete choice modelling, the multinomial logit model (MNL) is used to examine and analyse the preferences for choice responses from 86 snorkellers and 198 non-snorkellers. Following this, the latent class (LCM) and mixed multinomial logit (MMNL) models are used to account for the presence of any unobserved taste heterogeneity in Sections 4.5.2 and 4.5.3 respectively. Marginal and individual-specific WTP estimates are then derived using the parameter estimates from the chosen model specification in Section 4.6.

4.5.1 Parameter estimates of the MNL model

Tables 4.8 and 4.9 report the results of the MNL Models for the non-snorkellers and snorkellers respectively. Two MNL models are estimated for each group of respondents. The MNL-NSQ model is specified to account for the respondents' choice between coastal water quality policy options solely as a function of the attributes. The MNL-SQ model is specified to account for status quo effects. The status quo is specified using an alternative specific constant (ASC) and represents the utility of choosing the status quo alternative (§ Section 2.2.2). In this study the status quo alternative represented the choice to visit neither of the two beaches or alternatives in the choice cards.

Non-snorkellers

For the non-snorkellers, the MNL-NSQ model was statistically significant with a χ^2 statistic of 110.47, against a critical value 22.36 (with 13 degrees of freedom at alpha level 0.05) (§ Table 4.8). In the MNL-SQ model, the SQ coefficient was found to be positive and significant which indicates *ceteris paribus* that the respondents had positive preferences for the status quo. A negative sign would have meant they did not desire the status quo. The MNL-SQ model was also statistically significant with a χ^2 statistic of 126.24, against a critical value 23.69 (with 14 degrees of freedom at alpha level 0.05).

Comparison of the two models shows that when the SQ is included, there is only a slight increase in the R^2 value from 0.07 to 0.08. LL (log-likelihood) Ratio tests were used to compare these two nested models and showed that the MNL-SQ model does show statistical improvement over the MNL-NSQ model with a χ^2 statistic of 15.77 (with 1 degree of freedom at alpha level of 0.05). However, when the SQ is included, the parameter estimate for the fee attribute becomes insignificant. Only 4 persons out of the sample of 86 chose the status quo option. The positive value on the status quo may be a reflection of these respondents exhibiting protest votes since they consistently chose the status quo option in all choice cards.

In the MNL-NSQ model, 9 of the 13 attributes for the non-snorkellers have t-statistics which are significant at a 95 percent confidence level. The insignificant attributes were all associated with a low level of environmental quality. These attributes were the number of boats, the presence of a marine protected area, the level of development and vertical visibility. For the significant 9 attributes, the signs are correctly anticipated; that is attributes associated with a high level of environmental quality have positive signs and those with a low level of environmental quality have a negative sign.

As expected the coefficient on the attribute for fee is negative and significant. The negative sign supports the notion that the probability of visiting the beach is inversely related to its cost. In contrast, the parameters which are highly positive and significant, and therefore associated with beach attributes which increase the probability of a beach visit were: a low chance of contracting an ear infection (WQ2); vertical visibility of up to 10 meters (CLAR1); there are only up to 2 boats near the coastline (BTS2); there are less than 5 pieces of plastic near the coastline (PLAS2) and up to 25 percent development is allowed near the coast (DEV2). Non-snorkellers are less likely to visit beaches where there is a high chance of contracting an ear infection (WQ1) and up to 15 pieces of plastic along the coastline (PLAS1) and where there is a marine protected area which does not allow fishing (MPA2).

Table 4.8: Parameter Estimates from MNL, LCM and MMNL Models for non-snorkellers

	Parameter Estimates from MNL, LCM and MMNL Models for Non-snorkellers													
	MNL-NSQ		MNL-SQ		LCM				MMNL			
					Class 1		Class 2					
	Est.	t-stat	Est.	t-stat	Est.	t-stat	Est.	t-stat	Est.	t-stat	Std. Dev.	t-stat
BTS1_Low_Policy	0.179	1.46	0.362	2.69	0.346	2.59	-2.853	-3.35	0.523	3.09		
BTS2_High_Policy	0.397	3.03	0.501	3.65	0.488	3.46	0.804	1.13	0.867	5.00		
MPA1_Low_Policy	-0.025	-0.20	0.203	1.47	0.128	0.97	-34.050	0.00	0.012	0.06	0.927	3.80
MPA2_High_Policy	0.238	1.89	0.367	2.74	0.377	2.80	2.763	0.00	0.671	3.92		
DEV1_Low_Policy	-0.197	-1.53	-0.025	-0.18	-0.114	-0.81	-3.585	-3.05	-0.387	-1.50	1.501	5.26
DEV2_High_Policy	0.274	2.15	0.389	2.90	0.339	2.44	0.907	1.25	0.673	4.01		
WQ1_Low_Policy	-0.622	-4.60	-0.440	-3.04	-0.575	-4.03	-6.177	0.00	-1.088	-4.69	1.118	4.30
WQ2_High_Policy	0.487	4.00	0.597	4.68	0.580	4.34	31.395	0.00	0.941	4.78	0.951	3.96
CLAR1_High_Policy	0.469	3.91	0.648	4.95	0.602	4.68	0.775	1.04	0.725	4.27		
CLAR2_Low_Policy	0.031	0.24	0.130	0.94	0.114	0.81	-0.015	-0.02	0.185	0.93	0.631	2.20
PLAS1_Low_Policy	-0.312	-2.39	-0.130	-0.93	-0.201	-1.47	-34.062	0.00	-0.422	-2.52		
PLAS2_High_Policy	0.296	2.35	0.383	2.91	0.414	3.00	-33.146	0.00	0.587	3.46		
Fee	-0.025	-3.74	-0.010	-1.28	-0.018	-2.59	-0.018	-2.59	0.094	6.63	0.094	6.63
Status Quo			0.947	3.86								
Number of observations	2193											
Number of individuals	86											
Prob. of Membership					83%		17%					
Number of Parameters (K)	13		14		27				19			
log-likelihood (LL)	-747.35		-739.47		-660.75				-684.63			
BIC	1552.61		1541.29		1440.63				1453.89			
Pseudo R^2	0.07		0.08		0.18				0.15			

Snorkellers

The MNL-NSQ model for snorkellers was also statistically significant with a χ^2 statistic of 410.17, against a critical value 30.14 (with 19 degrees of freedom at alpha level 0.05) (§ Table 4.9). The MNL-SQ for snorkellers also had an SQ coefficient which was found to be positive and significant. The overall model was statistically significant with a χ^2 statistic of 458.58, against a critical value 31.41 (with 20 degrees of freedom at alpha level 0.05). Comparison of the two models shows that the number of insignificant parameters did not change with the inclusion of the status quo, and the statistical significance of 7 attributes increased. The fee value for the model with the inclusion of the status quo for this group of respondents remained significant but decreased in significance.

When the status quo is included, the R^2 value increases only slightly from 0.11 to 0.12. The model comparison LL Ratio tests indicate that the MNL-SQ model does show a statistical improvement over the MNL-NSQ model with a χ^2 statistic of 48.41 (with 1 degree of freedom at alpha level of 0.05). However, to be consistent with the non-snorkellers, the model is examined without the specification of the status quo.

The snorkellers' responses showed highly positive and significant preferences for beaches which had: less than 5 pieces of plastic near the coastline (PLAS2); up to 45 percent coral cover (CORAL1); a low chance of contracting an ear infection (WQ2); up to 25 percent development along the coastline (DEV2); vertical visibility of up to 10 meters (CLAR1); an MPA which does not allow fishing (MPA2) and up to 60 fishes being visible while snorkelling (FISH1). The parameters which were highly negative and significant were for those beaches with: a high chance of contracting an ear infection (WQ1); up to 75 percent development along the coastline; up to 5 metres vertical visibility (CLAR2) and up to 7 boats near the coastline (BTS1). The MNL-NSQ estimation for the snorkellers reveals that for the statistically significant attributes, the signs were as expected, that is, there were positive parameter estimates for the attributes which represented a higher level of environmental quality and negative parameter estimates for those which represented a lower level of environmental quality. Therefore, as with non-snorkellers, snorkellers also preferred beaches which had higher levels of environmental quality. Out of the 19 parameter estimates, 6 were statistically insignificant. These were for beaches which had: up to 7 boats near the coastline (BTS2); a marine protected area which allowed fishing (MPA1); up to 15 snorkellers per group (SNO1); up to 5 snorkellers per group (SN02); up to 15 percent coral cover (CORAL2) and up to 15 pieces of plastic along the coastline (PLAS1).

Table 4.9: Parameter Estimates from MNL, LCM and MMNL Models for Snorkellers

	Parameter Estimates from MNL, LCM and MMNL Models for Snorkellers												
	MNL-NSQ		MNL-SQ		LCM				MMNL			
					Class 1		Class 2					
	Est.	t-stat	Est.	t-stat	Est.	t-stat	Est.	t-stat	Est.	t-stat	Std. Dev.	t-stat
BTS1_Low_Policy	-0.197	-2.34	-0.091	-1.03	-0.147	-1.32	-0.596	-4.24	-0.330	-2.51		
BTS2_High_Policy	0.136	1.69	0.282	3.30	0.275	2.57	-0.333	-2.40	0.166	1.37		
MPA1_Low_Policy	0.125	1.50	0.298	3.29	0.369	3.37	0.221	1.55	0.291	2.13	0.180	4.14
MPA2_High_Policy	0.289	3.58	0.485	5.55	0.483	4.59	0.340	2.54	0.646	5.39		
DEV1_Low_Policy	-0.411	-4.74	-0.253	-2.70	-0.236	-2.18	-0.622	-4.03	-0.707	-4.55	0.185	5.16
DEV2_High_Policy	0.376	4.85	0.561	6.66	0.573	5.52	0.415	3.56	0.722	5.40	0.165	5.42
WQ1_Low_Policy	-0.421	-4.79	-0.301	-3.25	-0.411	-3.51	-1.259	-7.17	-0.980	-5.35	0.197	7.63
WQ2_High_Policy	0.459	5.85	0.621	7.41	0.370	3.63	0.741	6.18	0.667	4.98	0.182	4.71
CLAR1_High_Policy	0.311	3.92	0.497	5.70	0.600	5.54	0.209	1.54	0.700	5.84		
CLAR2_Low_Policy	-0.215	-2.60	-0.050	-0.57	-0.045	-0.44	-0.281	-1.88	-0.205	-1.56	0.239	2.58
PLAS1_Low_Policy	-0.166	-1.94	-0.033	-0.37	0.001	0.01	-0.991	-6.44	-0.459	-2.92	0.195	6.41
PLAS2_High_Policy	0.514	6.38	0.663	7.70	0.749	6.93	0.451	3.59	0.908	6.53	0.169	5.31
SNO1_Low_Policy	-0.119	-1.45	0.019	0.23	0.070	0.69	-0.910	-5.91	-0.324	-2.23	0.192	5.58
SNO2_High_Policy	0.108	1.32	0.232	2.67	0.221	2.08	0.139	1.06	0.118	0.98		
CORAL1_High_Policy	0.464	5.73	0.668	7.49	0.748	6.81	0.187	1.43	0.829	5.94	0.166	5.77
CORAL2_Low_Policy	-0.110	-1.30	0.069	0.76	0.113	1.08	-0.554	-3.61	-0.168	-1.34		
FISH1_High_Policy	0.240	2.95	0.443	4.91	0.447	4.24	0.147	1.06	0.556	4.53		
FISH2_Low_Policy	-0.092	-1.09	0.068	0.75	-0.008	-0.08	-0.169	-1.21	-0.082	-0.68		
Fee	-0.023	-5.78	-0.011	-2.65	-0.014	-2.94	-0.035	-5.53	0.058	8.04	0.007	8.04
Status Quo			1.277	6.75								
Number of observations	5346											
Number of individuals	198											
Prob. of Membership					61%		39%					
Number of Parameters (K)	19		20		39				30			
log-likelihood (LL)	-1742.92		-1718.71		-1578.91				-1604.02			
BIC	3586.31		3543.19		3364.05				3366.69			
Pseudo R^2	0.11		0.12		0.21				0.18			

Table 4.10: Model specification criteria for non-snorkellers

	Model Specification Criteria for Non-snorkellers					
	MNL-NSQ	MNL-SQ	LCM (3)	LCM (2)	LCM (2) - Restricted	MMNL
Log-likelihood	-747.35	-739.47	-631.77	-660.18	-660.75	-684.63
LL Ratio Test	110.47	126.24	342.63	285.81	284.67	236.91
AIC	1520.70	1506.93	1345.54	1374.37	1375.51	1407.26
AIC - 3	2281.05	2260.40	2018.31	2061.55	2063.26	2110.89
BIC	1552.61	1541.29	1446.17	1440.63	1441.77	1453.89
Pseudo R^2	0.07	0.08	0.21	0.18	0.18	0.15
Number of Observations	2193					
Number of Individuals (N)	86					
Number of Parameters (K)	13	14	41	27	27	19

4.5.2 Parameter estimates of the LCM

The LCM models for both groups of respondents were estimated initially over 2, 3, and 4 classes. Statistical criteria, namely Akaike Information Criteria (AIC) and Akaike Information Criteria 3 (AIC-3) (Andrews et al. 2002), were used in addition to the analyst's judgement on the number of chosen classes which best described the respondent population and addressed the relevant policy questions (§ Section 2.5.2). This analysis revealed that a two class model provided the best solution for both the non-snorkellers and snorkellers (§ Tables 4.8 and 4.9).

Non-snorkellers

The LCM was estimated for non-snorkellers over 2, 3 and 4 classes. The 4-class model did not converge using Nlogit 3.0. The 3-class model was also statistically significant with a χ^2 statistic of 342.63, against a critical value 56.94 (with 41 degrees of freedom at alpha level 0.05). However, this model had one class for which the fee parameter was theoretically implausible because a positive fee parameter was observed. The 2-class model was also statistically significant with a χ^2 statistic of 284.67, against a critical value 40.11 (with 27 degrees of freedom at alpha level 0.05). Even though the fee parameters were negative for both classes in this model, it was insignificant in class 1. Since the ultimate goal of these model specifications is to be able to calculate WTP, the fee parameter for the 2-class model was constrained to be equal to that of class 1 which had a significant fee parameter. This produced a 2-class restricted model which was statistically significant with a χ^2 statistic of 284.67, against a critical value 40.11 (with 27 degrees of freedom at alpha level 0.05). Table 4.8 shows the estimation results for this model and Table 4.10 shows the results of the statistical criteria used in comparing the LCM model specifications.

Class 1 of the 2-class LCM model represents 83% of the sampled population while class 2 represents 17% of the population. Individuals in class 1 prefer beaches that have: vertical visibility of 10 metres (CLAR1); a low chance of contracting an ear infection (WQ2); up to 5 pieces of plastic (PLAS2); up to 25% development (DEV2). They also have positive preferences for both levels of boats near the coastline but have stronger positive preferences for up to 2 boats near the coastline (BTS2).

The preferences in class 2 were not very clear as 11 out of the 13 parameter estimates were insignificant. However, for the parameters that were significant, it was observed that individuals in class 2 only expressed negative preferences for two attributes associated with a low level of environmental quality. These were that attributes for beaches which have up to 7 boats (BTS1) and up to 75% development (DEV1).

The AIC, AIC-3 and BIC criteria showed that there was significant improvement in model fit from the MNL-NSQ model to the LCM(2) - Restricted model (§ Table 4.10). However, the results indicated that by constraining the fee parameter of class 1 of the 2-class model to be equal to the fee parameter of class 2, the majority of respondents fit into class 1 while class 2 is too small to produce significant estimates (§ Table 4.8).

Snorkellers

The LCM Model for snorkellers was estimated with 2, 3 and 4 classes. The 4-class model did not converge. The 3-class model was statistically significant with a χ^2 statistic of 830.96, against a critical value 77.93 (with 59 degrees of freedom at alpha

Table 4.11: Model specification criteria for snorkellers

	Model Specification Criteria for Snorkellers				
	MNL-NSQ	MNL-SQ	LCM (3)	LCM (2)	MMNL
Log-likelihood	-1742.92	-1718.71	-1542.25	-1578.91	-1604.02
LL Ratio Test	410.17	458.58	830.96	757.64	707.41
AIC	3523.83	3477.42	3202.49	3235.81	3268.04
AIC - 3	5285.75	5216.13	4803.75	4853.72	4902.06
BIC	3586.31	3543.19	3396.51	3364.05	3366.69
Pseudo R^2	0.11	0.12	0.21	0.19	0.18
Number of Observations	5346				
Number of Individuals (N)	198				
Number of Parameters (K)	19	20	59	39	30

level 0.05). Based on the AIC-3 test statistic in Table 4.11, the 3-class model had the greatest explanatory power but class 2 of the 3-class model had a positive fee parameter. Therefore, to be consistent with economic theory, the 2-class model was chosen because both classes had negative estimates for the fee parameter. The 2-class model was also statistically significant with a χ^2 statistic of 757.64, against a critical value 54.57 (with 39 degrees of freedom at alpha level 0.05). Table 4.9 shows the estimation results for this model.

Estimation results for the 2-class model showed that there were differences between the two classes. Individuals in class 1 were likely to choose beaches which: allow up to 2 boats (BTS2); provide access to a marine protected area which may (MPA1) or may not (MPA2) allow fishing; have vertical visibility of 10m (CLAR1); allow up to 5 persons per snorkelling group (SNO2); provide up to 45% coral cover (CORAL1) and allow up to 60 fishes to be viewed while snorkelling (FISH1). Individuals in class 2 were likely to choose beaches which: do not allow any boats (BTS1 and BTS2); have a marine-protected park which allows fishing (MPA1); allow up to 15 persons per snorkelling group (SNO1) and provide up to 15% coral cover (CORAL1).

The most positive and highly significant parameter estimate for class 1 indicates that individuals in this class have the strongest preference for less than 5 plastics per 30 metres of coastline (PLAS2). For class 2 individuals, the strongest preference is for a reduced chance of contracting an ear infection (WQ2). Both classes had 6 parameters which were statistically insignificant. In addition, both classes had similar preferences for some attributes. For instance, both classes had positive preferences for a beach where there is: up to 5 pieces of plastic litter (PLAS2); a reduced chance of contracting an ear infection (WQ2); up to 25 percent development (DEV2) and an MPA which does not allow fishing (MPA2). Both classes were also less willing to visit a beach where there was a high chance of contracting an ear infection (WQ2) and up to 75 percent development(DEV1).

The results from the LCM model suggest that there is considerable unobserved taste heterogeneity within the snorkellers. This could be explained by classifying the snorkellers into 2 classes. The first class representing 61 percent of the sampled population seem to be composed of more avid snorkellers because of their strong preferences for higher levels of fish abundance (FISH1), coral cover (CORAL1), vertical visibility (CLAR1) and both types of marine protected areas (MPA1 and MPA2). The second class, representing 39 percent of the population, could be classified as the more occasional snorkellers with individuals who did not exhibit very strong preferences for the presence of higher levels of coral cover (CORAL1), fish abundance (FISH1 and FISH2) and levels of vertical visibility (CLAR1 and CLAR2). Both classes, however, did have strong preferences for a low chance of infection (WQ2), up to 25 percent development (DEV2) and up to 5 pieces of plastic on the coastline (PLAS2).

4.5.3 Parameter estimates of the MMNL model

The sensitivity of MMNL estimates to the number of draws used for simulation was explored. This analysis revealed that the model based on 300 draws provided sufficiently good approximations for the estimates from the non-snorkeller and snorkellers. For both groups of respondents, all attributes were first specified as random using the normal distribution. In order to ensure non-negative parameter estimates for the fee parameter, the distribution for the negative of this attribute was specified as log normal while all other attributes for both models were specified as normal. The results from these estimations revealed a number of parameters with insignificant standard deviations. This was used as the basis for selecting the random parameters (Hensher et al. 2005*a*), that is only those parameters with significant standard deviations were considered to be random. However, derivation of the WTP estimates for both restricted models specifying the fee parameter as log normal yielded implausible WTP estimates. The fee parameter was then specified using the constrained triangular distribution, which led to more behaviourally plausible WTP estimates, and also achieved the goal of a sign-constrained cost parameter (Hensher & Greene 2003). The final model was estimated with only the attributes which had significant standard deviations and treated as random. These were all specified as normally distributed with the exception of the fee parameter which was specified as random with a constrained triangular distribution as explained above.

Non-snorkellers

Table 4.8 shows the results of the MMNL Model for the non-snorkellers. 6 of the 13 parameters had significant standard deviations, indicating that there seemed to be considerable unobserved taste heterogeneity within this group of respondents. These six attributes were: a marine park which allowed fishing (MPA1); up to 75 percent development (DEV1); increased and reduced chance of contracting an ear infection (WQ1 and WQ2), vertical visibility of up to 5 metres (CLAR2) and the contribution fee for beach entrance (FEE). The MMNL model for the non-snorkellers was also statistically significant with a χ^2 statistic of 236.91, against a critical value 30.14 (with 19 degrees of freedom at alpha level 0.05). The results of the LCM model in Section 4.5.2 suggest that there is little unobserved taste heterogeneity within the non-snorkeller population. However, the MMNL model revealed that there was significant unobserved taste heterogeneity within this population for six attributes. It can therefore be concluded that unobserved taste heterogeneity within the non-snorkeller population is not supported by the use of the LCM model.

Snorkellers

Table 4.9 shows the parameter estimates of the MMNL Model for the snorkellers. 11 of the 19 estimated parameters were found to exhibit significant variation across respondents for which all estimated coefficients were found to have the expected sign. Once again, the

MMNL model revealed that snorkellers are willing to pay more to visit a beach which has both types of marine protected areas. Results of the estimates for 11 of the 19 parameters provide evidence of significant unobserved taste heterogeneity as they have statistically significant standard deviations. The fee attribute represents the parameter for which preferences vary the most. The MMNL model for the snorkellers was also statistically significant with a χ^2 statistic of 707.41, against a critical value 43.77 (with 30 degrees of freedom at alpha level 0.05).

The AIC, AIC-3 and BIC criteria showed that there was no significant improvement in model fit from the 2-class and 2-class restricted LCM models in comparison to the MMNL model for the non-snorkellers and snorkellers respectively. There was however a significant improvements in the MMNL model in comparison to the MNL-NSQ models for both groups of respondents.

4.6 Model selection for calculation of WTP estimates

The results of LCM and MMNL models suggest that there is considerable unobserved taste heterogeneity within snorkellers for several attributes. The results of the LCM model suggest that the snorkellers is comprised of two classes. An examination of the log-likelihood values indicated that the use of two latent classes did provide a significant improvement in the fit over the MNL model and the MMNL model. One reason for this could be that there is greater justification for the existence of different types of recreationists for a more specialised activity such as snorkelling as opposed to the group of non-snorkellers. There always exists in any recreational activity different extents to which people pursue that activity. Therefore, in the case of snorkelling, it is plausible to expect that there are some who regularly engage in this activity and some who are more occasional.

The non-snorkellers exhibits a similar, although rather weaker, suggestion of the existence of two classes. The statistical criteria suggests that the LCM provides a better fit than the MMNL model. However, it is clear from the results that most of the non-snorkellers all fall within one class. Therefore, it seems likely that the non-snorkellers represent recreationists

Table 4.12: Marginal WTP Estimates from MNL and LCM Models for snorkellers

	Marginal WTP Estimates from MNL and LCM Models for Snorkellers					
	MNL		LCM			
			Class 1		Class 2	
	Est.	t-stat	Est.	t-stat	Est.	t-stat
BTS1_Low_Policy	-8.711	-2.11	-10.219	-1.18	-17.152	-3.18
BTS2_High_Policy	6.031	1.67	19.058	2.05	-9.585	-2.04
MPA1_Low_Policy	5.553	1.50	25.605	2.43	6.355	1.50
MPA2_High_Policy	12.807	3.28	33.491	2.70	9.782	2.44
DEV1_Low_Policy	-18.196	-3.54	-16.409	-1.70	-17.903	-3.15
DEV2_High_Policy	16.653	4.05	39.763	2.75	11.946	3.11
WQ1_Low_Policy	-18.643	-3.59	-28.536	-2.26	-36.206	-4.06
WQ2_High_Policy	20.327	4.44	25.705	2.43	21.320	4.70
CLAR1_High_Policy	13.787	3.50	41.613	2.84	6.011	1.51
CLAR2_Low_Policy	-9.502	-2.28	-3.157	-0.42	-8.084	-1.80
PLAS1_Low_Policy	-7.335	-1.79	0.043	0.01	-28.509	-3.83
PLAS2_High_Policy	22.744	4.60	51.957	2.83	12.966	3.22
SNO1_Low_Policy	-5.275	-1.38	4.867	0.68	-26.177	-3.71
SNO2_High_Policy	-0.006	-1.32	-0.012	-2.08	4.010	1.05
CORAL1_High_Policy	20.571	4.46	51.876	2.93	5.372	1.43
CORAL2_Low_Policy	-4.869	-1.24	7.850	1.06	-15.937	-2.92
FISH1_High_Policy	10.636	2.80	30.985	2.60	4.229	1.08
FISH2_Low_Policy	-4.054	-1.05	-0.555	-0.08	-4.876	-1.16
Prob. of Membership			61%		39%	

who are more general beach users. As a result, in comparison to the snorkellers, there is less justification here to suggest that these recreationists can be further categorised, and hence why the meaningful identification of unobserved taste heterogeneity within the non-snorkellers was not best characterised by the LCM model. Given this observation, WTP values for the non-snorkellers are based on parameter estimates of the non-snorkeller MMNL model, while WTP estimates for snorkellers are based on parameter estimates from the 2-class LCM model.

4.6.1 Snorkellers WTP estimates using LCM

Marginal WTP estimates for discrete choice models are calculated by dividing the estimated coefficient of each attribute by the coefficient of the cost attribute (Hanemann 1994) (§ Section 2.6.1). The results of these calculations using the LCM model are presented in Table 4.12. The WTP estimates using the parameter estimates from the MNL model are presented to provide a base for comparison. These results show that snorkellers in class 1 had the highest WTP estimates of TT$51.96 to visit a beach where there were only up to 5 pieces of plastic per 30 metres of coastline (PLAS2), closely followed by TT$51.88 for up to 45 percent coral cover (CORAL1). On the other hand, the snorkellers in class 2 had expressed their highest WTP of TT$21.32 for a beach where there was a decreased chance of contracting an ear infection.

As described in Section 2.6.2, parameter estimates from the LCM model could be used to calculate individual-specific estimates on the observed choices (Train 2003). These individual-specific estimates could then be used to calculate individual-specific WTP values which give a distribution of WTP values for each attribute. Kernel density plots allow convenient comparisons between individual-specific WTP values for the two classes and levels for each attribute (Bowman & Azzalini 1997). These are presented in Figure 4.14 to Figure 4.18. All attributes exhibit a bi-modal distribution because the sample is composed of respondents belonging to two classes with different taste intensities. This provides further evidence of the clear distribution of preferences within snorkellers.

Number of boats

Figure 4.12 shows that one class of snorkellers has positive preferences and respondents in this class are therefore willing to pay to visit a beach with only up to 2 boats near the coastline (BTS2). Despite this level of this attribute representing a higher level of environmental quality than the status quo, one class is still not willing to pay to visit a beach with up to 2 boats near the coastline. However, neither class is willing to visit beaches with up to 7 boats (BTS1). Figure 4.12 shows that there is an overlap over the positive and negative orthants between two classes for each level of this attribute. This suggests that a certain percentage of the population were willing to pay as much as the other for a up to 2 boats and up to 7 boats at a beach.

Marine protected area

The presence of an MPA is the only attribute where most of the snorkellers have positive WTP values for both levels of this attribute (§ Figure 4.13). This result is not surprising

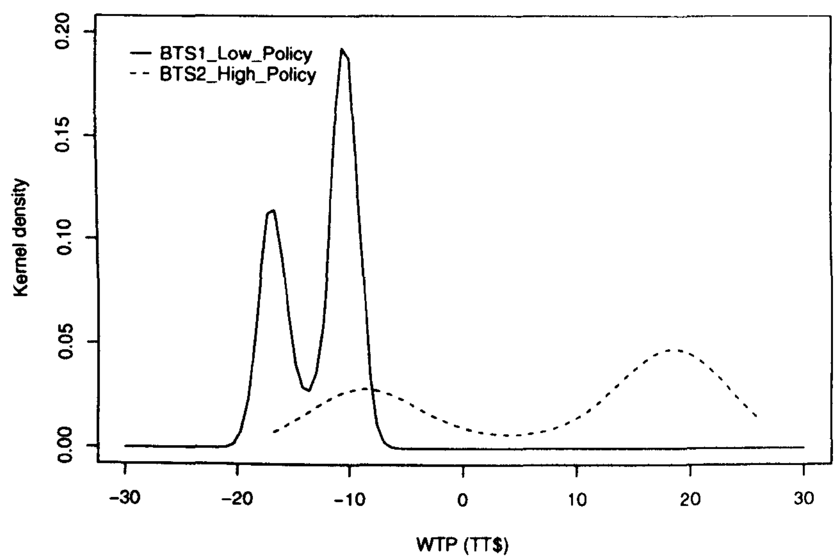


Figure 4.12: Distributions of individual-specific WTP for number of boats

since the descriptive results revealed that 95 percent of the population thought that there were too few MPAs while only 3 percent thought that one was enough for the island. This would suggest that both classes of snorkellers still prefer to visit a beach which has access to an MPA, irrespective of whether or not it allows fishing. Both classes clearly have higher WTP values for an MPA which does not allow fishing (MPA2). This could be explained by the fact that most snorkellers probably understand that the presence of a MPA which provides protection from extraction can increase the likelihood of seeing greater numbers of fish and a higher level of coral. Futhermore, only 22 of this sampled snorkeller population actually participate in fishing to some degree. As was the case for the more restrictive level of development, there is a large difference in WTP between the two classes with one class willing to pay 3 times as much for an MPA which allows fishing and 4 times as much on average for an MPA that does not.

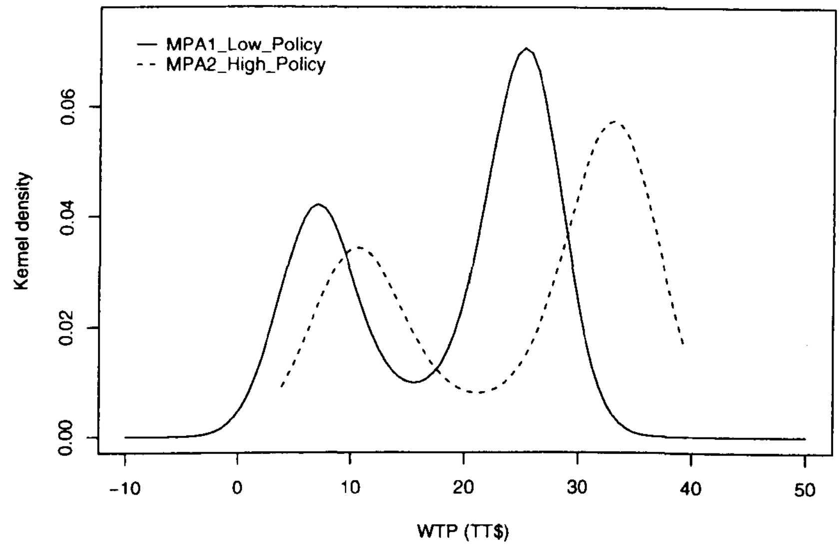


Figure 4.13: Distributions of individual-specific WTP for the presence of a marine protected area

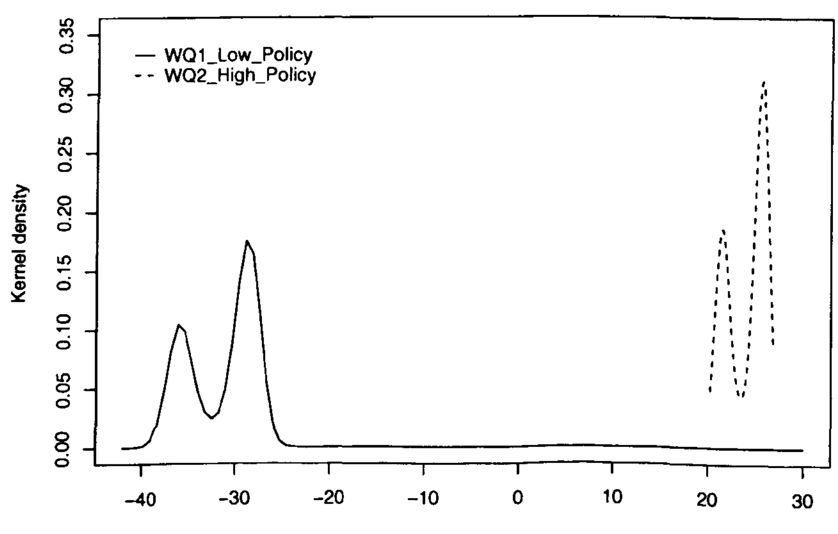


Figure 4.14: Distributions of individual-specific WTP for chance of an ear infection

Chance of an ear infection and coastline development

Figures 4.14, 4.15 and 4.16 show that for the two levels of policy improvement for the two attributes concerning the chance of contracting an ear infection (WQ1 and WQ2) or average bathing water quality and the level of development (DEV1 and DEV2), there is almost no intersection between the distributions of WTP for the two levels of quality. Furthermore, each level strictly lies within either the positive or negative orthant of the graph. Both groups of the population have positive WTP values for beaches with a low chance of infection and up to 25 percent development, but are not willing to pay for beaches with a high chance of infection and up to 75 percent development.

There is a distinction between these two attributes in terms of the magnitude of spread of the WTP values for each class. There is little difference between the WTP values between of each class for both levels of the chance of infection (WQ1 and WQ2) since the spread of these WTP distributions is very small. On the other hand, there is a very wide spread in the distribution of WTP for more restricted development (DEV2) amongst both classes of snorkellers. This suggests that even though the respondents from both classes have similar preferences on whether they would visit a beach, their actual WTP values can vary a great deal within each class. For example, even though both classes have positive WTP values for up to 25 percent development, one class is willing to pay TT$12 on average while the other is willing to pay TT$40 on average, four times as much. This contrasts with the attribute for a low chance of infection where both classes were willing to pay an average within the narrow range of TT$22 to TT$27 for a beach where there is a reduced chance of infection (WQ1).

Number of plastics

WTP results for this attribute show that the majority of the population have positive WTP values for up to 5 pieces of plastics (PLAS2) and negative WTP values for up to 15 pieces of plastics (PLAS1) (§ Figure 4.17). Once again, it can be observed that one class is willing to pay approximately TT$17 on average while the other is willing to pay TT$57 on average for a beach with only up to 5 pieces of plastic litter per 30 metres near the

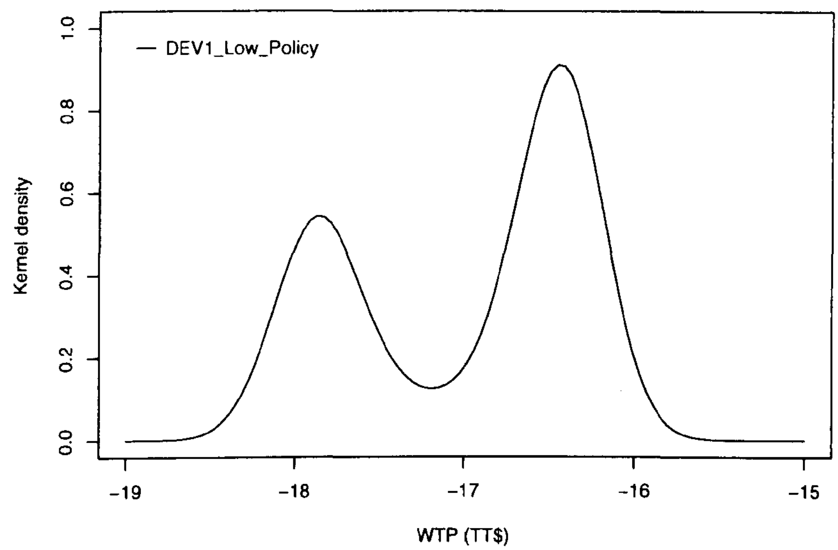


Figure 4.15: Distributions of individual-specific WTP for up to 75 percent development

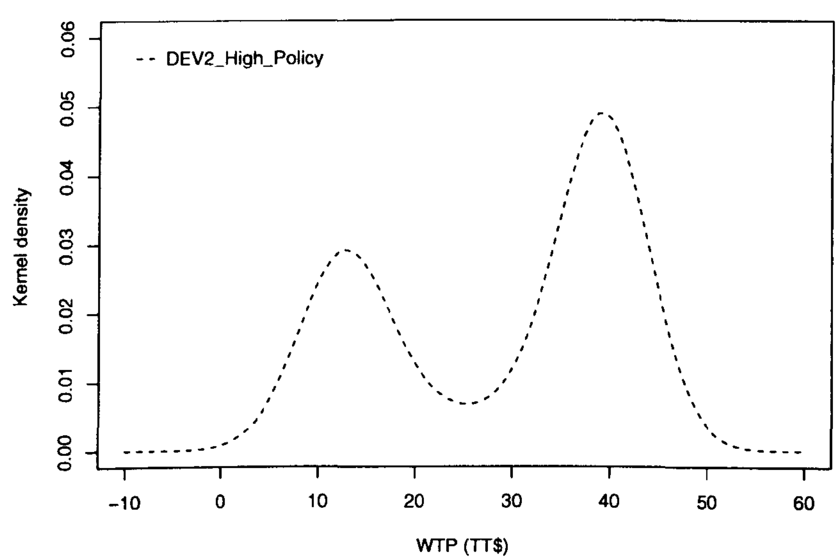


Figure 4.16: Distributions of individual-specific WTP for up to 25 percent development

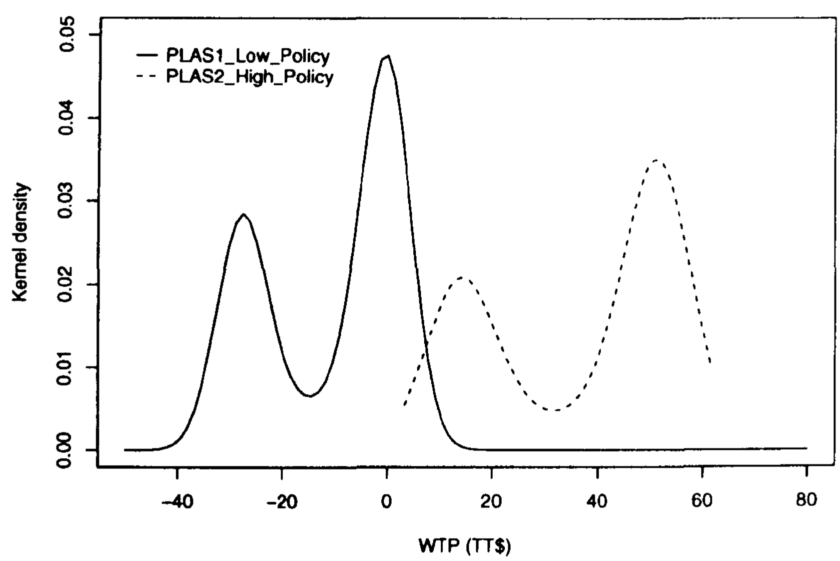


Figure 4.17: Distributions of individual-specific WTP for number of plastics

coastline. There is a slight overlap centred over the positive orthant which indicates that a smaller proportion of snorkellers are still willing to pay to visit a beach which has 15 pieces of plastic per 30 metres of coastline.

Vertical visibility

Figure 4.18 shows that both classes are willing to pay for high vertical visibility or high clarity. One class is willing to pay up to TT$40.00 on average while the other is willing to pay up to TT$10.00 on average, 4 times as much. Snorkellers were not willing to pay to visit a beach where vertical visibility is only up to 5 metres.

Abundance of fish

Figure 4.19 shows that one class' average WTP to view up to 60 fishes while snorkelling (FISH1) is approximately TT$5.00 while the other class' WTP for the same number of fish is on average TT$35.00. Despite there being a greater degree of overlap between two

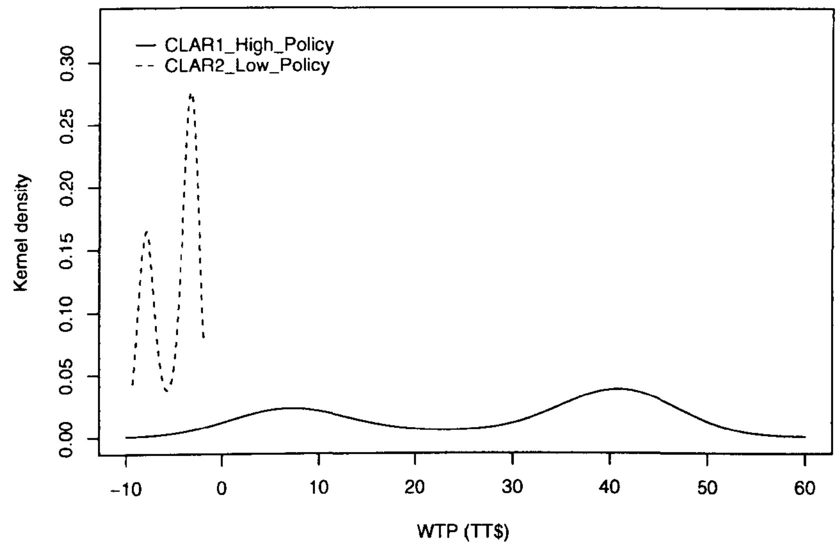


Figure 4.18: Distributions of individual-specific WTP for level of vertical visibility

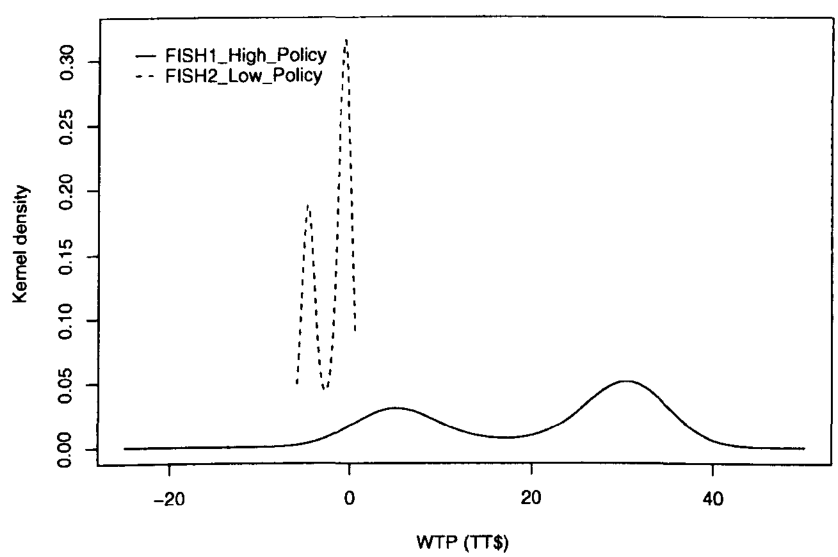


Figure 4.19: Distributions of individual-specific WTP for abundance of fish

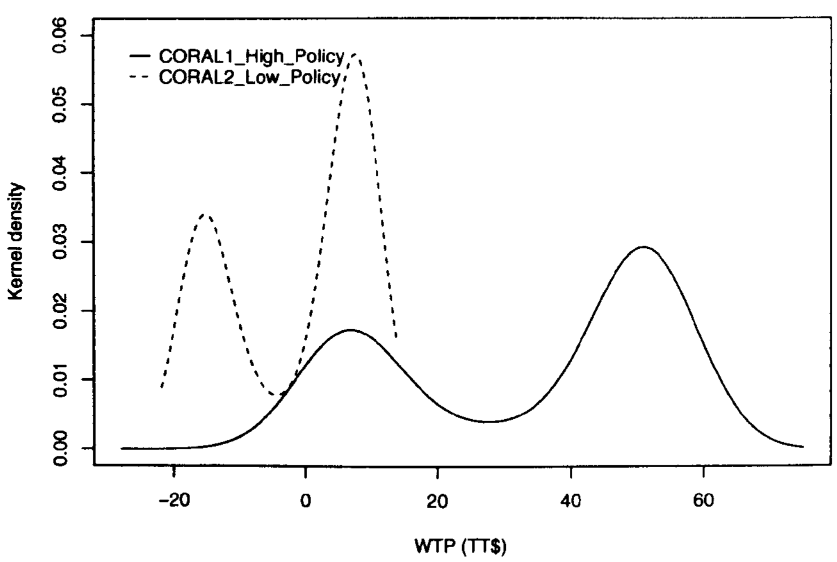


Figure 4.20: Distributions of individual-specific WTP for level of coral cover

class' WTP for either level of this attribute, this overlap occurs on the negative side of the orthant. This suggests that these respondents are not willing to pay to view up to 10 fishes while snorkelling (FISH2). Therefore, while a certain percentage of snorkellers have positive WTP values for up to 15 percent coral cover (CORAL2), some snorkellers are not willing to pay extra to visit a beach where they can view only up to 10 fishes (FISH2). These results are similar to those of Williams & Polunin (2000) who investigated divers' preferences for attributes of coral reefs in Jamaica. This study found that attributes associated with fish were more important than those related to coral. One reason for this could be that tourists are more responsive to distinguishing abundance of fish than abundance of living coral between sites (Barker 2003).

Coral cover

The results depicted in Figure 4.20 suggest that one class of snorkellers is willing to pay approximately TT$10 on average while the other is willing to pay TT$50 on average, almost 5 times as much, for up to 45 percent coral cover(CORAL1). There is a great deal of

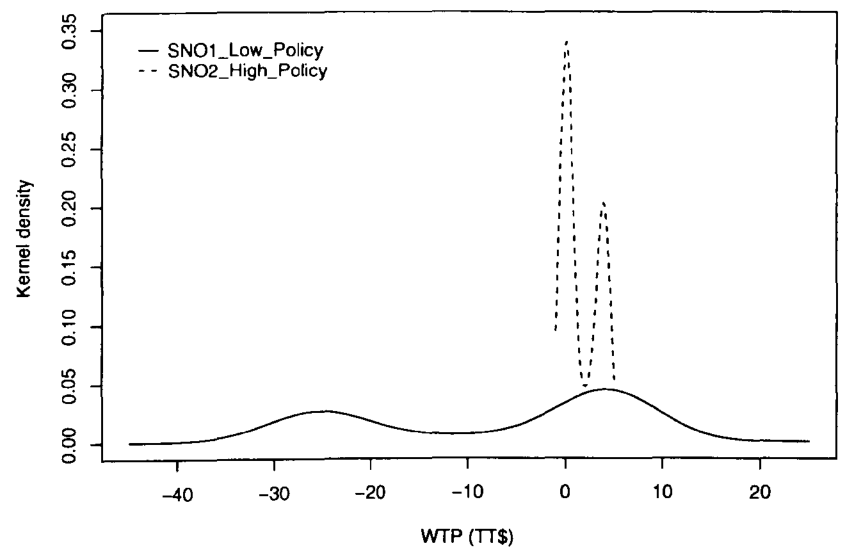


Figure 4.21: Distributions of individual-specific WTP for size of snorkeller group

overlap in WTP for up to 45 percent coral cover expressed by one class and WTP for up to 15 percent coral cover expressed by another over the positive orthant of the graph. This suggests that some respondents are willing to pay just as much to see 15 percent coral cover as they are to see 45 percent coral cover. There are two possible explanations why a certain percentage of snorkellers express a positive WTP for a level of coral cover which is lower than the status quo. Firstly, approximately one third (36 percent) of the snorkellers were first time snorkellers. Secondly, while the most popular reason for our sample stating why they wanted to snorkel was to view marine life (93 percent) the second most popular reason was for fun and the sense of adventure of a new experience (77 percent). Therefore, these respondents were still willing to pay to visit a beach with a lower level of coral cover (up to 15 percent) On the other hand the there is one class who are clearly not willing to visit a beach where there is only up to 15 percent coral cover (CORAL2), and they thus express a negative WTP under these conditions.

Table 4.13: WTP estimates from MNL and MMNL models for non-snorkellers

	WTP Estimates from MNL and MMNL Models for Non-snorkellers			
	MNL		MMNL	
	Est.	t-stat	Est.	t-stat
BTS1_Low_Policy	7.118	1.42	5.547	3.04
BTS2_High_Policy	15.763	2.90	9.200	4.92
MPA1_Low_Policy	-1.008	-0.20	0.125	0.06
MPA2_High_Policy	9.458	1.89	7.118	4.05
DEV1_Low_Policy	-7.832	-1.36	-4.110	-1.44
DEV2_High_Policy	10.887	2.26	7.141	4.34
WQ1_Low_Policy	-24.704	-3.00	-11.545	-3.85
WQ2_High_Policy	19.362	3.27	9.980	4.75
CLAR1_High_Policy	18.633	2.89	7.689	3.93
CLAR2_Low_Policy	1.249	0.24	1.968	0.96
PLAS1_Low_Policy	-12.384	-1.98	-4.473	-2.32
PLAS2_High_Policy	11.762	2.28	6.234	3.52

Number of snorkellers per group

One class is willing to pay an average of approximately TT$5.00 for up to 15 snorkellers per group (SNO1) while the other is not willing to pay for this restriction). Respondents have widely varying WTP values for SNO1 as depicted in Figure 4.21. One class is also willing to pay an average of TT$5.00 for restricting snorkellers to 5 per group (SNO2).

4.6.2 Non-snorkellers WTP estimates using MMNL

The marginal WTP values for non-snorkellers obtained by dividing the estimated coefficient of each attribute by the coefficient of the cost attribute in the non-snorkellers MMNL model are also presented in Table 4.13. The WTP estimates using the parameter estimates from the MNL model are also presented here to provide a base for comparison. These results show that non-snorkellers express their highest WTP of TT$9.98 for a beach where there is a low chance of contracting an infection. The parameter estimates derived from the MMNL model can also be used to estimate individual-specific estimates which are conditional on the observed choices (§ Section 2.6.2). The results of this analysis are also presented using kernel density plots as shown in Figure 4.25 to Figure 4.23.

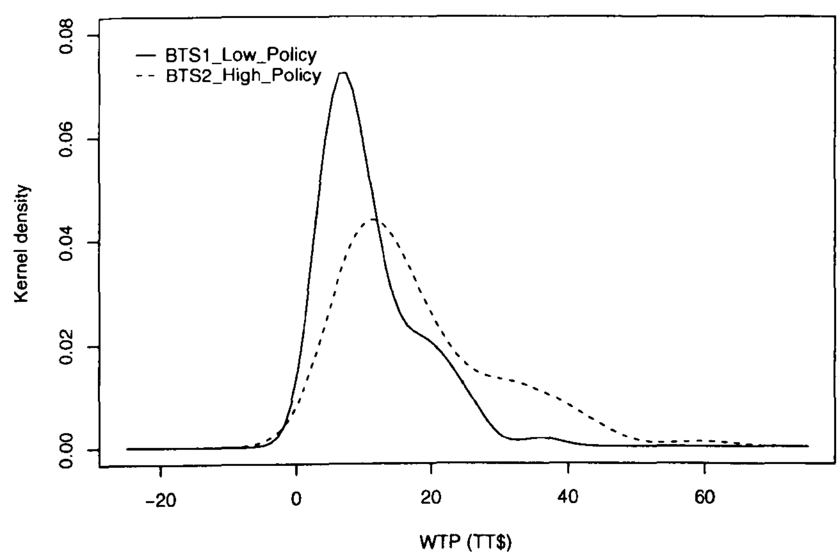


Figure 4.22: Distributions of individual-specific WTP for number of boats

The results show that there is much more overlap in WTP between the lower levels and higher levels of environmental quality for all attributes for non-snorkellers in comparison to snorkellers. One possible reason for this could be that most of the non-snorkeller population was made up of locals (64 percent) while most of the snorkeller population was made up of international visitors (89 percent). Visitors from more industrialised nations tend to demand pristine environments when they visit non-industrialised countries like Tobago (Mercado & Lassoie 2002). Therefore, in comparison to international visitors, local populations tend to be more tolerant of a lower level of environmental quality.

Number of boats

There is again considerable overlap over the positive orthant for WTP of this attribute (§ Figure 4.22). Non-snorkellers are willing to pay TT$14.00 on average to visit a beach with up to 2 boats near the coastline (BTS2) in comparison to an average of TT$8.00 for up to 7 boats near the coastline (BTS1). These results differ from those of the snorkellers, the majority of whom were not willing to pay to visit a beach with up to 7 boats near the coastline.

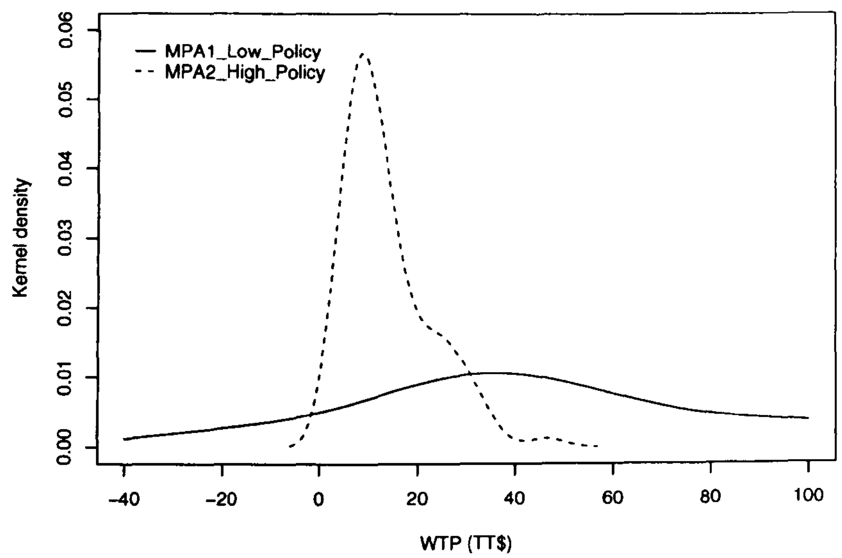


Figure 4.23: Distributions of individual-specific WTP for presence of a marine protected area

Marine protected area

As is also true of snorkellers, non-snorkellers express positive WTP on average for both types of MPA at a beach. The results show that the non-snorkellers are willing to pay an average of approximately TT$40.00 for an MPA which allows fishing in comparison to an average of approximately TT$10.00 for an MPA which does not allow fishing (§ Figure 4.23). There is also a wide spread of the WTP distribution for an MPA which allows fishing, particularly over the positive orthant.

Coastline development

The results depicted in Figure 4.24 suggest that there are widely varying WTP values amongst non-snorkellers for visiting a beach with up to 75 percent development on a beach (DEV1). The results also show that non-snorkellers have on average a WTP of about TT$10.00 for a visit to a beach with up to 25 percent development (DEV2). This suggests that, in comparison to snorkellers, non-snorkellers are more tolerant of beaches which have

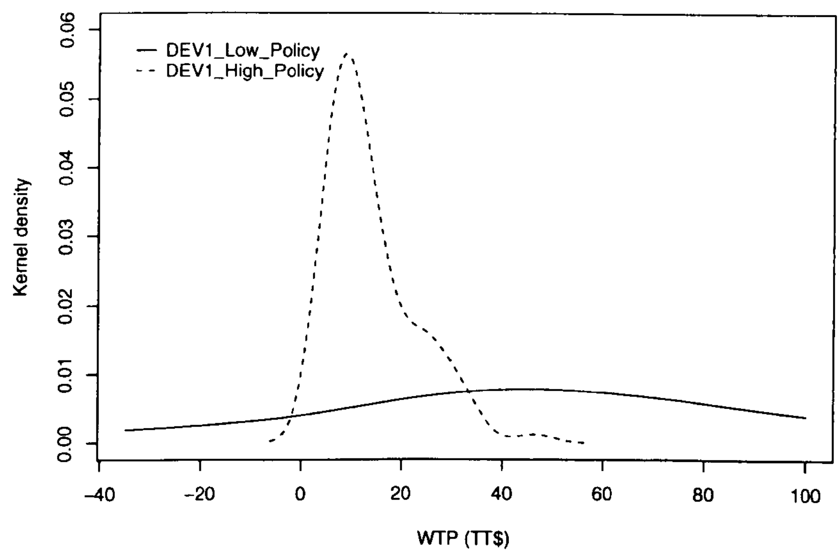


Figure 4.24: Distributions of individual-specific WTP for level of development

a higher level of development.

Chance of an ear infection

Figure 4.25 shows that the majority of non- snorkellers have a higher average WTP for visiting a beach with a low chance of infection (WQ2) or low average bathing water quality than for visiting a beach where there is a high chance of infection (WQ1) (TT$50.00 compared with TT$20.00). In contrast to snorkellers, there is a wider spread in the WTP distributions and a great deal of overlap between the results for WTP for the two levels of this attributes. This suggests that, within the non-snorkellers, a larger percentage of the population were still willing to pay to visit a beach with a high chance of contracting an infection.

Number of plastics

Non-snorkellers are willing to pay an average of approximately TT$7.00 to visit a beach with up to 5 pieces of plastic near the coastline and are not willing to pay to visit one where there are up to 15 pieces of plastic (§ Figure 4.26). Similar to the snorkeller results,

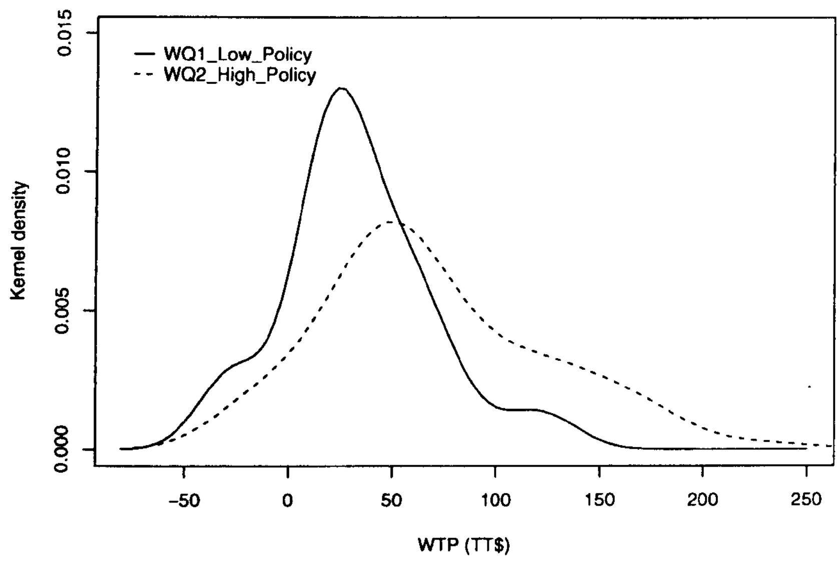


Figure 4.25: Distributions of individual-specific WTP for chance of an infection

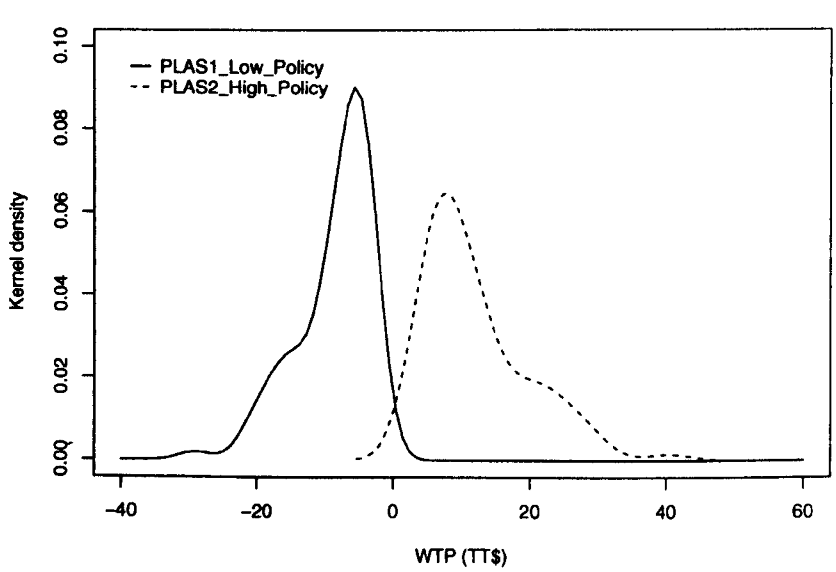


Figure 4.26: Distributions of individual-specific WTP for amount of plastics

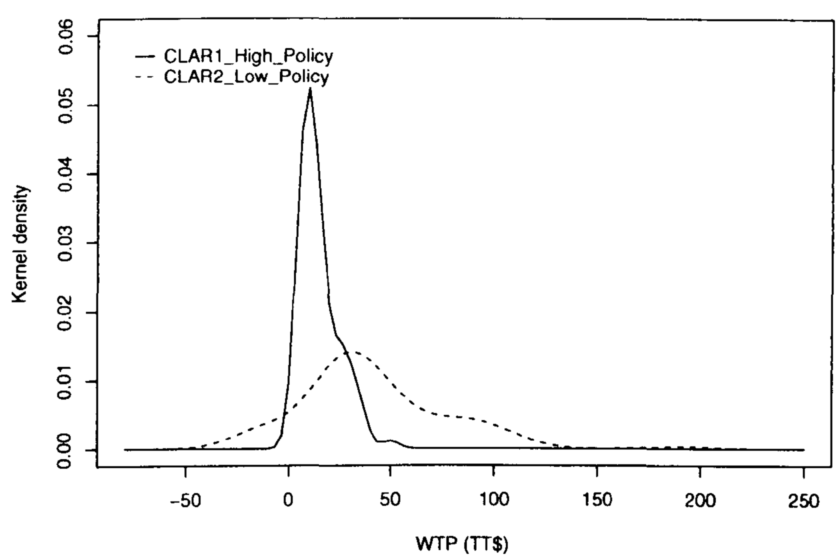


Figure 4.27: Distributions of individual-specific WTP for level of vertical visibility

there is not much overlap between expressed WTP for the two levels of this attribute. This may indicate that most respondents were not able to distinguish clearly between the two levels of this attribute.

Vertical visibility

The results depicted in Figure 4.27 show that the majority of non-snorkellers were willing to pay to visit a beach with vertical visibility of up to 10 metres (CLAR1) or high clarity. There is a wide spread, particularly over the positive orthant, in WTP for up to 5 metres of vertical visibility (CLAR2). This suggests that amongst non-snorkellers, a larger percentage of persons are willing to pay to visit a beach with up to 5 metres of vertical visibility. This is quite different to the WTP results for snorkellers where neither classes were willing to pay for up to 5 metres vertical visibility. This can be explained by the fact that the level of vertical visibility directly affects the snorkelling experience. In contrast, a lower level of visibility is adequate for non-snorkellers who do not engage in activities which depend on the clarity of the water.

4.7 Compensating variation estimates

Identification and quantification of heterogeneous preferences within the population allows policy makers to obtain more accurate welfare estimates. This in turn allows them to understand how policies and changes in different characteristics affect different segments of the population. In order to evaluate snorkellers' and non-snorkellers' valuation of a potential improvement scenario for the beaches in Tobago, the parameter estimates from the MNL model were used to compute the compensating variation estimates for both groups of respondents. As described in Section 4.7 individual-specific parameter estimates from discrete choice models could also be used to compute a measure of compensating variation. This was done using the individual-specific parameter estimates derived from the 2-class restricted LCM model and MMNL model for the snorkellers and non-snorkellers respectively. The results of the MNL model were used as a basis for comparison.

The potential improvement scenario used was that which enacted the maximum environmental quality improvement possible at all 42 beach sites and for all attributes for both groups of respondents. This involved independently changing each of the beach attributes from its base level condition to the highest level attainable as defined in this experiment. Each beach had to be described and coded in terms of the attribute descriptors used in this experiment to represent the current status that would be experienced if an individual were to visit that beach.

The highest level of improvement possible for each attribute varied depending on the beach site and thus had to be coded and described separately. For example, the maximum improvement of the "Store Beach" site for the non-snorkellers for the number of boats attribute involved changing the base level from the status quo scenario to one where the high level of policy could be experienced. In the case of boats, the maximum improvement would require a situation where there were only up to two boats near the coastline (BTS2).

WTP estimates per choice occasion (i.e. per beach visit) for both groups of respondents are presented in Table 4.14. Under the MNL model, snorkellers would be willing to pay an average of TT$98.71 per beach visit for the maximum improvement in beach quality while

Table 4.14: Compensating variation estimates from MNL, LCM and MMNL models

	Mean WTP Per Choice Occasion		
	MNL	LCM	MMNL
Snorkeller	98.71	150.86	
Non-snorkeller	68.67		47.38

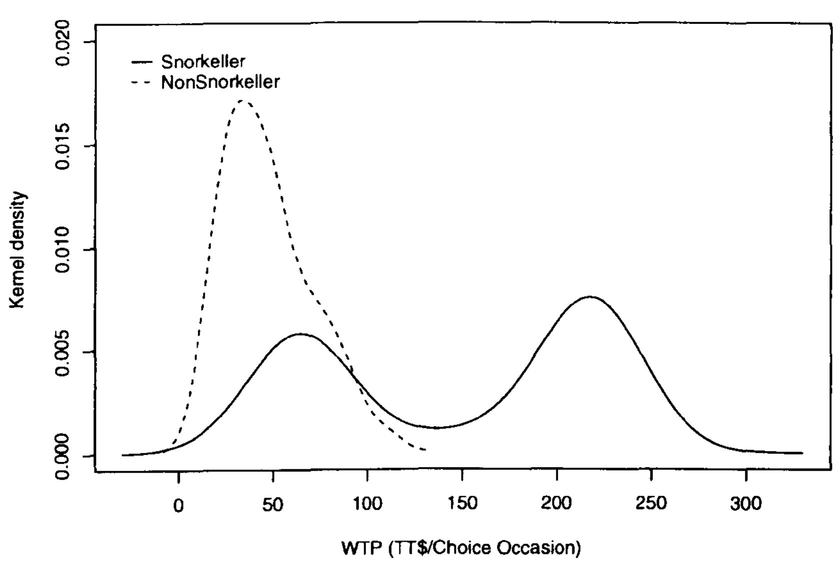


Figure 4.28: Distribution of WTP per choice occasion for snorkellers and non-snorkellers

non-snorkellers would be willing to pay an average of TT$68.67 per beach visit for the same levels of improvement. For snorkellers under the 2-class restricted LCM, the value was calculated based on the individual-specific WTP estimates. This yielded a compensating variation estimate of TT$150.86. For non-snorkellers, average WTP per choice occasion was also calculated based on the individual-specific WTP estimates from the MMNL model and yielded a value of TT$47.38. The distribution of snorkellers' and non-snorkellers' WTP per choice occasion for the proposed improvement scenario derived from the individual-specific WTP estimates from the LCM model and MMNL model are shown in Figure 4.28.

4.8 Policy implications of results

This section discusses the policy implications of the empirical findings to provide management recommendations for natural resource policy makers and managers in Tobago. The policy implications will take into account the findings and preferences within the two sampled groups of recreationists, snorkellers and non-snorkellers. The suggested recommendations will also take into account the additional information revealed about the population through the analysis of unobserved taste heterogeneity.

By understanding how preferences vary between and within the sub populations, policy makers are better able to manage this natural resource in a sustainable way and to strategically position the recreational product to accommodate these differences. By linking the management recommendations to WTP values, they can also gain an understanding of how different recommendations will be valued by different segments of users. This gives managers a measure of how well potential policies will be accepted if they are implemented.

Tobago's beaches provide recreational benefits for two groups of users - residents and tourists. Effective planning and management of recreational resource requires the understanding of the patterns of behaviour of its users (Hecock 1970, Revelle 1967, Clawson 1964). The identification of hitherto unobserved taste heterogeneity within the user groups of a recreational resource in addition to quantification of systematic differences between user groups is important because it provides a richer picture of preferences[4]. Furthermore, there is a substantial body of literature which provides evidence that tourist user groups are also becoming more segmented. Some authors have referred to this stage in the tourism cycle as post-Fordism or new age tourism (Fayos-Sola 1996, Poon 2002). This suggests that in order for destinations to remain competitive, policy makers should focus on developing and marketing their tourist product to cater to the demands of a differentiated user group (Poon & Stabler 1997). However, accounting for all the taste heterogeneity of interests, income levels, goals, and values translates into conflicting preferences with regard to environmental resources (Paavola & Adger 2005) and therefore increases the cost

[4]Examples of studies where accounting for taste heterogeneity has benefitted policy recommendations for recreational resources (Provencher & Bishop 2004, Scarpa & Thiene 2005, Hilger 2005, Hynes & Hanley 2006).

of managing and improving the resource (Alexandros & Jaffry 2005).

In light of the results of this study into the two sampled groups of respondents, and in order to minimise these transaction costs, policy makers could first concentrate their improvement efforts on those attributes which appeal to both groups. They could then turn their attention to policies which deliver value to subgroups of recreationists. This has to be coupled with targeted marketing and promotion focused on the different segments in the population. In this way, the costs of improving and marketing this resource are minimised and the benefits are maximised. For example, the empirical results clearly show that both groups of respondents exhibit very distinct preferences for certain levels of attributes. In the case of snorkellers, by examining attributes between the two groups derived from the LCM model it is possible to identify those attributes for which both classes of snorkellers have strong positive or negative preferences. The MMNL model also allows the identification of those attributes for which there was least unobserved taste heterogeneity of preference by observing the standard deviation surrounding the parameter estimates. This analysis reveals that both groups of respondents had strong positive or negative preferences for the attributes of chance of contracting an ear infection, level of development, presence of a marine protected area and the level of plastics on the coastline. More specifically, in terms of the levels of policy action associated with these attributes, snorkellers and non-snorkellers were both willing to visit a beach with an MPA which did not allow fishing and also had a low chance of causing infection. On the other hand, they were not willing to visit a beach with a high level of development and a high chance of causing infection.

The results of the above analysis seem to suggest that policy makers should focus on (1) reducing the health risks in coastal waters, (2) ensuring that there is proper planning and development control, (3) aiding the creation of more MPAs, and (d) actively implementing and enhancing solid waste collection programs. These improvements will have spill-over effects on other aspects of the environment such as improvement of vertical visibility and an increase in coral cover and fish abundance. Secondly, they could implement strategies and programs which help to further reduce the adverse impacts of recreational use. These include provision of adequate facilities for boaters and managing the behaviour of reef users. Further education would also help with the effective implementation of any management program. However, in order to provide sound policy recommendations, a cost-benefit analysis study should be undertaken. This can be done by firstly calculating the aggregate benefits of the attributes representing beach improvements and secondly by calculating the cost of implementing these improvements. Cost-benefit analysis studies are an important tool for determining which policy options should be ultimately implemented.

The following subsections discuss the management or policy implications of improving the level of each attribute in Tobago.

4.8.1 Chance of infection or average bathing water quality

Parameter and WTP estimates have shown that both classes of snorkellers have very clear preferences with regards to the chance of contracting an ear infection. They were willing to visit a beach with a low chance of contracting an ear infection but were much less willing to visit a beach with a high chance. Both classes had similar WTP values for each level of this attribute. Non-snorkellers however displayed much more overlap between their WTP values for these two attributes levels. However, most of the non-snorkellers had similar preferences to the snorkellers for this attribute. These results indicate that all sampled recreational users do not want to swim in polluted waters. However, since sewage is the major pollutant of the coastal waters in Tobago, there is in fact a high risk that persons will contract ear infections while swimming in coastal waters.

Sewage pollution occurs due to inadequate sewage treatment (Louis et al. 2006, EMA 1999). Wastewater treatment in Tobago is currently managed by The Water and Sewerage Authority of Trinidad and Tobago (WASA) which is part of the government Ministry of Public Utilities and the Environment. The portfolio of the Ministry of Public Utilities and the Environment includes responsibilities for environmental management, pollution control, solid waste and hazardous substances management, water resources, and enterprises. Despite the existence of this institution, the entire population is not connected to a central sewerage system. There are only 14 sewage treatment plants on the island[5]

[5]Sewage is treated either by 5 sewage treatment plants owned by WASA, The National Health Authority

which serve roughly 30 percent of the total population located mainly in urban areas, while the rest of the urban population and most of the rural population use septic tanks or pit latrines. With the exception of a limited number of connections[6] the bulk of black water flows to cesspools and septic tanks with drainfields. The bulk of grey water flows untreated over land into irrigation plots, surface waters, or migrates into the vadose zone as groundwater. The majority of the sewage treatment plants only service blackwater and grey water is not serviced. Furthermore, recent reports have indicated that these sewage treatment plants do not operate at full capacity (Louis et al. 2006, EMA 1999).

Apart from the human health threats to locals and tourists, there are also the negative impacts on the marine environment to contend with, including damage to coral reefs, seagrass beds, mangrove ecosystems, coastal erosion, increased algal growth and a decline in near-shore fisheries (Cambers 1996). These all reduce the recreational benefits which users gain from the coastal waters.

There is an urgent need to invest heavily in the construction of adequate central sewerage facilities on the island to allow adequate disposal of sewage and wastewater. The cost of implementing these systems is not cheap and timescales may extend to several years. In the meantime however, the government can implement temporary measures to reduce the impact of sewage pollution. These include the use of aquatic plants for tertiary treatment (Kanabkaew & Puetpaiboon 2005), the replacement of soakaway pits with sealed composting dry toilets to prevent leaching of nutrients into groundwater (Goreau & Thacker 1994) and the enforcement and regulation of trained operators to manage the private and public treatment plants (Louis 2007). Although the dire need for adequate sewage treatment in Tobago and in the Caribbean is well known and the construction of such plants has been repeatedly recommended (Louis et al. 2006, UNEP 1997, Mercado & Lassoie 2002, Siung-Chang 1997), this is the first study conducted in Tobago which has incorporated user preferences in making this argument.

(NHA) or the Crown Point International airport. There are also 9 private sewage treatment plants owned by hotels (Louis et al. 2006).

[6]These are the Smithfield sewage treatment plant located in St. Andrew, package units at hotels, and a modular sewage treatment plant in St. Patrick (Louis et al. 2006)

4.8.2 Coastline development

Both classes of snorkellers are much more likely to visit a beach with a low level of development than one with a high level of development. The significant standard deviation as well as the large spread of WTP values for the policy on high development for the non-snorkeller group however also shows that there is a large percentage of this group of respondents who are still willing to pay to visit a beach with a high level of development. These results suggest that there are two types of users, those that highly value a pristine and undeveloped beach and those who will be willing to visit a beach that is highly developed.

Within the last decade, Tobago has experienced strong development pressure arising from increasing revenues derived from the international tourism market. The majority of this development has taken place along the south-west coast while northern areas have remained relatively underdeveloped. It is estimated that 2150 of the 2595 tourist rooms in Tobago are located in this south-west region of the island (SEDU 2002).

Currently, in order to pursue any type of development, a developer has to obtain a Certificate of Environmental Clearance. This may require an Environmental Impact Assessment from the Environment Management Authority. Several other legislative and institutional bodies which should also be involved in this process are, in fact, excluded. These include, for example, the ministries responsible for planning and tourism development. There should be coordination between these organisations to ensure that national planning and tourism development priorities are established to include natural resource management and environmental planning. This ensures that any further development can take place within a comprehensive framework in order to better manage the land resources and ensure sustainable development. These organisations may want to minimise development on the south-west coast and manage any further development on the north coast using environmental planning guidelines.

Small islands like Tobago do not usually have the luxury of creating many different types of tourism markets because of the limited land space. However, since most of the southern side is already developed, it may well be better if the amount of development on the north coast remains limited while any further development on the southern side is carried out in accordance with environmental planning measures. This would allow the two user groups to be satisfied with both developed and underdeveloped beaches on the same island.

4.8.3 Marine protected areas, fish abundance and coral cover

The results of this study show that both snorkellers and non-snorkellers prefer to visit a beach where an MPA in present. Both groups of recreationists have higher WTP for an MPA which does not allow fishing in comparison to one that does allow fishing. The preferences for coral cover and fish abundance also satisfied *a priori* expectations that respondents would have a higher WTP value for greater fish abundance and higher coral cover in comparison to the lower levels. An interesting point pertaining to these three attributes with reference to the two classes within snorkellers was that one class was willing to pay at least three times more than the other class on average for a higher level of environmental quality. This suggests an appropriate categorisation of these two groups into avid snorkellers or 'purists' and occasional snorkellers.

The results also showed that non-snorkellers were still willing to pay a premium to visit a beach which had access to an MPA. This suggests that the creation of more MPAs on this island could be successful. The results also show that MPAs which do not allow fishing (have no-take zones) elicited higher WTP values than ones which did. One possible reason for this is that recreationists perceive that no-take zones may increase the probability of seeing more coral cover and a greater fish abundance. Finally, the significant difference in WTP between the two classes of snorkellers suggests that the introduction of restricted access at certain sites based on a pricing policy could be one way to satisfy the demand for this type of more exclusive access. For this to be successful, appropriate regulation and enforcement would be required here.

The Buccoo Reef Marine Park located on the south-west of the island is currently the only MPA[7]. This park has been designated a no-take zone but illegal fishing still takes place.

[7]There are draft plans to designate another MPA in the Speyside area (IMA 2001).

Due to its geographic location, this park is subject to a high suspension of solids due to the sediment laden freshwater discharges from the Orinoco river (IMA 1995, Simmons 1996). In addition, it has also been affected by man-made stressors such as reef walking and anchor damage.

There are approximately 16 coral reef sites of varying sizes dotted around Tobago. It has been estimated that in order to meet human and conservation goals, 20 percent or more of all marine biogeographic zones should be incorporated within fully protected marine reserve networks (Roberts & Hawkins 2000). Therefore, further research should be carried out to determine which sites should be designated as marine parks so that a marine reserve network can be created. The criteria for selection of these sites should allow prioritisation of social, economic and biological criteria (Roberts et al. 2003). This study indicates how preferences of locals and tourists could be used to support such a prioritisation.

It is important that the impact of visitors is managed at the Buccoo Reef Marine Park and at any MPA's which may be designated in the future. Some improvements include the provision of mooring buoys and limiting the number of boats which are allowed to tie up to a mooring (Barker 2003) and the use of underwater cameras (Rouphael & Inglis 1997, Barker 2003). Other factors which should be taken into consideration when implementing restrictions to assist conservation include the type of reef species present (Garrabou et al. 1998), whether or not the site is used for practice dives and night dives, and whether dives are launched from the shore or boats (Barker 2003). The designation of a marine reserve network and the implementation of user restrictions should help maintain ecological biodiversity on the island.

4.8.4 Number of plastics

The presence of plastics and others form of marine litter is unsightly and can lead to a decrease in visitation to the beach. The results suggest that both snorkellers and non-snorkellers are less likely to visit a beach with a high level of plastics. Plastic litter is a major problem in Tobago as it is one of the most prevalent forms of litter which washes up along the coastline. One of the reasons for this is that the lack of plastic recycling facilities on the island means that there is no incentive to collect plastics. There is also a severe lack of waste disposal bins at beaches. At some of the more iconic beaches such as Store Bay located on the south-west of the island, plastic litter is cleaned up on a daily basis by local authorities. This has proven an inadequate management strategy since large amounts of plastics still wash ashore on a daily basis (Santos et al. 2005).

Destination managers and the government should try to enhance waste disposal and collection facilities. One method of doing this is to increase the amount of trash bins on the beach. Public education programs and enforcement of legislation[8] which prohibits littering can also help minimise plastic levels.

4.8.5 Number of boats

Overall, both snorkellers and non-snorkellers are willing to pay more to visit a beach where there is a low number of boats near the coastline in comparison to a higher number. However, on closer examination of the results it is apparent that non-snorkellers are more tolerant of boats and still willing to pay to visit a beach where there is a higher number of boats. For one class of snorkellers however, respondents are still unlikely to visit a beach, even if there are only up to 2 boats near the coastline. These results indicate that policy makers should make effort to create proper mooring facilities for the users of recreational and fishing boats so that they are not moored near popular beaches.

With the exception of a few beaches which have jetties[9] most of the beaches do not have launching sites. Fishermen and recreational boat users use a combination of practices for mooring their boats which include anchors, jetties or bringing their boats onto the shoreline. These practices can obstruct access to the beaches.

At certain beaches in Tobago, there is a higher incidence of finding boats moored off the coastline. This occurs for three main reasons. The first is that at some beaches fish is sold

[8]Litter Act, Chp. 30:52 (Act No. 27 of 1973, amended by 10 of 1981) - The Act prohibits littering, *inter alia*, of public places.

[9]The beaches which have jetties include Pigeon Point Beach, Anse Bateaux, Parlatuvier, Castara and Man O' War Beaches.

commercially[10]. The second is that due to the presence of coral reef sites off the coastline, a greater number of recreational tour companies operate off adjacent beaches[11]. Thirdly, because some beaches provide sheltered anchorage, yachts are usually moored off these beaches[12].

Boat operators form part of two industries that are important in Tobago: fishing and recreational tours. The latter is an integral part of the tourism product offered on this island. However, the results of this study suggest that it is important to have proper facilities for boat mooring and management as this benefits not only the boat operators but also the public perception of the beaches.

As already noted there is increased boat traffic at certain beaches for particular reasons. Therefore, managers can focus on improving facilities at these beaches first. Enhancements could include the provision of launching ramps, docks, fuelling stations and buoys. Once these facilities are in place, the government can use properly enforced legalisation to ensure that boats are not moored in the waterways of beaches. The enhancement of these boat facilities will not only keep the environment clean but also make recreational boating activities more accessible to visitors (*Boating Access Program* 2007).

4.8.6 Vertical visibility or clarity

The results of this study show that vertical visibility is an important aspect of beach quality for snorkellers. Indeed, both groups of respondents have positive WTP values for high vertical visibility and negative values for low vertical visibility. However, non-snorkellers are in general less averse to low vertical visibility. This can be explained by the fact that a low level of visibility was defined as visibility of 5 metres, a value which is suitable for most recreational activities apart from snorkelling and scuba diving.

If policy makers would like to attract the niche tourism markets of tourism for snorkelling

[10]These include Mt. Irvine, Great Courland Bay, Castara Bay, Man O War Bay, Little Rockly and Little Back Bay beaches

[11]These include Store Bay, Buccoo Bay, Mt. Irvine and Speyside beaches.

[12]These include Anse Bateau, Parlatuvier, Man O War Bay and Kings Bay beaches.

and scuba diving, then a high level of water vertical visibility is important. Due to its location down-current from the Orinoco river, Tobago's waters are naturally cloudier than destinations such as Barbados or St. Lucia which are higher up the Caribbean chain of islands. The implementation of proper sewage treatment for the island as discussed in Section 4.8.1 will also improve the vertical visibility of the waters. Watersheds on small islands are closely linked to the wider costal and marine environment (Haynes & Schaffelke 2004). On an island like Tobago, this means that the coastal waters are more vulnerable to agro-chemical pollution. Taking measures to monitor and reduce pollution will also increase vertical visibility.

4.8.7 Number of snorkellers per group

This study suggests that respondents had a mix of preferences for this attribute. Recent research has shown that people's perceptions of crowding in marine environments are affected by their level of experience (Inglis et al. 1999). For example, respondents who are more experienced snorkellers are less tolerant of the number of persons around them than novices. Novices on the other hand prefer to have more people around them due to the lack of confidence in their snorkelling abilities. Since one third of respondents in this survey were novices and two thirds were experienced snorkellers, the variation of preferences could be explained by this phenomenon.

It is clear from these results that more research is needed to understand how people perceive crowding in marine environments. There is substantial research showing that crowding in marine environments affects the quality of marine life (Barker 2003, Rouphael & Inglis 1997, Hawkins et al. 1999). By educating users about why snorkelling in small groups is better for the environment, policy makers have an opportunity to manage snorkelling activities to ensure that minimal damage is caused by over-crowding.

4.8.8 Positioning and marketing the tourism product

For effective promotion of tourism, countries need to identify the kind of tourism they wish to promote and the type of tourist they wish to cater for (Barker 2003). Whether a destination should pursue visitor quality as opposed to visitor volume is an issue that remains heavily debated in the Caribbean (Mather & Todd 1993). For small islands like Tobago the most obvious choice would be to target the up-market visitor because this would encourage smaller visitor volumes which remain within the island's carrying capacity. However, the disadvantage of this approach is that this single market may not be sufficient to sustain the industry throughout the year.

Substantial tourism growth has only begun to take place in Tobago in the last decade, making it a relative late-comer into the international tourism market (SEDU 2002). The advantage of this is that the island is still in a position to intervene and plan its development so that further environmental degradation is minimised. From an examination of the results for each attribute addressed in this survey (and with the exception of water quality and the number of snorkellers), a significant difference in strength of preferences and willingness to pay values can be observed. The emergence of two main types of visitors to the beach can be seen across the two types of recreationists. The first is one that prefers exclusive unspoilt tourism and is willing to pay a premium for it, while the other is the tourist who is more tolerant of a lower level of environmental quality and is also not willing to pay as much.

Improving coastal water quality alone is unlikely to be sufficient for Tobago to remain competitive in the tourism industry. It will also necessary to market the island destination to cater to the preferences of these user groups. As most marketing efforts are directed at tourists from industrialised countries, it is important that advertisement focuses on the attributes which tourists from these countries desire. For example, as this study showed, most international tourists are snorkellers. Therefore, funds should be directed at improving those attributes most important for this class of visitor and, in particular, those attributes for which a high WTP is observed in comparison to the cost of carrying out improvements. By understanding the environmental attributes tourists seek, a positive spiral of environmental improvements and increased visitors numbers can be achieved. This brings benefits not only to the visitor but also to the local population of Tobago.

4.9 Summary

This chapter reported the results of two discrete choice experiment surveys carried out on two groups of beach recreationists. The purpose of the two surveys was to determine the WTP estimates of snorkellers and non-snorkellers for improvements to coastal water quality on the island of Tobago.

The chapter began with a summarised presentation of the research background, motivation and research questions. Following this, a review of the related literature on the recreational benefits of improved coastal water quality was presented. This revealed two key points. The first point is that despite the abundance of previous studies that derived the benefits of improvements to coastal water quality for recreational activities, only a small number of these studies had investigated this issue within the context of beach recreation in particular. The second key point is that very few of these studies had used the discrete choice experiment method - the majority had utilised other valuation methods such as contingent valuation or travel cost.

The descriptive statistics of the beach recreationists were analysed and revealed important differences and similarities between these two groups. For instance, these results confirmed that the majority of the local population and domestic visitors had never snorkelled. On the other hand, the majority of international visitors had engaged in at least one snorkelling session during their lifetime. One of the main similarities between these two groups is that almost all respondents had engaged in some sort of beach recreation. Another important similarity which had implications for this study was that coastal water quality was the most important factor amongst other beach amenities which affected the quality of the beach recreationists' experience. An important finding was the result of the follow-up questions in both surveys. These identified that respondents were not considering all the attributes that were presented to them. The incidence of this increased in the discrete choice experiment for snorkellers when a larger number of attributes was introduced.

The analysis of the two groups began with the standard MNL model. The basic finding across the two groups was that most of the respondents were more willing to pay to visit a beach with attributes associated with a higher level of environmental quality and were willing to pay less to visit one with a lower level of environmental quality.

In order to investigate the presence of unobserved taste heterogeneity, the MMNL and LCM models were specified for both groups of respondents. BIC and AIC tests were used to compare the MMNL and LCM model specifications. These two specifications outperformed the MNL model in all cases. In addition, an examination of the significant standard deviation estimates in the MMNL models and the presence of classes in the LCM models revealed the presence of unobserved taste heterogeneity. In the case of snorkellers, a 2-class LCM model provided a significant improvement in fit over the MNL and MMNL model specifications. In the non-snorkellers , the MMNL model provided the most explanatory power and revealed unobserved taste heterogeneity for 6 attribute levels.

The parameter estimates from the chosen model specifications were used to calculate marginal and individual-specific WTP estimates. The individual-specific WTP estimates were depicted and contrasted for each level of attribute. These results revealed that in the case of snorkellers, a large variation could be observed between positive and negative WTP values for the two attribute levels representing the higher and lower levels of environmental quality. On the other hand, in the case of the non-snorkellers, there was a significant amount of overlap between the two levels of the same attribute over the positive orthant. One reported implication of this result was that, in comparison to the snorkeller respondents, non-snorkellers were more willing to pay for attributes representing a lower level of environmental quality.

The individual-specific WTP estimates were examined in order to derive policy recommendations for improvements to coastal water quality. The advantage of having used more flexible econometric models to capture unobserved taste heterogeneity was that it allowed the tailoring of policies for each attribute and recreator group. For example, it was found that there were two subgroups of snorkellers: avid and occasional snorkellers. Therefore, this meant that it was possible to consider a pricing policy that differentiated between the activities engaged by the beach recreationists. It was also found that an examination of the

WTP estimates could also reveal similarities of tastes between the two groups. This could also help with suggesting which policy issues could be further examined by implementing a cost-benefit analysis study. This was done through an examination of the attributes by highlighting those that were (1) similar in significance and sign to both classes of snorkellers and (2) did not show unobserved taste heterogeneity in the MMNL model. The results of this examination led to a list of attributes in which both groups of recreationists had strong preferences for these attributes. In the case of a small developing country like Tobago, it was found that it may be more important to recommend policies that are common to both groups first and then focus resources on policies that deliver benefits to subgroups of recreationists. The common attributes that both groups of respondents were willing to pay to visit a beach for were: an MPA which did not allow fishing (MPA2) and a low chance of contracting an ear infection (WQ2). They were both however not willing to pay to visit a beach with a high level development (DEV1) on the coastline and high chance of contracting an ear infection.

Chapter 5

The implications of researcher-selected versus respondent-selected attributes on valuation estimates

Abstract

Follow-up questions within the discrete choice experiments reported in Section 4.4.8 identified that a considerable proportion of individuals in both groups of respondents were not attending to all attributes which they were asked to consider. These results raise the question as to why certain attributes were not being attended to, and the effect this may have on the derived utility estimates. Previous research has shown that respondents may not attend to all attributes due to various factors such as complexity, limited information processing capability and relevance. This chapter investigates whether the *relevance* of attributes has a role in explaining why respondents may not attend to all attributes and also the effect this has on empirical estimates.

This chapter begins by describing the motivation for this area of research and the specific research questions addressed. This is followed in Section 5.2 by a review of the related literature and the contributions made in this study. To carry out this investigation, a discrete choice experiment is designed that allows for a systematic examination of differences in parameter estimates associated with the inclusion and exclusion of attributes as specified by respondents (§ Section 5.3). The novelty of this approach is that it allows tailoring of

each respondent's experimental design based on the number of attributes they deem to be relevant. The choices made from this experimental manipulation (defined here as the respondent-selected treatment) are then compared to a typical choice experiment (defined here as the researcher-selected treatment). In order to make a comparison between these two treatments, scale effects are controlled for within MNL and MMNL model specifications.

The results of the chapter are presented as follows. Firstly the descriptive results of the respondent-selected treatment are presented in Section 5.4. Secondly, the results of the choice model estimations using the MNL and MMNL specifications are presented in Sections 5.5 and 5.6 respectively. In Section 5.7 the scale effect is identified in order to compare the pooled datasets from the researcher-selected and respondent-selected treatments. Individual-specific WTP of the respondents in the respondent-selected are calculated and depicted using kernel density plots in Section 5.8. Finally the chapter concludes with a discussion and summary of the implications of the results of this study.

5.1 Introduction

In a discrete choice experiment, respondents are assumed to be rational and behave in accordance with the axioms of consumer choice theory[1]. This requires the use of compensatory decision strategies as opposed to non-compensatory decision strategies when making choices. The central distinction between these two stategies is the extent to which respondents make tradeoffs among attributes (Payne et al. 1993). For instance, the use of compensatory strategies implies that respondents make tradeoffs between all attributes whereas the use of non-compensatory strategies imply that they do not.

Researchers in applied economics fields base their policy conclusions and recommendations on the assumptions underlying discrete choice theory. Decision making lies at the heart of discrete choice theory. The study of decision making by consumers has been of greatest interest to psychologists who have made significant progress in this area. This is evidenced by the vast literature in the consumer decision making field[2] (Bettman et al. 1991).

[1]These include continuity, completeness, transitivity, convexity, monotonicity and local non-satiation. See (Varian 1992) for a further discussion on utility theory.

[2]This includes fields and literature in psychology including judgment and behavioural decision making.

Here, psychologists have established that individuals use multiple decision strategies, both compensatory and non-compesatory, in different situations. This is an adaptive response to a number of factors such as task, context and an individual's limited capacity to process information (Payne et al. 1988). In other words, an individual's use of a decision strategy is highly contingent on the properties of the decision problem (Payne et al. 1993). As a result, when choices are made using non-compensatory strategies, they cannot be represented as preferences through a utility function. This has important implications on the accuracy of welfare estimates.

A bridging of the gap between the multidisciplinary fields of consumer decision making and economics has taken place over the past twenty years. Earlier on, researchers in applied economic fields began to question whether empirical research was accounting sufficiently for the various decision heuristics and limited information processing capability of respondents in their empirical studies. A number of studies have been undertaken in marketing, transport and, more recently, environmental economics, which have all investigated disparate aspects of this central question.

One of the more popular areas of investigation in environmental economics seeks to determine how the complexity of a decision task is affected by changes in the number of attributes, attribute levels and alternatives, and the effect these have on welfare estimates (DeShazo 2002, DeShazo & Fermo 2004). Another seeks to detect the use of non-compensatory decision strategies during choice experiments, the most popular of these being detection of the lexicographic decision rule (Sœlensminde 2005, Rosenberger et al. 2003, Spash & Hanley 1995).

One of the more recent debates (and as examined in this chapter) concerns attributes being included or excluded in the choice experiment. Recent research has shown that when attributes are not included by the researcher (Louviere & Islam 2004), or not attended to by the respondent (Hensher 2006*a*, Campbell et al. 2006), an impact is observed on the utility estimates. However, what has not been addressed in the literature to date is the question of *why* respondents ignore or do not attend to attributes. While there are many ways to proceed with this gap in the literature, the research in this chapter focuses on the aspect of attribute relevance. We hypothesise that attribute relevance based on the activities one pursues at the beach could be a contributory factor to why a respondent may not attend to all attributes in the choice experiment. For instance, if an attribute is not truly relevant to an individual, then this may lead that individual to use decision heuristics which effectively ignore or exclude that attribute in the choice experiment. This exploratory study is carried out in this chapter by explicitly designing a survey to allow the respondents to carry out a choice experiment based on the attributes they deem as important to them on their day out at the beach (respondent-selected). By comparing choices from the respondent-selected treatment with those of a typical choice experiment (researcher-selected treatment) while controlling for scale effects, the following research questions are addressed:

1. Is attribute-relevance a contributory factor in explaining why respondents may not attend to or exclude attributes in a discrete choice experiment?

2. Does the experimental manipulation in the respondent-selected treatment have implications on WTP estimates?

5.2 Related Literature and Contribution

There are several strands of literature from various fields which question whether respondents attend to all attributes presented to them in a choice experiment. The first field to address this question was that of psychology and behavioural decision making. Research on identification and characterisation of strategies used by decision makers revolve around three main factors which are believed to influences strategies used by decision makers. These are (1) characteristics of the decision problem (such as task and context variables (Simon 1990)), (2) characteristics of the person (such as cognitive ability and prior knowledge (Alba & Marmorstein 1987, Chi et al. 1988, Shanteau 1988)) and (3) the social context (such as accountability and group membership (Tetlock 1985))[3].

Payne et al. (1993) made an important contribution to the literature in a summary of previous work which showed that individuals use various decision strategies flexibly

[3]These areas of research were greatly influenced by pioneering work done on mathematical and descriptive models formulated in (Simon 1955, Tversky 1972, Dawes 1964).

(both compensatory and non-compensatory) in response to different decision tasks[4]. Task complexity is defined here as a function of the number of alternatives, the number of attributes and time pressure, and is recognised to be just one of the factors which influence the type of strategy ultimately adopted by the decision maker (§ Figure 5.1 for other factors). It has been shown that as task size increases (as defined by the number of attributes (Sundstrom 1987, Biggs et al. 1985) and alternatives (Payne 1976)), the use of non-compensatory strategies also increase. In other words, as decisions become more complex, individuals prefer to use simplifying decision heuristics which are usually non-compensatory (Payne 1976).

In spite of the existence of the research in the aforementioned contributions, only a small number of authors in applied economic fields such as marketing, transport and environmental economics have attempted to investigate the sensitivity of factors influencing the use of decision strategies and to then incorporate these factors into econometric models of consumer choice.

One of the first empirical studies to build on research from the consumer decision making literature in a logit framework was carried out in the field of marketing by Malhotra (1982). In particular, Malhotra (1982) investigated the effect of varying the numbers of attributes and alternatives on the concept of information overload. This concept was first established by Jacoby et al. (1974), authors from the behavioural and consumer decision making field. Characteristics information overload were recorded using a self report measure and included feelings such as confusion, satisfaction and certainty. Malhotra (1982) found that when consumers were asked to choose among alternatives for houses, choice accuracy decreased when the number of attributes increased from 5 to 15 or more (up to 25) and when the number of alternatives increased from 5 to 10 or more (also up to 25).

In the field of economics, Heiner (1983) was one of the first authors to argue that individuals' limited information capacity prevents them from employing decision strategies which are utility maximising. Palma et al. (1994) also investigated the notion of consumers

[4]For a full discussion on the decision strategies proposed in describing choice behaviour, see chapter two of (Payne et al. 1993).

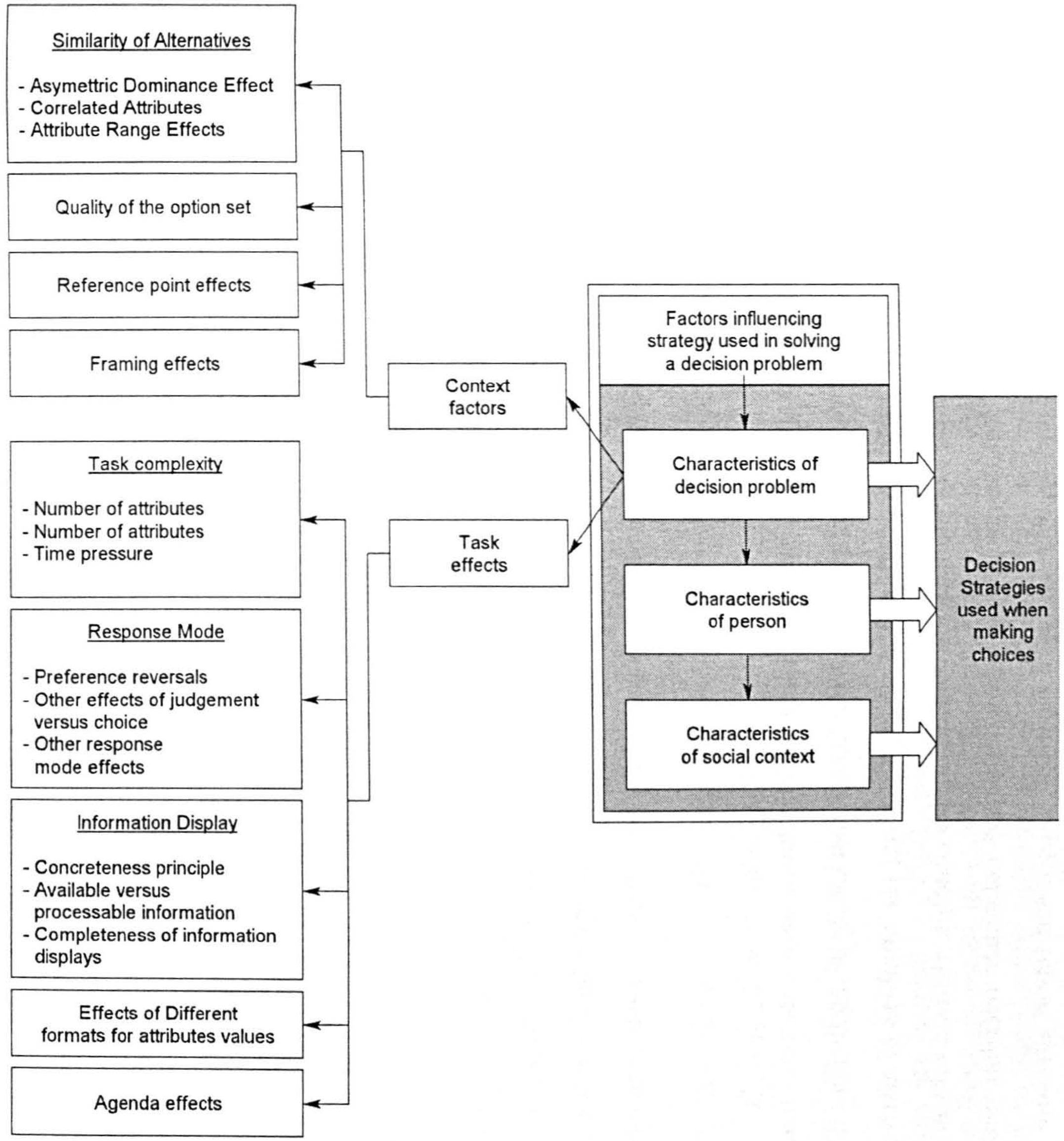


Figure 5.1: Factors affecting decision making strategies. This illustration is based on the summary and discussion of types of decision strategies used by individuals in Payne et al. (1993)

having limited information capacity and modelled consumers with differing abilities to choose. They found that variations in the ability to choose produced different choices. Mazzotta & Opaluch (1995) explored Heiner's hypothesis and investigate the implications of decision heuristics on coefficient estimates. Their results showed that complexity effects can have important implications for welfare analysis.

One of the first studies to model task complexity in the field of transport was undertaken by Bradley & Daly (1994) within a random utility model framework. Here, complexity was modelled in pairwise and ranked choice data and it was concluded, using the logit scaling method, that the amount of unexplained variance increases as rankings become lower and as the number of pairwise choices become greater.

In 2001, Swait & Adamowicz (2001*a*,*b*) were the first to acknowledge that, despite contributions from the consumer research literature which concluded that multiple choice strategies were commonly used, little work had been undertaken to link these findings to models for multi-attribute tasks, including choice experiments. In particular, there had been little work on translating these findings into empirical econometric models. In order to bridge this gap, the two aforementioned contributions were made. Swait & Adamowicz (2001*b*) extended the work of Palma et al. (1994) who had postulated that variations in a consumer's ability to choose creates the variance associated with preferences.Swait & Adamowicz (2001*b*) constructed a theoretical model that included market and choice complexity as well as a constraint on the amount of information processing resources available. This model was tested empirically using stated preference and revealed preference data which showed that task complexity did have a significant effect on the parameters of choice models. Swait & Adamowicz (2001*a*) constructed a latent class model which allowed decision strategy to change as a function of task complexity, cognitive burden and task order. Complexity was defined as an entropy index which was linked to variations in the number of attributes, number of alternatives and correlation of attributes. The results supported the notion that preference parameters depended on the degree of complexity in the choice task. This study also showed that at high levels of task complexity, changes in choice behaviour towards simpler processing strategies can be observed.

The two contributions by Swait & Adamowicz (2001*a*,*b*) inspired a number of studies in transport, environmental economics and marketing, all of which varied aspects of the choice experiment to determine if there was any effect on choice consistency. In addition to identifying a bias with respect to the design of the study, this literature also examined the impact which choice consistency had on welfare estimates. For example, DeShazo (2002) made the first contribution of this type in environmental economics literature with an investigation into the effect of complexity on choice consistency. He developed 5 measures of complexity based on the number of attributes, the number of alternatives and the degree of correlation within and across all alternatives. The analysed data was collected from recreationists in Costa Rica who assessed the economic value of services and infrastructure in a national rainforest park. The results showed that all measures of choice complexity affected choice consistency and hence welfare estimates. In a working paper by Gómez-Lobo et al. (n.d.), the authors applied the model developed by Swait & Adamowicz (2001*b*) to stated preference data that valued the environmental impact of hydroelectric projects in Chile. These results also showed that accounting for choice complexity did have an impact on valuation estimates.

In the fields of transport (Hensher 2006*b*, Caussade et al. 2005) Hensher and Caussade varied design dimensions (such as the number of attributes and attribute levels) to determine if variations in the design had an impact on the attribute parameters. Hesher used a mixed logit model to help study the effect of complexity while Caussade used a heteroscedastic model. They both concluded that complexity affected choice consistency, but while Hensher found differences in WTP, Caussade did not. In a related study, Arentze et al. (2003) defined task complexity not only in terms of attributes and alternatives but also in terms of the presentation method. As this study was carried out in a developing country, literacy levels of the respondent was also considered as a factor which may have affected the size of error variance. The findings suggested that presentation methods and literacy levels had no significant effect on error variance, but that an increase in the number of attributes caused the scale of error variance to increase.

Three recent and important contributions on the subject of attribute inclusion and exclusion were made in the marketing (Louviere & Islam 2004), transport (Hensher et al. 2005*b*) and environmental economics (Campbell et al. 2006) fields. In the study by Louviere & Islam (2004), design dimensions for each respondent were varied. This allowed a direct comparison of WTP estimates to be made without having to control for scale effects. Qualitative research on the most salient attributes informed the authors on which attributes should be included or excluded. Hensher et al. (2005*b*) tried to determine if respondents were genuinely ignoring attributes while completing a choice experiment and sought to observe if this behaviour affected WTP estimates. This was done by asking respondents after they completed the choice experiment whether they attended to all attributes or not. Hensher et al. (2005*b*) modelled attribute inclusion and exclusion by aggregating attributes depending on the number of attributes which each respondent indicated they attended to. In order to compare estimates from both treatments, two MMNL models were specified. The first assumed that respondents attended to all attributes while the second was based on supplementary questions which asked which attributes the respondent ignored. The results of this work showed that the two models produced significant differences in WTP estimates. In the study by Campbell et al. (2006), the authors also used supplementary information in an environmental economics application and found that even with as few as 4 attributes, respondents still did not necesssarily consider all attributes. In order to determine the impact on WTP, Campbell et al. (2006) specified two MMNL models, the first of which did not account for people ignoring attributes while the second did. This was achieved by the use of dummy variables. The results showed significant differences in WTP between the two estimated models.

Having established that attribute inclusion and exclusion affects utility estimates, some researchers have suggested that further studies be carried out to investigate the role which personal relevancy may play in determining whether respondents include or exclude attributes in a choice experiment (Hensher 2006*a*, Rose et al. 2004). In addition, others have suggested that further research be carried out to understand the *processes* by which individuals make choices in the field (DeShazo 2002, Louviere et al. 2004). The study detailed in this chapter contributes to this gap in research in 2 ways. In particular, it is the first study to:

1. Design a field study which explicitly allows the systematic inclusion and exclusion of attributes based on each respondent's preferences.

2. Investigate the role that attribute-based relevancy may have on whether respondents include or exclude attributes in a discrete choice experiment. This study also evaluates the impact of the respondent-selected treatment on WTP estimates and uses these for recommending policy actions.

5.3 Administration and design of the respondent-selected treatment

As described in Section 3.4, 50 surveys were administered for this survey in the departure lounge of the Piarco International Airport in Tobago. Of these, 3 persons refused to participate in the survey, representing a 6 percent refusal rate, while 5 were unusable. In all, 42 surveys were collected with usable responses. The data was collected by presenting respondents with six attributes[5] and then asking them to choose which attributes were most important to them on their day out at the beach. They were advised that their choices should be based on their preferences for recreational activities at the beach. They were also advised that they could choose to include any number or type of attribute in their choice decision. If the respondent chose five or more attributes, then that person was asked to rank these attributes so that the top four could be chosen. This represents one of the limitations of this treatment, but was necessary as it was important that each respondent completed one entire design. As shown in Table 5.1, the number of choice sets generated with 5 and 6 attributes were too numerous to administer to respondents due to the sampling location and the time constraints sensible for voluntary surveys. Monotonicity tests and preference stability tests were also included in the treatment. In administering this survey, the designs for 2, 3 and 4 attributes were printed and the varying levels were assigned a code which was used to help design the choice sets on site. Each choice set was constructed individually on-site using magnetic labels and a magnetic board as shown in Figure 3.16 on page 100. Figure 5.2 shows a schematic of the typical or 'researcher-selected' treatment in comparison to the 'respondent-selected' treatment.

[5]The attributes were the same presented in the non-snorkellers discrete choice experiments.

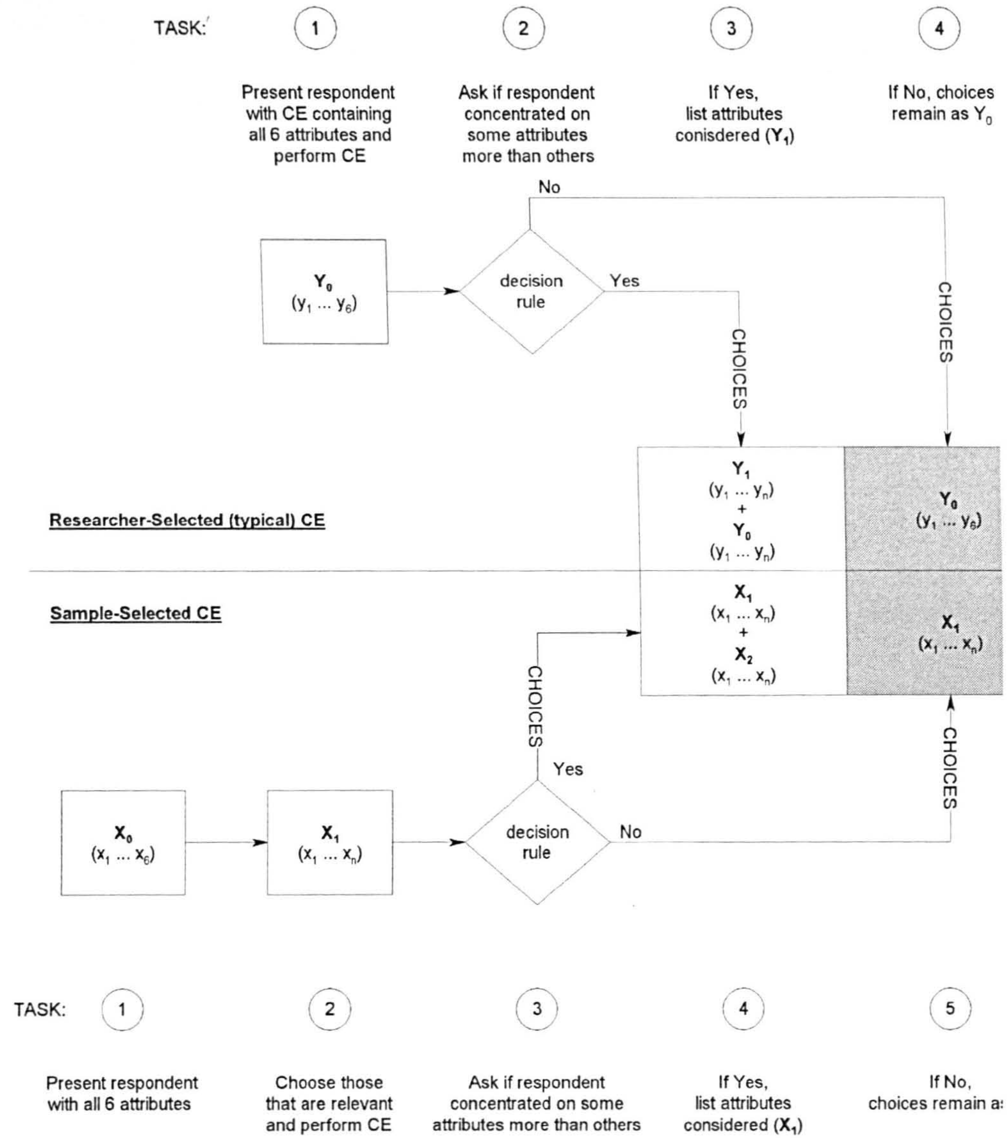


Figure 5.2: Comparison of steps involved in researcher-selected treatment or typical choice experiment and respondent-selected treatment

Table 5.1: Number of choice sets generated

Number of attributes	Number of choice sets generated from design
2	7
3	8
4	9
5	16
6	17

5.4 Descriptive results

This section presents the results of the experiment described in Section 5.3. First, descriptive results of the respondent-selected treatment are presented in Sections 5.4.1 to Section 5.4.4. This is followed in Sections 5.4.5 to 5.4.9 by the results of follow-up questions on the number and type of attributes chosen by each respondent.

5.4.1 Distribution of visitors and residents

The majority of respondents (64 percent) in the respondent-selected treatment were local residents from either Trinidad or Tobago. International visitors made up 36 percent of the sample (§ Figure 5.3).

5.4.2 Income, employment and education

50 percent of respondents worked full time (40 hour plus week), while 29 percent were self employed. The median income[6] (20 percent) fell within the range TT$36,000 - TT$84,000 (19 percent). The most common level of eduction was a postgraduate degree (24 percent). Tables 5.2, 5.3 and 5.4 detail the distribution of employment, income and education respectively.

5.4.3 Age, sex and household size

The majority of respondents belong to the 18-30 age group (43 percent). About half of the respondents were male (52 percent), while 48 percent were female. The most frequent (38

[6]The currency reported is Trinidad and Tobago dollars (TT$). Approximately GBP1.00 is equal to TT$12.67

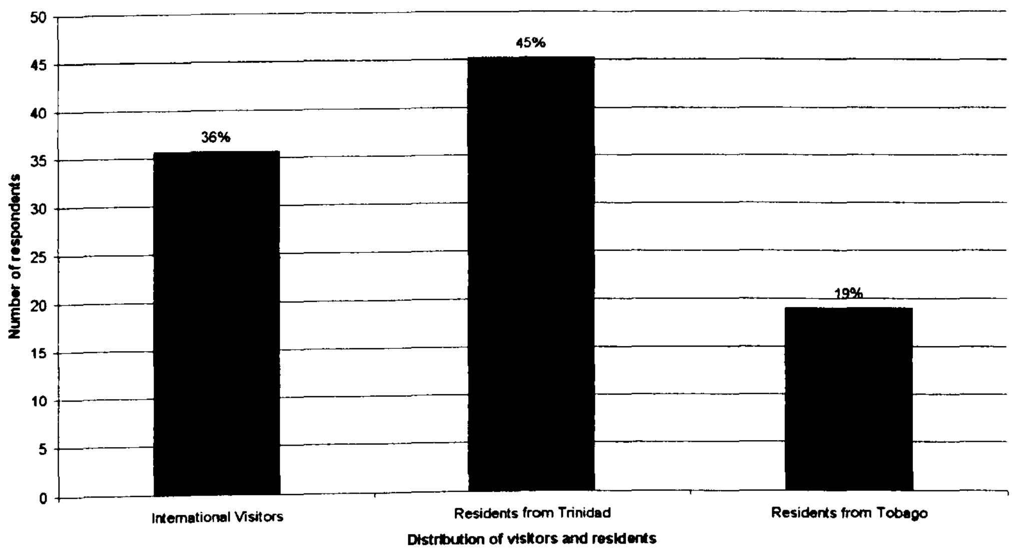


Figure 5.3: Distribution of visitors and residents

Table 5.2: Employment types of respondents

	Non-snorkellers	
Employment	Percent	Frequency
Self employed	28.57	12
Employed full time (40 hours plus per week)	50.00	21
Employed part time (less than 40 hours per week)	9.52	4
Student	0.00	0
Housewife	4.76	2
Retired	4.76	2
Unemployed	2.38	1
Unable to work due to sickness of disability	0.00	0
Total	100	86

Table 5.3: Income of respondents

Total Gross Income per Year (TT$)	Non-snorkellers Percent	Frequency
Under 12 000	7.14	3
12 000 - 36 000	16.67	7
36 000 - 60 000	19.05	8
60 000 - 60 000	19.05	8
84 000 - 108 000	11.90	5
108 000 - 121 000	7.14	3
121 000 - 156 000	2.38	1
156 000 - 180 000	0.00	0
180 000 - 204 000	2.38	1
204 000 - 375 030	9.52	4
375 030 - 525 042	4.76	2
525 042 - 675 054	0.00	0
675 054 - 756 310	0.00	0
756 310 - 975 078	0.00	0
975 078 - 1 125 090	0.00	0
1 125 090 - 1 275 102	0.00	0
Over 1 275 102	0.00	0
Total	100	42
Average Income	103765	

Table 5.4: Education level of respondents

Level of Education	Non-snorkellers Percent	Frequency
Primary	0.00	0
G.C.S.E O Levels/C.X.C	16.67	7
Advanced Levels or Advanced vocational training	21.43	9
Professional qualification of degree levels	14.29	6
College Degree/ University Undergraduate degree	21.43	9
Postgraduate Education	23.81	10
Total	100	42

Table 5.5: Age, sex and household size of respondents

	Non-snorkellers	
	Percent	Frequency
Age		
18-30	42.86	18
31-40	28.57	12
41-50	11.90	5
51-64	14.29	6
65+	2.38	1
Total	100	42
Sex		
Male	52.38	22
Female	47.62	20
Total	100	42
Household size		
1	16.67	7
2	16.67	7
3	14.29	6
4	38.10	16
5	4.76	2
6	2.38	1
> 6	7.14	3
Total	100	42

percent) household size of the 42 respondents is a size of 4 persons. Table 5.5 details the distribution of household size and age among respondents.

5.4.4 Attitudes

Respondents were asked a number of questions to determine their opinion on coastal water quality and its protection and use by visitors and locals. Most of the respondents agreed that everyone should pay for environmental improvement and an even larger percentage strongly agreed that the government is responsible for the maintenance of the coastal water quality. In this group of respondents, the most important amenity at a beach was stated to be the provision of good water quality (58 percent) followed by the presence of facilities such

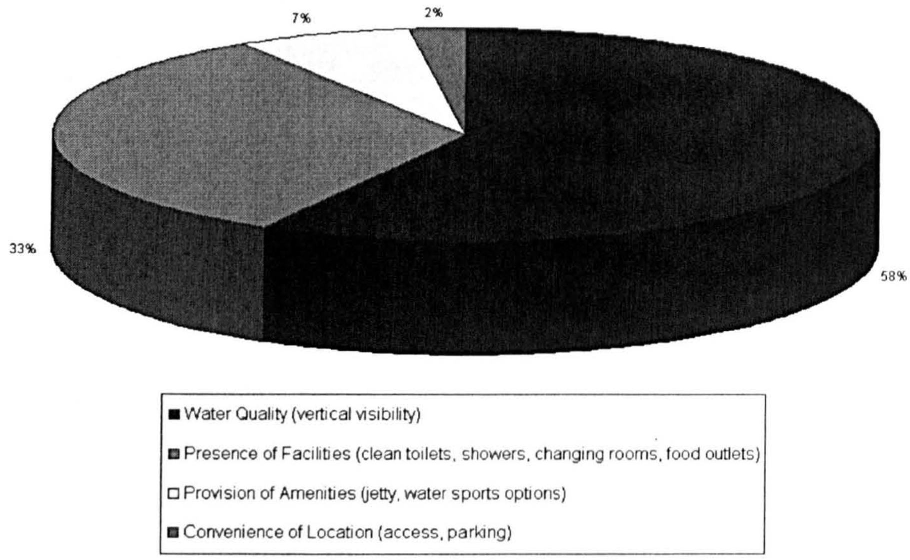


Figure 5.4: Attitudes towards beach amenities

as food outlets and changing rooms (33 percent). These results are presented in Figure 5.4 and Figure 5.5 respectively.

5.4.5 Follow-up questions and beach use

The reasons which respondents gave to explain why they chose their preferred beach scenario when completing the choice sets are presented in Figure 5.6. The most popular reason was to allow themselves and their family to enjoy the beaches (33 percent), followed by allowing future generations to enjoy the beach (24 percent). The results in Figure 5.7 show that the most popular activity which most respondents always participate in is swimming.

5.4.6 Number of attributes chosen by each respondent in the respondent-selected treatment

Each respondent was asked whether all 6 attributes were important to them on their day out at the beach based on the recreational activities they engaged in. Table 5.6 reports the results of this question and shows the number of attributes which were chosen by each respondent. 76 percent of the sample indicated that all 6 attributes were important to them on their day out at the beach. The majority of the sample who chose a subset of attributes chose 3 attributes (12 percent), followed 4 attributes (chosen by 10 percent).

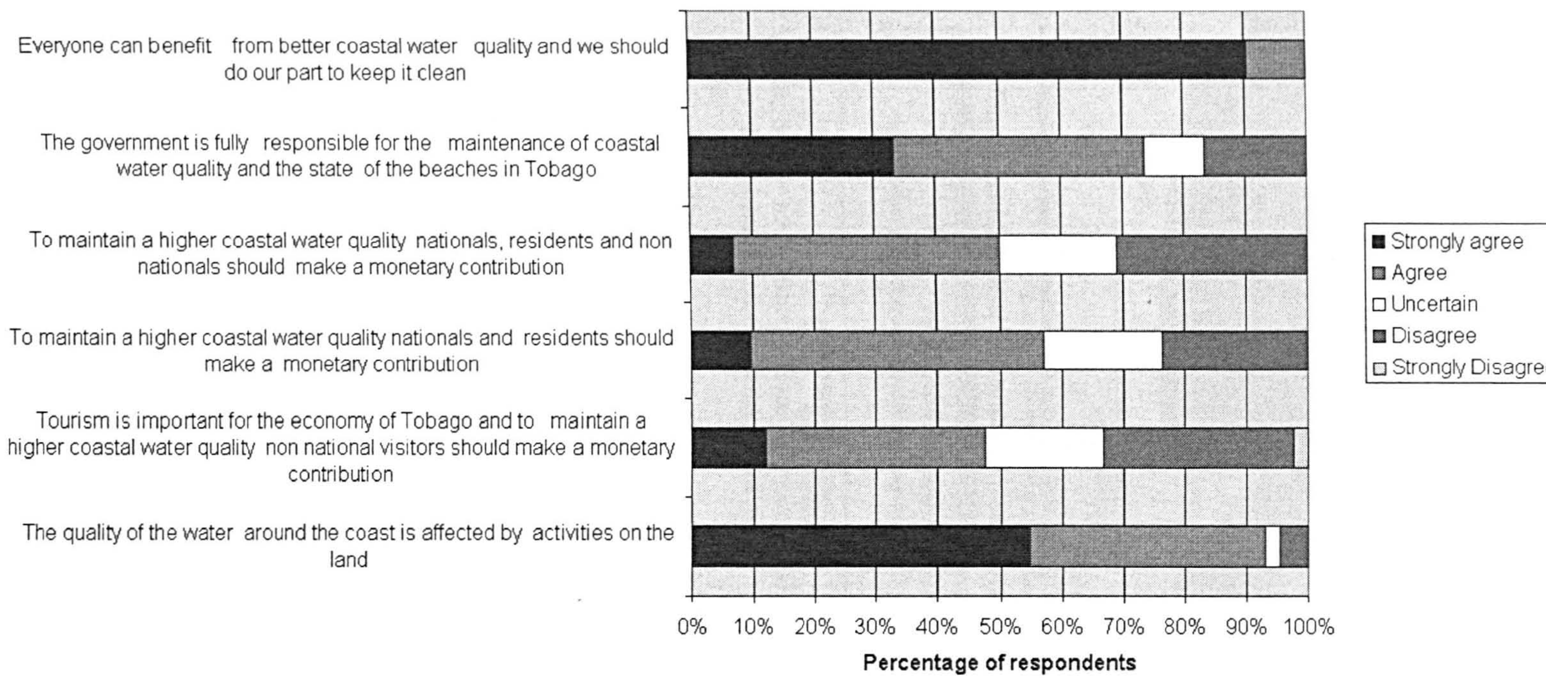


Figure 5.5: Attitudes towards water quality

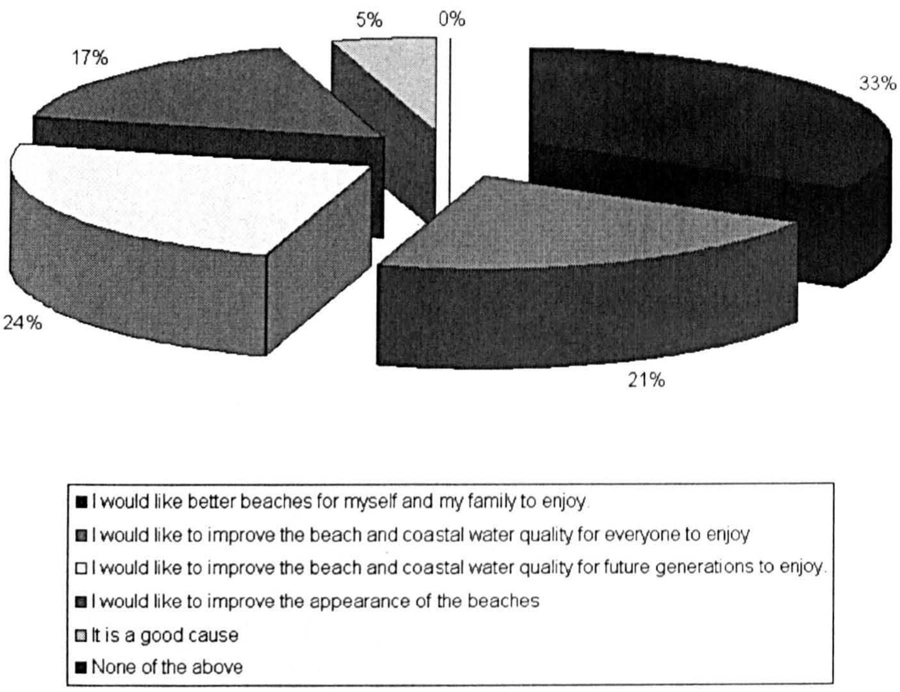


Figure 5.6: Rationale for paying to improve water quality

Only 1 person (2 percent) indicated that 5 of the 6 attributes were important.

5.4.7 Number of respondents who chose each attribute type in the respondent-selected treatment

Table 5.7 reports the number of persons who chose each attribute. The most popular attribute chosen was that representing the risk of contracting an ear infection from swimming (WQ1 and WQ2) which was chosen 34 times (21 percent) by the 42 respondents. The number of plastics per 30 metres of coastline (PLAS1 and PLAS2) was chosen 32 times (20 percent) This was followed by level of development (DEV1 and DEV2) and vertical visibility (CLAR1 and CLAR2), both of which were chosen 30 times (19 percent). The presence of a marine protected area was chosen 26 times (16 percent) while the attribute which was chosen the least was the number of boats (BTS1 and BTS2) this being chosen 9 times (6 percent).

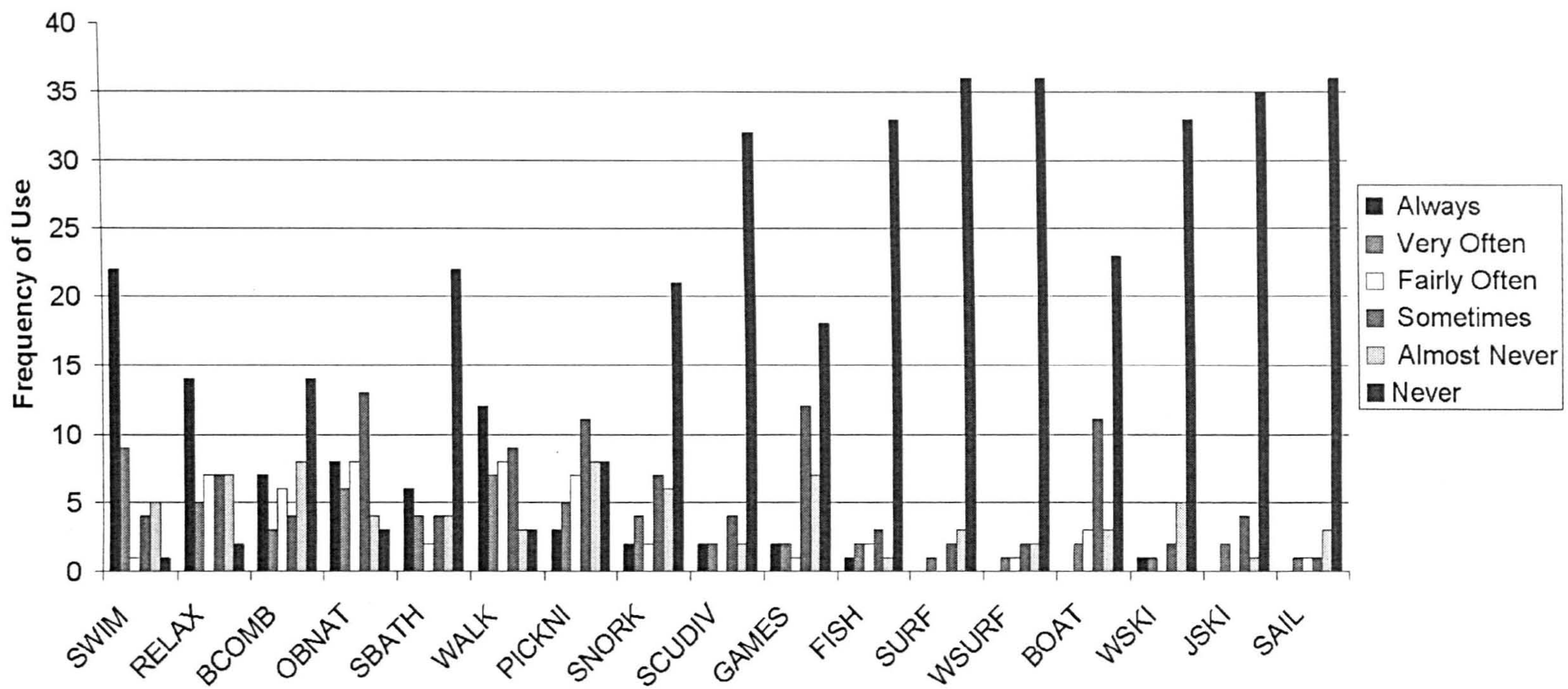


Figure 5.7: Respondents' beach use

Table 5.6: Number of attributes chosen by each respondent

Number of Attributes	Frequency	Percent
1	0	0.00
2	0	0.00
3	5	11.90
4	4	9.52
5	1	2.38
6	32	76.19
Total Number of Persons in Sample	42	100

Table 5.7: Number of persons who chose each attribute

Attribute	Frequency	Percent
Number of recreational and fishing boats near the coastline	9	5.59
Presence of a marine protected area	26	16.15
Level of development on the coastline	30	18.63
Risk of contracting an ear infection from swimming in polluted water	34	21.12
Level of vertical viability	30	18.63
Number of plastics per 30 meteors of coastline	32	19.88
Total number of times all attributes were chosen	161	100.00

5.4.8 Occurrence and comparison of respondents not attending to all attributes in researcher-selected and respondent-selected treatments

Respondents were asked in the respondent-selected discrete choice experiment whether they attended to all chosen attributes. The results in Table 5.8 show that of the 42 respondents, 34 (81 percent) attended to all the attributes they had selected, while the remaining 8 still attended to a subset of these attributes. A comparison of the incidence of respondents considering fewer attributes than the number presented to them in the discrete choice experiment for the researcher-selected treatments (6 or 9 attributes), and the respondent-selected treatment (3 or 4 attributes) is presented in Table 5.8 and depicted in Figure 5.8. The respondent-selected treatment shows a decrease in the number of persons who focus on a subset of attributes once respondents have been asked to choose those attributes that are relevant to them. Here, 81 percent of the respondents attended to all the attributes presented to them, in contrast to half of the respondents who performed the discrete choice experiment with 6 attributes (45 percent) and even fewer persons who performed the 9 attribute experiment (40 percent).

Table 5.8: Comparison of percentage of respondents who attended to a subset of attributes

	Snorkeller 9 attributes		Non-snorkeller 6 attributes		Respondent-selected 3 or 4 attributes	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Attended to a subset of attributes	114	59.69	45	54.88	8	19.05
Attended to all attributes	77	40.31	37	45.12	34	80.95
	191**		82*		42	

* 4 chose the no option alternative for non-snorkellers
** 7 chose the no option alternative for snorkellers

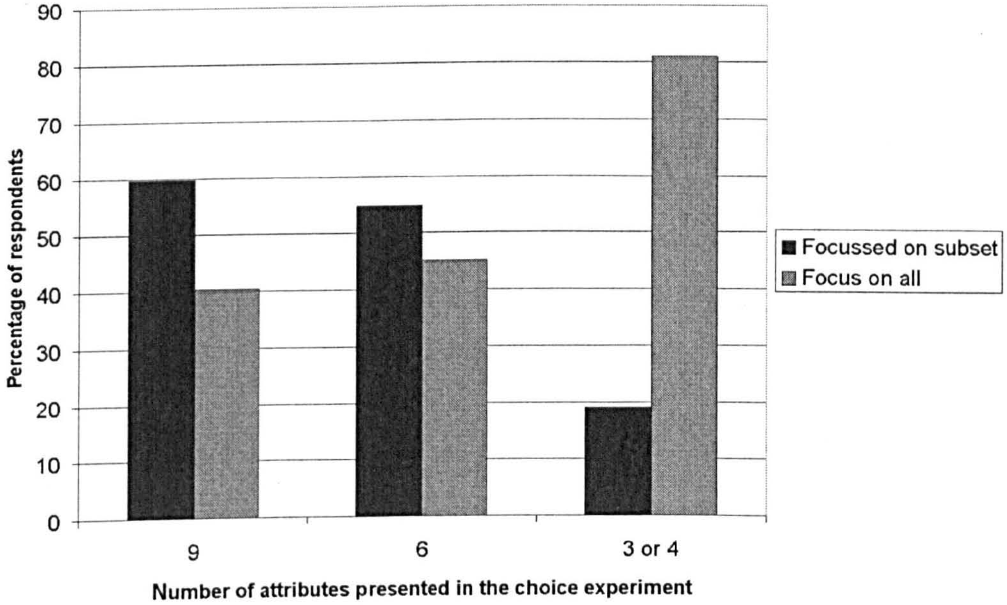


Figure 5.8: Comparison of percentage of respondents who attended to a subset of attributes

Table 5.9: Comparison of respondents not attending to all attributes in researcher-selected and respondent-selected treatments

Time when respondents indicated they attended to attributes in CE	After the choice experiment				Before the choice experiment	
	Snorkeller 9 attributes		Non-snorkeller 6 attributes		Respondent-selected 3 or 4 attributes	
Attribute attended to	Frequency	Percent	Frequency	Percent	Frequency	Percent
Number of recreational and fishing boats near the coastline	11	2.96	6	11.54	9	5.59
Presence of a marine protected area	14	3.76	7	13.46	26	16.15
Level of development on the coastline	49	13.17	9	17.31	30	18.63
Risk of contracting an ear infection from swimming in polluted water	81	21.77	12	23.08	34	21.12
Level of vertical visibility	56	15.05	10	19.23	30	18.63
Number of plastics per 30 metres of coastline	66	17.74	8	15.38	32	19.88
Number of snorkellers allowed per group	7	1.88				
Level of coral cover	48	12.90				
Abundance of fish	40	10.75				
TOTAL	372	100.00	52	100.00	161	100.00

* 4 chose the no option alternative for non-snorkellers

** 7 chose the no option alternative for snorkellers

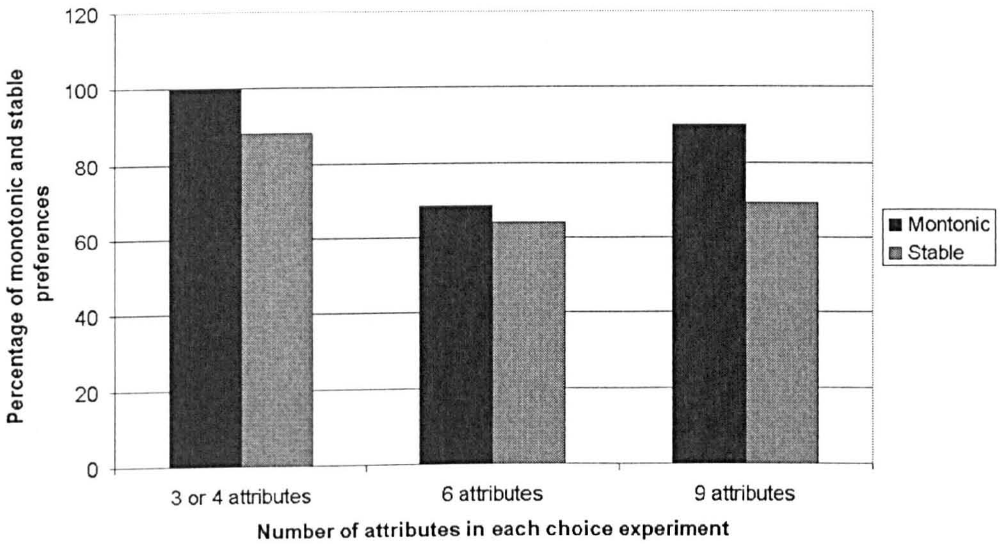


Figure 5.9: Comparison of respondents not attending to all attributes in researcher-selected and respondent-selected treatments

Table 5.9 shows a comparison of the results of the number of persons who attended to a subset of attributes either stated after the discrete choice experiment (researcher-selected treatment) or stated before the discrete choice experiment (respondent-selected treatment). The results show that in both treatments respondents indicated that the most popular attribute they attended to as part of a subset was the risk of contracting an ear infection. For example, in the discrete choice experiment with 6 attributes, 23 percent chose the attribute representing the chance of contracting an ear infection as part of the subset of attributes they attended to while 22 percent and 21 percent respectively indicated they did the same for the 9 attribute and respondent-selected treatments.

Table 5.10: Incidence of monotonic and stable preferences in respondent-selected treatment

		Monotonic		Non-monotonic		Stable		Non-stable	
Subsamples	Number of attributes	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Respondent-selected	4	0	0.00	42	100.00	32	91.43	3	8.57
	3	0	0.00	42	100.00	5	71.43	2	28.57
Total samplee		**0**	**0.00**	**42**	**100.00**	**37**	**88.10**	**5**	**11.90**

5.4.9 Choice consistency

Table 5.10 shows the results of consistency tests for this sample. Of the 42 respondents, 37 (88 percent) had stable preferences while 5 (12 percent) had unstable preferences. Of these 5 respondents with unstable preferences, 3 of them completed the discrete choice experiment with 4 attributes while the remaining 2 completed the discrete choice experiment with 3 attributes. The entire respondent-selected the dominant alternative and this exhibited a monotonic response.

Figure 5.9 shows a comparison of the results of monotonicity and stability tests from the experiments undertaken with 6 and 9 attributes with corresponding results from the respondent-selected sample. Consistency and preference stability tests increased when persons were asked to complete a discrete choice experiment with the attributes they deemed to be important. There are many possible reasons for this difference, but two of the main reasons could be a reduction in cognitive burden and a lack of relevance. Section 5.7 presents results which help determine whether relevancy is a contributing factor in the variation of results observed in the consistency tests.

5.5 Parameter estimates of the MNL model

A MNL specification was used to investigate the discrete choice results from the researcher-selected and respondent-selected datasets. Table 5.11 reports the results of the parameter estimates for both datasets. The researcher-selected model was derived from the choices made by respondents who were given a discrete choice experiment designed with 6 attributes, this being identical to the experiment described in Chapter 4. The respondent-selected model was derived from the choices made by respondents who were allowed to choose the attributes in their DEC and thus perform the discrete choice experiment only with those attributes which they had said were important to them on their day out at the beach.

The two models were both found to be statistically significant with χ^2 statistics of 110.47 and 100.01, against a critical value of 22.36 (with 13 degrees of freedom at alpha level

Table 5.11: Parameter estimates for the MNL specification

	MNL					
	Researcher-selected		Respondent-selected		Joint dataset	
	Est.	t-stat	Est.	t-stat	Est.	t-stat
BTS1_Low_Policy	0.179	1.46	-0.414	-1.18	0.010	0.10
BTS2_High_Policy	0.397	3.03	0.659	2.22	0.326	3.04
MPA1_Low_Policy	-0.025	-0.20	0.328	1.57	0.070	0.73
MPA2_High_Policy	0.238	1.89	0.567	2.77	0.291	3.07
DEV1_Low_Policy	-0.197	-1.53	-0.180	-0.87	-0.193	-1.98
DEV2_High_Policy	0.274	2.15	0.514	2.64	0.295	3.11
WQ1_Low_Policy	-0.622	-4.60	-0.663	-3.21	-0.551	-4.93
WQ2_High_Policy	0.487	4.00	0.331	1.88	0.383	3.89
CLAR1_High_Policy	0.469	3.91	0.775	4.03	0.494	5.29
CLAR2_Low_Policy	0.031	0.24	0.250	1.27	0.101	1.04
PLAS1_Low_Policy	-0.312	-2.39	-0.017	-0.08	-0.175	-1.75
PLAS2_High_Policy	0.296	2.35	0.870	4.66	0.440	4.76
Fee	-0.025	-3.74	-0.037	-4.31	-0.024	-4.92
Scale					1.38	1.55
Number of Observations	2193		1110		3303	
Number of Individuals	86		42		128	
Number of Parameters (K)	13		13		14	
χ^2 statistic	110.47		100.01		196.56	
Log Likelihood (LL)	-747.35		-354.33		-1111.29	
Pseudo R^2	0.069		0.124		0.081	
BIC	1552.61		757.25		2290.51	

of 0.05) (Table 5.11). Even though these two models are not directly comparable, the results of the R^2 value and BIC criteria of the respondent-selected model suggest that this model produces a better fit to the relevant data than the researcher-selected model. The signs on the parameter estimates for the researcher-selected sample satisfy *a priori* expectations with the exception of the low level policy attribute for number of boats (BTS1). These results are similar to those obtained for the non-snorkellers in Chapter 4 who also have positive estimates for the attribute level of up to 7 boats near the coastline (BTS1). As with the non-snorkellers, the respondent-selected treatment also contained a higher percentage of locals. This could be one reason why there is higher tolerance for this level of attribute. Four levels of attributes have insignificant parameter estimates: up to 2 boats near the coastline (BTS1); an MPA which does not allow fishing (MPA1); up to 75 percent development along the coastline (DEV2) and vertical visibility of up to 5 metres (CLAR2). For the respondent-selected model, the signs on the parameter estimates are similar to those of the researcher-selected treatment except for the attribute representing the presence of marine protected area. The respondents in this treatment are willing to pay more to visit a beach with both types of MPA, unlike those of the researcher-selected treatment who are only willing to pay to visit an MPA which does not allow fishing.

In the respondent-selected treatment, 5 of the attribute levels are insignificant: up to 2 boats near the coastline (BTS1); an MPA which does not allow fishing (MPA1); the presence of an MPA which did not allow fishing (MPA2); vertical visibility of up to 5 metres (CLAR2) and up to 15 pieces of plastic on the coastline (PLAS1). This increase in the number of insignificant attribute levels could be due to the fact that respondents ignored certain attributes when completing the choice tasks. For example, as seen in Table 5.7, the number of boats near the coastline and the presence of a marine protected area were the attributes selected least frequently by respondents.

The most positive and highly significant parameters were attributes representing: up to 5 pieces of plastic on the coastline (PLAS2); up to 10 metres clarity (CLAR1) and up to 25 percent development (DEV2). The most negative and highly significant parameter was that for the attribute representing a high risk of contracting an ear infection from swimming in polluted water (WQ1). These empirical results indicate that the high significance of certain attribute levels are attached to the attributes which were most frequently chosen by respondents (§ Table 5.7).

Table 5.12: Parameter estimates for the MMNL specification

	MMNL											
	Researcher-selected				Respondent-selected				Joint dataset with scale			
	Est.	t-stat	Std. Dev.	t-stat	Est.	t-stat	Std. Dev.	t-stat	Est.	t-stat	Std. Dev.	t-stat
BTS1_Low_Policy	0.269	1.73			-0.455	-1.12			0.128	0.91		
BTS2_High_Policy	0.558	2.61	1.038	4.91	0.885	2.27	0.392	0.78	0.692	3.74	1.028	5.01
MPA1_Low_Policy	0.032	0.20			0.321	1.32			0.045	0.33		
MPA2_High_Policy	0.319	1.81	0.550	1.58	0.716	2.90	0.156	0.40	0.422	3.00	-0.291	-1.28
DEV1_Low_Policy	-0.201	-1.17			-0.154	-0.65			-0.217	-1.54		
DEV2_High_Policy	0.425	2.15	0.884	3.72	0.781	2.84	0.655	2.00	0.643	3.65	0.907	4.58
WQ1_Low_Policy	-0.861	-4.13	0.731	2.72	-1.351	-2.88	1.765	3.76	-0.978	-5.05	1.198	5.41
WQ2_High_Policy	0.695	3.62	0.978	4.83	0.394	1.80	0.487	0.35	0.541	3.59	0.837	4.93
CLAR1_High_Policy	0.733	4.20	0.657	2.77	0.785	2.73	0.929	2.89	0.783	4.88	0.740	4.05
CLAR2_Low_Policy	0.004	0.02			0.240	1.05			0.141	1.02		
PLAS1_Low_Policy	-0.395	-1.88	0.854	2.92	-0.314	-0.84	1.170	3.44	-0.522	-2.68	1.129	5.34
PLAS2_High_Policy	0.523	2.89	0.729	3.02	1.159	4.78	0.452	1.23	0.706	4.63	0.776	4.01
Fee	-0.038	-4.38			-0.043	-4.39			-0.040	-5.71		
Scale									0.990	0.002		
Number of Observations	2193				1110				3303			
Number of Individuals	86				42				128			
Number of Parameters (K)	21				21				22			
χ^2 statistic	225.072				139.834				344.46			
Log Likelihood (LL)	-690.55				-336.57				-1037.34			
Pseudo R^2	0.140				0.172				0.142			
BIC	1474.64				751.63				2181.42			
Number of Draws	300				300				1000			

5.6 Parameter estimates from the MMNL model

An MMNL model was also used to investigate discrete choice responses in the researcher-selected and respondent-selected datasets. As described in Chapter 2, this specification allows the researcher to account for unobserved taste heterogeneity among respondents associated with the attributes. The results of the MNL model reveal a number of attributes with significant standard deviations. The results from these estimations are used as the basis for selecting 8 random parameters, each of which is specified with a normal distribution. These parameters are: up to 2 boats near the coastline (BTS2); an MPA which does not allow fishing (MPA2); up to 25 percent development along the coastline (DEV2); a high chance of contracting an ear infection (WQ1); a low chance of contracting an ear infection (WQ2); a level of vertical visibility of up to 10 metres (CLAR1) and up to 5 pieces and 15 pieces of plastic along the coastline (PLAS2 and PLAS1 respectively). Although the fee parameter estimate was significant, it was specified as a fixed parameter. 300 Halton draws were used in the estimation.

The results of both researcher-selected and respondent-selected MMNL models are reported in Table 5.12. Both models were found to be statistically significant with χ^2 statistics of 225.07 and 139.83 respectively against a critical value of 32.67 (with 21 degrees of freedom at alpha level of 0.05). Even though these two models are not directly comparable, the results of the R^2 value and BIC criteria of the respondent-selected model again suggest that this model provides a better fit to its data than the researcher-selected model.

The signs of the parameter estimates for the MMNL specification satisfied *a priori* expectations and were similar to the results of the MNL specification in Section 5.5 for the researcher-selected sample. The only difference is that the parameter for an MPA which allows fishing (MPA1) has a positive estimate in the MMNL model, whereas in the MNL specification it has a negative estimate. In the respondent-selected sample, the signs again satisfy *a priori* expectations and reflect the results of the MNL specification.

The standard deviations of the parameter estimates in both samples show several differences. For example, the attributes with the greatest and least level of variation differed between the two samples. In the researcher-selected model the attributes in which preferences vary the most are those representing up to 2 boats near the coastline (BTS2) followed by that representing a low chance of contracting an ear infection while swimming in polluted water (WQ1). The attribute in which preferences vary the least is that representing an MPA which does not allow fishing (MPA2), hence showing that most of the population have positive preferences for this type of MPA. In the respondent-selected model, the attributes for which preferences vary the least are all found to be associated with a high level of environmental quality. This means that for these attributes, most respondents preferred a higher level of environmental quality than a lower one. These attributes are: an MPA which did not allow fishing (MPA2); up to 2 boats near the coastline (BTS2); a low chance of contracting an ear infection (WQ2) and up to 5 pieces of plastic on the coastline (PLAS2). The former two attributes were also the least popular attributes chosen by respondents. Preferences vary the most for the attribute representing a low chance of contracting an ear infection (WQ1) followed by that representing a high level of plastic on the coastline (PLAS1), both of which represented lower levels of environmental quality.

5.7 Accounting for scale differences to compare datasets

In order to determine if the differences in parameter estimates between the two sets of data are a result of differences in experimental treatments, the differences arising from scale effects must be isolated (Swait & Louviere 1993, Louviere et al. 2000)(§ Figure 2.2.2). The scale parameter is inversely related to the variance of the error term. Ordinarily, the scale factor cannot be estimated independently because of confounding with the utility parameters *(ibid.)*. Therefore, the scale parameter is normalised to 1. However, in this case, since multiple datasets are used, the ratio of the scale factor can be isolated, thereby allowing a comparison of parameters.

Estimates from the pooled dataset containing the observations of both the researcher and respondent-selected treatments is presented in Table 5.11 and Table 5.12 for the MNL and MMNL specification respectively. The pooled model for the MNL specification is

Table 5.13: Parameter estimates from the MNL and MMNL specifications with dummy variables

	MNL		MMNL			
	Est.	t-stat	Est.	t-stat	Est.	t-stat
BTS1_Low_Policy	0.190	1.54	0.308	1.92		
BTS2_High_Policy	0.428	3.33	0.500	2.43	0.984	4.71
MPA1_Low_Policy	-0.023	-0.18	-0.026	-0.16		
MPA2_High_Policy	0.259	2.07	0.269	1.50	0.665	2.80
DEV1_Low_Policy	-0.186	-1.44	-0.247	-1.42		
DEV2_High_Policy	0.306	2.45	0.309	1.58	0.929	4.61
WQ1_Low_Policy	-0.628	-4.62	-1.081	-4.35	1.292	5.68
WQ2_High_Policy	0.512	4.26	0.692	3.56	1.037	5.33
CLAR1_High_Policy	0.479	3.98	0.718	3.76	0.856	4.01
CLAR2_Low_Policy	0.055	0.42	0.044	0.26		
PLAS1_Low_Policy	-0.308	-2.36	-0.537	-2.49	1.048	5.04
PLAS2_High_Policy	0.318	2.55	0.424	2.37	0.721	3.32
Fee	-0.030	-5.64	-0.043	-6.46		
BTS1	-0.635	-1.72	-0.794	-1.80		
BTS2	0.200	0.63	0.344	0.67		
MPA1	0.311	1.30	0.340	1.15		
MPA2	0.280	1.19	0.395	1.19		
DEV1	-0.026	-0.11	0.075	0.26		
DEV2	0.173	0.78	0.414	1.19		
WQ1	-0.054	-0.22	-0.072	-0.17		
WQ2	-0.206	-0.99	-0.281	-0.85		
CLAR1	0.242	1.11	0.185	0.56		
CLAR2	0.176	0.76	0.252	0.87		
PLAS1	0.252	1.07	0.380	1.01		
PLAS2	0.513	2.37	0.699	2.27		
Number of Observations	3303					
Number of Individuals:	128					
Number of Parameters (K)	25		33			
χ^2 statistic	214.45		338.37			
Log Likelihood (LL)	-1102.23		-1040.27			
Pseudo R^2	0.088		0.139			
BIC	2325.76		2240.66			
Number of Draws	300					

statistically significant with a χ^2 statistic of 196.56 against a critical value of 23.69 (with 14 degrees of freedom at alpha level of 0.05). All parameter estimates are of the expected sign with the exception of those for the attributes representing the number of boats (BTS1 and BTS2), the level of vertical visibility (CLAR1 and CLAR2) and the presence of a marine protected area (MPA1 and MPA2). The parameter estimates of these latter attributes are positive, even though they represent a lower level of environmental quality. The scale parameter is also insignificant in this case. The MMNL specification may reduce the chance of the scale from variation of taste intensities being confounded with the scale from the experimental manipulation (Scarpa & Thiene 2006). The pooled model for the MMNL specification is also statistically significant with a χ^2 statistic of 344.46 against a critical value of 33.92 (with 22 degrees of freedom at alpha level of 0.05).

The relative scale factor was estimated by identifying the two datasets as separate groups using Biogeme 1.4 (Bierlaire 2005). This allowed the hypothesis of equal scale parameters to be tested. The estimations were based on MNL and MMNL specifications. The results of the LL values after accounting for differences in scale are reported in Table 5.11 and Table 5.12. Using the test proposed by Swait and Louviere (Swait & Louviere 1993) the log likelihood values were used to test the assumption of parameter equality:

MNL Specification:

$$-2[(LL_{Researcher-selected} - (LL_{Respondent-selected} + LL_{Researcher-selected}))]$$

$$= -2[(-1111.29)-(-747.351+(-354.325))] = 19.23$$

MMNL Specification:

$$-2[(LL_{Researcher-selected} - (LL_{Respondent-selected} + LL_{Researcher-selected}))]$$

$$= -2[(-1037.34)-(-690.55+(-336.57))] = 20.44$$

The result for the MNL specification is 19.23 which does not exceed the critical value of 23.69 (with 14 degrees of freedom at alpha equal to 0.05 and 13 being the number of parameters). The result for the MMNL specification is 20.44 which does not exceed the critical value of 33.924 (with 22 degrees of freedom at alpha equal 0.05 and 21 being the number of parameters). Both results of the MNL and MMNL specification lead to failure to reject the null hypothesis of equal parameters between the two datasets.

To further account for differences between the datasets, dummy variables were specified for every attribute to represent whether the attribute was chosen by the respondent or not. This allowed the determination on a per-attribute basis of whether allowing respondents to choose their attributes made any significant difference. As shown in Table 5.13, the MNL model specification is statistically significant with a χ^2 statistic of 214.45, against a critical value of 37.65 (with 25 degrees of freedom at alpha level of 0.05). The MMNL model specification is also statistically significant with a χ^2 statistic of 338.37, against a critical value of 47.40 (with 25 degrees of freedom at alpha level of 0.05).

As shown in Table 5.13 all the interaction attributes are insignificant with the exception of the number of plastics on the beach (PLAS2), which is not highly significant. Given these results, as well as the results of the Swait and Louviere test (Swait & Louviere 1993), it can be concluded that the experimental treatments did not have a systematic effect on utility estimates. This suggests that the preference structure is independent of the way the attributes were selected. Therefore, the results suggest that it is unlikely that any variations in the coefficient estimates between the two methods comes from the method of asking respondents to perform the discrete choice experiment based on the attributes which they deemed as important. This means that the two datasets contain the same preference structure and therefore that any differences between the utility estimates are accounted for by the scale parameter. Other possible sources of variation between the two datasets could include meaningful differences in utility estimates, sampling errors or combinations of these two (Louviere et al. 2000).

5.8 Individual-specific WTP

Having ruled out that any differences in parameter estimates are due to the experimental treatments. Individual-specific WTP estimates were calculated for the 42 respondents in the respondent-selected treatment to determine the effect these valuations would have on

Table 5.14: Parameter estimates from the MMNL model

	MMNL			
	Respondent-selected			
	Est.	t-stat	Std. Dev.	t-stat
BTS1_Low_Policy	-0.448	-1.09		
BTS2_High_Policy	0.886	2.45	0.122	0.12
MPA1_Low_Policy	0.395	1.57		
MPA2_High_Policy	0.765	3.05	0.043	0.09
DEV1_Low_Policy	-0.095	-0.39		
DEV2_High_Policy	0.777	2.76	0.693	1.79
WQ1_Low_Policy	-1.364	-2.86	1.786	3.74
WQ2_High_Policy	0.425	1.84	0.629	1.91
CLAR1_High_Policy	0.922	3.19	0.890	2.65
CLAR2_Low_Policy	0.294	1.25		
PLAS1_Low_Policy	-0.146	-0.42	1.213	3.32
PLAS2_High_Policy	1.146	4.49	0.637	1.74
Fee	-0.056	-4.61	0.056	4.61
Number of Observations	1110			
Number of Individuals	42			
Number of Parameters (K)	21			
χ^2 statistic	143.36			
Log Likelihood (LL)	-334.80			
Pseudo R^2	0.176			
BIC	748.10			
Number of Draws	300			

policy recommendations. To calculate these values, an MMNL model was estimated with the parameters with insignificant standard deviations in the MNL model specified as fixed. These were the attributes representing: up to 7 boats near the coastline (BTS1); an MPA which allows fishing (MPA1); up to 75 percent development along the coastline (DEV1) and up to 5 metres vertical visibility (CLAR1). The remaining 8 parameters with significant standard deviations were specified as random with normal distributions. Following (Hensher & Greene 2003), the fee parameter was specified with a bounded triangular distribution where the location parameter is constrained to be equal to its scale. 300 Halton draws was also used in this estimation. Table 5.14 shows the results of this estimation. The model is statistically significant with a χ^2 statistic of 143.36, against a critical value of 32.67 (with 21 degrees of freedom at alpha level of 0.05). The results of the individual-specific WTP values are presented in Figures 5.12 to 5.10.

5.8.1 Number of Boats

The results in Figure 5.10 show that there is little overlap between WTP for the two attribute levels. A large percentage of the sampled population were willing to pay about TT$30.00 for up to 2 boats near the coastline (BTS2) but were not willing to pay for up to 7 boats near the coastline (BTS1).

5.8.2 Marine protected area

The results depicted in Figure 5.11 indicate that the group of respondents from the respondent-selected treatment had higher WTP for an MPA which does not allow fishing (MPA2) than an MPA which does (MPA1). There is a certain degree of overlap in this group but much less than the degree of overlap observed for the non-snorkellers in Chapter 4. This suggests that most individuals in this group have stronger preferences for differences between these attribute levels.

5.8.3 Chance of an infection

The results presented in Figure 5.12 show that there is a large degree of overlap between the two levels of this attribute over the positive orthant. This is similar to the results of the WTP values for this attribute in the non-snorkellers. However, in the group of respondents from the respondent-selected treatment, a larger percentage of persons were willing to pay

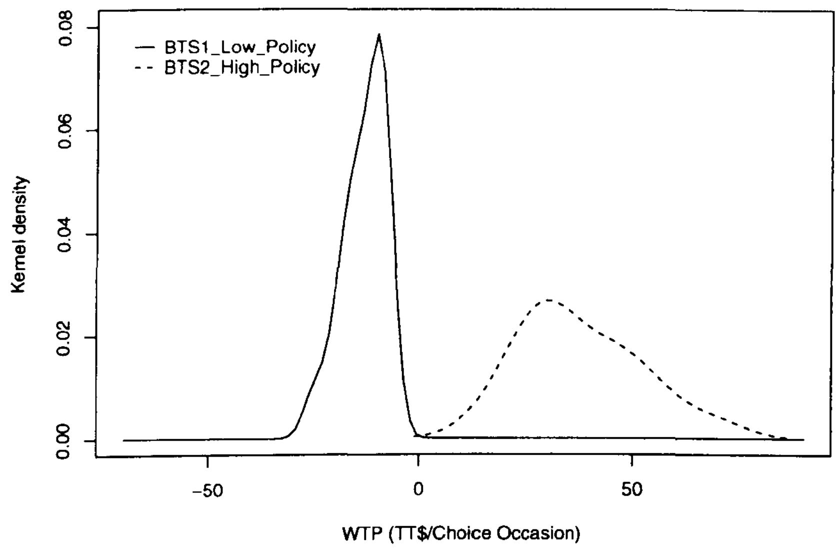


Figure 5.10: Distribution of individual-specific WTP for number of boats

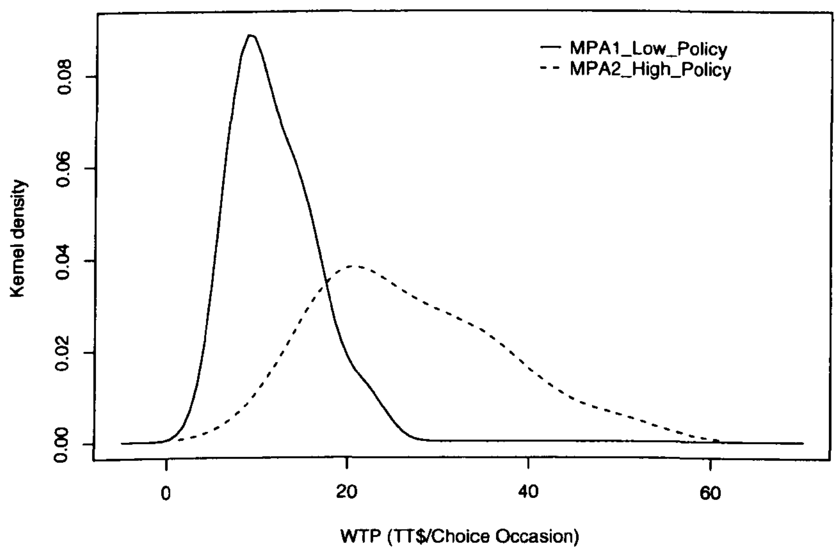


Figure 5.11: Distribution of individual-specific WTP for presence of a marine protected area

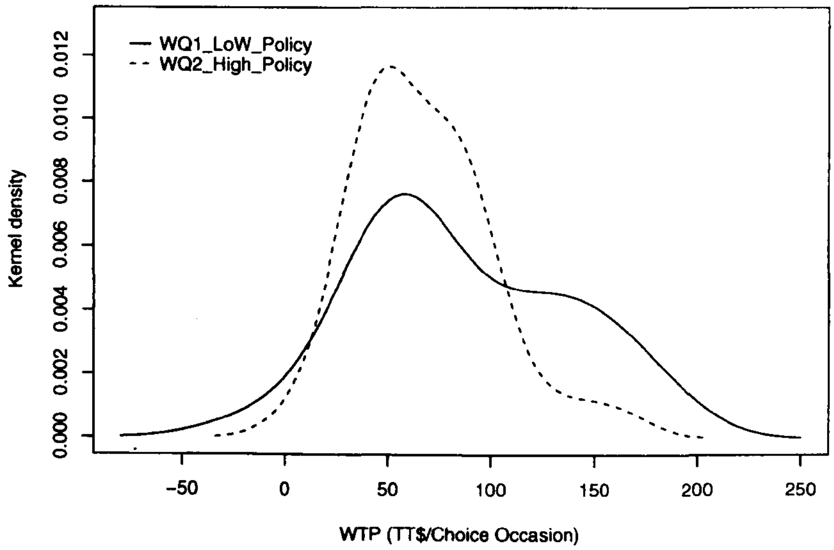


Figure 5.12: Distribution of individual-specific WTP for chance of an infection

to visit a beach where there was an increased chance of infection. The results show that the majority of this group were willing to pay around TT$60.00 to visit a beach with a reduced chance of infection (WQ2).

5.8.4 Coastline development

The results suggest that for the attribute representing up to 25 percent development along the coastline (DEV2), there is a varying degree of WTP over the positive orthant. In the group of respondents from the respondent-selected treatment, most persons were not willing to visit a beach with up to 75 percent level of development (Figure 5.13). There is less overlap in the group of respondents from the respondent-selected treatment in comparison to the non-snorkellers in Chapter 4, showing that more respondents in the non-snorkellers were also willing to pay to visit a beach with up to 75 percent development (DEV1).

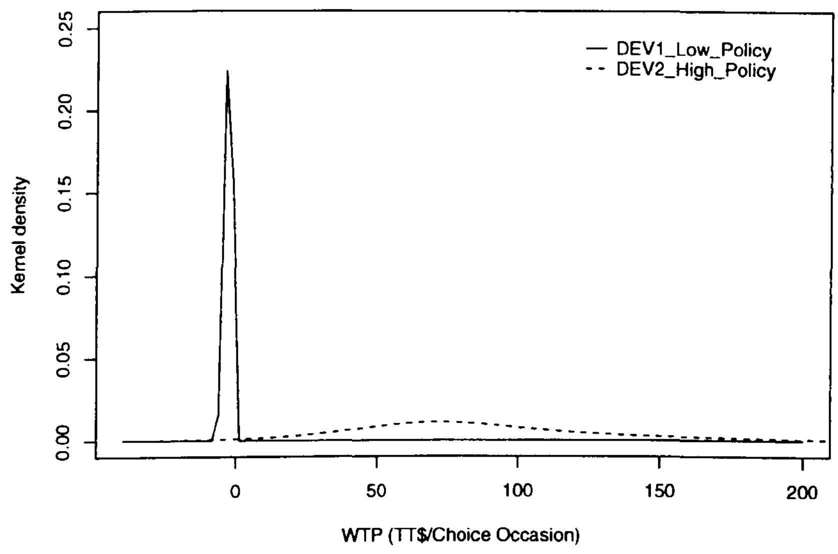


Figure 5.13: Distribution of individual-specific WTP for level of development

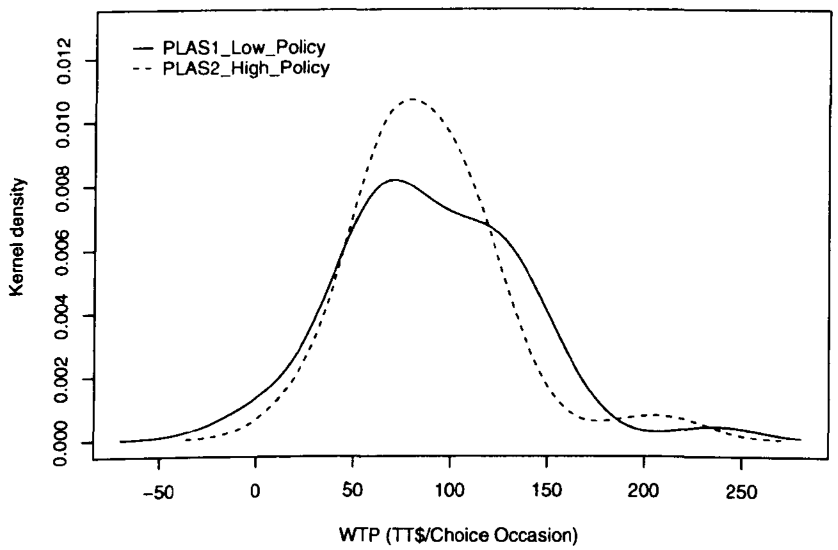


Figure 5.14: Distribution of individual-specific WTP for number of plastics

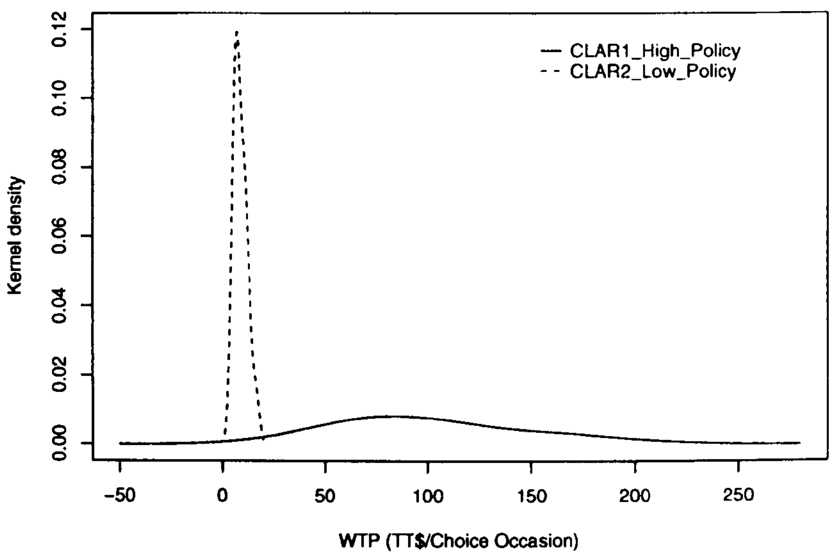


Figure 5.15: Distribution of individual-specific WTP for level of vertical visibility

5.8.5 Number of plastics

There is also considerable overlap between the two levels of this attribute over the positive orthant (Figure 5.14). These results differ from the WTP estimates derived for the non-snorkellers in Chapter 4 where there was very little overlap between the two levels of this attribute. The majority of the respondents from the respondent-selected treatment are willing to pay TT$70.00 to visit a beach with up to 5 pieces of plastic near the coastline (PLAS2).

5.8.6 Vertical visibility

Figure 5.15 shows a large variation in WTP values for the attribute representing up to 10 metres of vertical visibility (CLAR1) or high clarity. Respondents were not willing to pay to visit a beach with up to 5 metres of vertical visibility (CLAR2). There is little overlap between the two attribute levels.

5.9 Summary and discussion

This chapter examined whether attribute relevance was a contributory factor to respondents not attending to all attributes in a discrete choice experiment consisting of 6 attributes. This investigation was carried out by asking respondents to choose only those attributes which were relevant to them on their day out at the beach and then asking them to complete a discrete choice experiment based on those attributes. The utility estimates of the attributes from this respondent-selected treatment were then compared to estimates from a typical discrete choice experiment where respondents are asked to attend to all attributes presented to them.

The results of consistency tests and follow-up questions were examined for the respondent-selected treatment and compared against those of the discrete choice experiments containing 6 and 9 attributes (researcher-selected treatments). The results of the respondent-selected treatment showed an increase in the presence of stable and monotonic preferences. In addition, the results of the follow-up questions showed that a greater percentage of persons attended to all the attributes in the respondent-selected treatment in comparison to the researcher-selected treatments. These results are encouraging as they indicate that the experimental manipulation used in the respondent-selected treatment may have caused respondents to consider all attributes presented to them. However, these results could not be deemed conclusive and further investigations were then carried out to compare the two experimental treatments.

Initial investigations of the two datasets from the researcher-selected and respondent-selected treatments began with an MNL model specification. Although full comparisons could not be made, the respondent-selected dataset seemed to have better fit than the researcher-selected one. An MMNL specification was also used to examine the two datasets so that any unobserved taste heterogeneity associated with the attributes could be identified. An examination of the utility parameters showed differences in parameter signs, significance and utility estimates for both model specifications. However, to determine whether these differences could be attributed to the difference in the experimental treatments, it was necessary to account for scale differences. The null hypothesis was therefore that the experimental treatment did not affect the utility estimates. This was first tested using the Swait and Louviere parameter equality test (Swait & Louviere 1993). A further test was then carried out in which dummy variables were specified for each attribute based on whether that attribute was selected by a respondent. Both these tests revealed that the preference structures of both datasets were essentially the same and that any differences in utility estimates between the respondent-selected and researcher-selected treatments was not due to the experimental manipulation. As a result, WTP estimates were also calculated for the 42 respondents from the respondent-selected dataset. Since the preference structure of the respondent-selected treatment was not significantly different to that of the non-snorkellers, the policy priorities would remain the same as those derived for the non-snorkellers in Chapter 4.

There may be several explanations as to why the experimental manipulation of the respondent-selected treatment did not yield differences in utility parameters. Two plausible reasons are that the respondents in the researcher-selected treatment could have been (1) subconsciously ignoring attributes which they would then not select in the respondent-selected treatment and (2) employing decision heuristics due to the complexity of the treatment which effectively caused them to ignore some attributes. Both treatments would therefore yield similar utility estimates. With respect to the first explanation, one way to determine the process individuals use while doing discrete choice experiments is to design studies which investigate the mental structures and habits used in discrete choice experiments. As noted in (Hensher 2006*a*), one such study is the process-dissociation procedure developed in (Jacoby 1991) and adaptations of this as tested in (Jacoby et al. 1994, Aarts & Dijksterhuis 2000). These procedures consist of experiments used to investigate the relative influence of conscious and unconscious processes in memory performance. With respect to the second explanation (that is in order to determine if cognitive burden is a contributory factor), an experiment similar to the respondent-selected treatment can be designed where treatments differ based on the level of complexity. This will allow direct comparisons to be made.

The two possible explanations noted above raise the question of how can a researcher really identify whether respondents are indeed ignoring an attribute because of cognitive burden or some form of heuristic, or are actually expressing their preferences. The results of this study, as well as earlier research as described in Section 5.2, highlight the difficulty in arriving at concrete answers to these questions. This is due to the large number of confounding variables that must be considered in deriving a conclusion in this regard. One viewpoint proposed by Lancsar*et.al* in the health economics literature (Lancsar & Louviere 2006) suggests that discrete choice experiments can handle variation in preferences irrespective of whether they stem from choices which are inconsistent or those made using decision heuristics such as lexicographic rules. The authors note that random utility theory is based on the premise that some components of preferences are unobservable and therefore treated as random. This random component is generally defined as capturing all unobserved taste heterogeneity and is often a result of the researcher's inability to accurately capture respondents preferences. They quote a suggestion from (McFadden 1997): "randomness in utility which is usually interpreted as inter-personal preference heterogeneity could equally well be interpreted as intra-personal randomness in preferences". With respect to our study, this means that even though respondents may have been subconsciously or consciously ignoring attributes for a number of reasons (such as non-relevance and use of decision heuristics) this variation is still picked up by the randomness component accounted for with scale parameters, and therefore explains why no significant difference is noted in the parameter estimates of the systematic components.

In spite of the need for further conclusive research into why respondents may ignore attributes in a discrete choice experiment, researchers should nevertheless make good use of existing results. For example, as already noted in Section 5.2, research from the consumer decision making literature has shown that people use multiple strategies to make decisions. Even though there are many factors which affect the use of the decision strategies, determining which of these factors are used is non-trivial. However, it has been proven that as decisions become more complex, respondents tend to use simplifying decision heuristics which tend to be non-compensatory. Empirical studies in transport, marketing and environmental economics have supported this finding and suggest that despite the economic good in question, an increase in choice complexity does affect consistency of results. Indeed, the results of this research show that respondents are less inclined to focus on a subset of attributes in a discrete choice experiment when the number of attributes is low (Figure 5.8). Therefore, a good starting point is to preempt the strategic use by respondents of non-compensatory strategies by ensuring that each choice task is made as simple as possible and involves few attributes.

The following suggestions to limit complexity were inspired by those of (Lancsar & Louviere 2006) to do more thorough pilot testing. For example, the use of well structured follow-up questions in pilot tests can be used to determine if attributes specified by the researcher are being ignored or whether they are less important to the respondent. In the latter case, this is what researchers should expect since it may be unlikely that every single attribute is important to every single individual (Lancsar & Louviere 2006). This range in preferences is what discrete choice experiments are trying to capture. In the former case, one should try to determine the reasons why attributes are being ignored. For example, one reason may be that the attributes are not relevant to the individuals. However, even though an attribute may be irrelevant to a respondent, it may still be important to understand what values that respondent may place on that attribute given that this is a hypothetical choice situation. Another reason why respondents may have been ignoring attributes could be because of cognitive burden of the experiment which limits the respondent's ability to focus on all attributes and levels for each alternative considered. While this will vary with the information processing ability of each individual, one can try to ensure that the processing ability required to carry out the discrete choice experiment is as minimal as possible. As noted in the research summary by (Payne et al. 1993) decisions differ based on people, decisions and social context, these being aspects which differ in every discrete choice experiment. This would suggest that the factors that influence complexity may also differ in every discrete choice experiment.

Therefore, qualitative research is required in the early stages of survey design to detect these and plan the discrete choice experiment so as to minimise choice task complexity to respondents. Indeed, there may not be an optimal design dimension which defines a non-complex discrete choice experiment. Efforts in this direction are important because if respondents ignore attributes just because they cannot process them all, then valuable information on their preferences may be lost. In addition, efforts to find and use more sophisticated modelling techniques to accommodate individual taste heterogeneity may be in vain if thorough qualitative research to help design and collect choices in the field is not carried out.

It is known that investigations such as that described in this chapter are exploratory and imperfect as different approaches to measuring attribute importance can lead to very different conclusions. However, these studies are important and useful because they allow researchers to gain an understanding of the processes by which respondents made choices. This is a request which has been echoed previously by many researchers in the stated preference arena (Louviere et al. 2004, Hensher 2006*a*, DeShazo 2002).

Chapter 6

Conclusion

This thesis addressed two research gaps in the field of environmental economics. The first is the lack of valuation estimates and therefore the inability of policy makers to derive more informed natural resource and environmental policies in Tobago. The second is the need to improve the usefulness and accuracy of these estimates by investigating and incorporating methodological advances in the field. Three research objectives were defined in this thesis to address these gaps. This chapter concludes by summarising the contributions made in this research and how they fulfill these objectives. Future research directions are discussed both with respect to the empirical application and methodological advances in the field of discrete choice modelling. Finally, a brief note on the key message of this thesis concludes this work.

6.1 Summary of key contributions

This section highlights the contributions made in this thesis to achieve the three research objectives.

Objective 1: To determine valuation estimates of the recreational benefits of improved coastal water quality for beach recreationists in Tobago using the discrete choice experiment method.

The parameter and marginal willingness-to-pay (WTP) estimates of beach recreationists for an improvement in attributes linked to better coastal water quality in Tobago were presented in Chapter 4. These empirical results clearly showed that beach recreationists did derive benefits from an improvement in attributes associated with coastal water quality. In addition, these results demonstrated that beach recreationists were also willing to help pay for improvements through the implementation of a beach contribution fee. The snorkeller respondents were willing to pay for seven attributes at the high level of environmental quality whereas non-snorkellers were willing to pay for six. The attitudinal data collected confirmed that both the resident and visitor beach users rank the quality of the coastal waters to be the most important factor that determines the enjoyment of their beach recreational experience.

Objective 2: To increase the reliability of valuation estimates by incorporating two methodological advances in the design of the study through:

- accounting for and investigating the presence of observed and unobserved taste heterogeneity.
- an investigation into whether any attributes are excluded by individuals in decision making.

Accounting for the presence of observed taste heterogeneity as described in the first part of Objective 2 was addressed in Chapter 4. The results of the initial qualitative research indicated that snorkelling is one of the most popular activities carried out by beach visitors in Tobago. However, while most of the international visitor population engaged in snorkelling, most of the locals and domestic visitors did not. This fact motivated the systematic design of two discrete choice survey instruments to capture and compare the observed taste heterogeneity of these two groups of recreationists. The empirical and descriptive results presented in Chapter 4 confirmed that there were indeed differences and similarities in preferences between these two groups. One key similarity was that both groups had higher and positive WTP values for attributes associated with higher environmental quality than those with a lower environmental quality. A key difference was that the two groups had differing WTP values for some attributes. For example, snorkellers were not willing to pay to visit a beach with up to 7 boats near the coastline. In contrast, non-snorkellers were willing to pay TT$8.00 on average.

The observed differences between the two groups of recreationists prompted the investigation into the presence of taste heterogeneity which may have been unobserved by the researcher. As required by Objective 2 (and also addressed in Chapter 4), the MMNL and LCM models were used to carry out this investigation. The results showed that unobserved taste heterogeneity was indeed present within both groups of recreationists. The results of the LCM model revealed that within the snorkellers group, two homogenous subgroups which had varying tastes could be identified. Further examination of the preferences of these respondents led to the description of two groups of snorkellers: avid snorkellers and occasional snorkellers. The MMNL model revealed that a large variation in tastes could be observed for six out of the ten attributes considered by the non-snorkeller respondents. Taste variation was limited for the remaining four attributes. The use of the MMNL and LCM models allowed the calculation of individual-specific WTP estimates. This provided more detailed information, such as the distribution of WTP for each attribute. For some attributes (such as the attribute representing coral cover of up to 45% in the snorkellers) a larger variation in WTP could be noted whereas for others (such as the attribute representing up to 5 pieces of plastic per 30m in the non-snorkellers), this variation was smaller. These parameter estimates were also used to evaluate a potential policy scenario through the calculation of a measure of compensating variation. These results revealed that snorkellers were willing to pay more per beach visit than non-snorkellers. Under the assumption that this fee was guaranteed to result in maximum improvement of all beach sites, the snorkeller respondents were willing to pay up to TT$150 and non-snorkellers up to TT$47 on average per day to visit a beach.

The second part of Objective 2 was addressed in Chapter 5. With increasing evidence of respondents ignoring attributes in discrete choice experiments, this chapter presented the results of a study to systematically investigate whether attribute relevance is a contributor to this occurrence. The main benefit of this investigation was that it helped to determine whether the use of non-compensatory strategies in a discrete choice experiment had an impact on the values of model estimates. This was done by comparing choices made in a systematically designed choice experiment (i.e. respondent-selected) to those of a "typical" choice experiment (i.e. researcher-selected). This allowed the researcher to test the hypothesis that model parameters were the same after accounting for whether the attributes were respondent-selected or researcher-selected. The results of the analysis presented in Chapter 5 revealed that there were no significant differences in WTP estimates derived from the two treatments. These results contrast with previous research which indicated that model estimates were indeed affected.

Objective 3: To help develop policy recommendations for attributes linked to improved coastal water quality through the evaluation of the valuation results, and to refine these recommendations by the application of recent methodological developments.

The empirical results of Chapters 4 and 5 both had implications for recommending policy actions to improve coastal water quality on the island of Tobago. The two key results of Chapter 4 were that (1) beach recreationists were willing to pay for improvements to coastal water quality and (2) that their recreational experience is significantly affected by the condition of the environment at the beach. Moreover, the results of Chapter 4 demonstrated that accounting for observed and unobserved taste heterogeneity does have an impact on the valuation estimates.

Accounting for taste heterogeneity does not only allow the various attributes affecting coastal water quality to be valued but also provides detailed information that helps prioritise policy recommendations. For example, an examination of the individual-specific estimates for both snorkellers and non-snorkellers revealed important similarities and differences. One difference was that, within the snorkeller respondents, there existed two subgroups. This was not the case for the nonsnorkeller respondents. On the other hand, there were also similarities between snorkellers and non-snorkellers. For example, it was found that both sets of respondents were willing to visit a beach with a marine protected area which did not allow fishing and also where there was a low chance of contracting an ear infection. Similarly, they were both not willing to visit a beach with a high level of development and a high chance of contracting an infection. On small island states like Tobago where financial resources are limited and conflicting development interests exist, it may be more important to focus on policies which deliver benefits to the largest cross section of beach recreationists and subsequently focus on policies which deliver benefits to subgroups. This information can be crucial to natural resource managers in order to allow them to make optimal decisions regarding natural resource management.

The results of Chapter 5 were also important in formulating policy recommendations. These results showed that even though respondents chose attributes that were important to them and did not consider all attributes presented in the choice experiment, there was no significant effect on the WTP estimates. The results of the scale ratio test and individual-specific WTP estimates helped to demonstrate that respondents in both the researcher-selected and respondent-selected treatments had essentially the same preference structure. Therefore, the recommended policy actions would not be altered from those based on the results in Chapter 4.

6.2 Future work

Two main areas of future work based on the results and limitations of this thesis can be addressed. The first is to provide further policy recommendations and to improve the design and implementation of these policies. The second is to improve the methodology behind discrete choice experiments.

6.2.1 Policy

The results of ecological studies have shown that nutrient pollution is the largest source of pollution affecting the coastal waters. The results of this thesis show that this increase in pollution is not only a concern for natural scientists but also to the recreational users of this resource. In addition, the different types of recreational users are willing to pay varying amounts for improvement of the same resource. Therefore, one area of future research is to use a decision support tool (such as cost-benefit analysis) for appraising the benefits and costs of investing in various policy recommendations. The results of this thesis also showed that human health issues are an important concern for recreational users. Therefore, priority could be given to evaluating the cost of implementing policies that improve infrastructure for sewage treatment and implement agricultural practices, both of which help reduce the amount of nutrient pollution and hence reduce health risks.

The use of the coastal waters for beach-recreation is only one area of benefit gained from improving the coastal waters. There are other benefits such as for conservation, fishing and biological support. Therefore, further studies could be carried out to quantify these alternative benefit streams. This could help to justify the costs of implementing the recommended policy actions highlighted in this work and those stemming from these further valuation studies.

6.2.2 Methodology

Studies in the experimental design field have undertaken research to explore various techniques that can lead to more efficient experimental designs. For practitioners in environmental valuation, this is an important consideration since this can ensure that the maximum amount of information is extracted from each sampled individual. Chapter 3 showed that updating the experimental design using a numerical optimisation technique led to varying levels of improvement in efficiency of the design for the two sampled groups of respondents. These results provided confirmation that the use of the numerical optimisation technique did improve the efficiency of the design. However, more research is needed in this area. Two such avenues for further research include (1) designing empirical studies which incorporate the methodological advances in the experimental design field and (2) evaluating the impact these advances have on the precision of valuation estimates.

An evaluation of the results of MNL, MMNL and LCM models in this thesis showed the inadequacy or ability of various model specifications to account for unobserved taste heterogeneity. One area of additional research could be to use socioeconomic and attitudinal variables to further account for observed taste heterogeneity. This could help characterise sources of unobserved taste heterogeneity within the avid and occasional snorkellers and between the snorkellers and non-snorkellers.

The results of the monotonicity and stability tests for all three discrete choice experiments revealed the presence of inconsistent choices. Therefore, these tests should be used in the design of standard choice experiment surveys to ensure that the responses used in data analysis are taken from respondents who make consistent choices. Further research can be carried out to determine if the existence of inconsistent choices are linked to fatigue effects. One way to achieve this is to insert the choice sets that test for monotonicity and preference stability at various points during the presentation of the choice cards and compare the effect this has on the incidence of instable and monotonic preferences.

The results of Chapter 5 demonstrated that there were no effects on WTP estimates after respondents ignored attributes. In light of the conflicting results of this research with that of earlier research, further investigation of this issue is warranted. For example, a similar study to that reported in Chapter 5 could be carried out with a discrete choice experiment containing various number of attributes for the same public good. The results of these discrete choice experiments could be compared so that the following research questions could be addressed:

1. Are respondents still ignoring attributes? If so, is there an impact on WTP estimates? Does this impact vary with the number of attributes contained in the discrete choice experiments?

2. Is there a minimum number of attributes that the majority of respondents are able to fully consider in the discrete choice experiment for that particular good? Are there observed factors (for example education level and income) which affect this minimum number?

6.3 Final word

The coastal and marine environment of small island states like Tobago provides tourists with an escape from the increasing urbanisation of the developed world. Beach recreation is an important contributor to welfare on this island and degradation of the beach environment would present a considerable threat to the dynamic and diverse population who depend on beach recreation as a source of enjoyment and income.

The correct determination of valuation estimates for public goods such as coastal water quality is essential information for economically optimal environmental protection and management. This thesis adopts two approaches to ensure that these estimates are as reliable as possible and thereby enabling a more informed case to be made for environmental protection and improving policy making. The first approach is an investigation into whether accounting for heterogeneity of taste has an impact on the measurement of preferences. The second approach is the implementation of an exploratory study designed to determine the implications of respondents excluding attributes based on their individual-specific relevance in a discrete choice experiment. The purpose of investigating these two research areas in modelling the random component of utility is to better understand and model choice behaviour. If the field of environmental valuation is to benefit from methodological advances, then there is a need to incorporate these advances in empirical applications as done in this thesis.

Appendix A

Questionnaire for snorkellers and sample choice sets administered per respondent

Stated Preference Survey for Coastal Water Quality in Tobago

Environment Department
University of York
Heslington
United Kingdom

MAIN SURVEY

SNORKELLERS

QUESTIONNAIRE NUMBER__________

DATE: [ ][ ] / [ ][ ] / [ ][ ]

INTERVIEW START TIME (24 HOUR CLOCK): [ ][ ] : [ ][ ]

INTERVIEW FINISH TIME (24 HOUR CLOCK): [ ][ ] : [ ][ ]

TOTAL TIME TAKEN: __________minutes

SAMPLING POINT..

TYPE OF INTERVIEW ....

Hello, my name is Nesha Beharry and I am a student from the University of York, carrying out research on the beaches of Tobago. You have been selected because I am asking persons in the airport after they have completed their vacation in Tobago and may be waiting for their departure flight.

This questionnaire will take approximately thirty minutes and I am sure you will find it very interesting. The answers will be used to make improvements to the beaches in Tobago.

Do you agree to conduct this interview?
If yes, thank and proceed.
If no, thank and withdraw

A. INTRODUCTION

A1. Do you live in Tobago?

1	Yes	If Yes, Ask A6
2	No	If No, Ask A2

A2. When did you arrive in Tobago?

☐☐ / ☐☐ / ☐☐

A3. When do you plan to leave?

☐☐ / ☐☐ / ☐☐

A4. Is this your first trip to Tobago? [CIRCLE ONE ANSWER]

1	Yes	If Yes, Ask A6
2	No	If No, Ask A5

A5. When were your previous visits and how long did you stay during those visits? [RECORD DATE(s) VISITED AND DURATION OF STAY]

....

....

....

[GO TO → → A6]

A6. [SHOW RESPONDENT PROMPT CARD ONE – *MAP OF BEACHES*] On your <u>most recent visit</u> to Tobago have you visited any of the beaches shown in the map for <u>leisure or doing some outdoor sport activity</u>?

1	Yes	If Yes, Ask A10
2	No	If No, Ask A7

A7. [SHOW RESPONDENT PROMPT CARD ONE – *MAP OF BEACHES*] In the past <u>twelve months</u> have you visited any of the beaches in Tobago shown in the map for <u>leisure or doing some outdoor sport activity</u>?

1	Yes	If Yes, Ask A9
2	No	If No, Ask A8

A8. Have you visited ever any of the beaches in Tobago?

1	Yes	If Yes, Ask A9
2	No	If No, Ask A13

A9. Can you tell me when was your most recent visit to a beach in Tobago? [SHOW RESPONDENT PROMPT CARD ONE]

1	In the past twenty four months (two years)
2	Last 36 months (three years)
3	Last 48 months (four years)
4	Last five years
5.	Greater than five years.
6.	Other, Please specify

A10. [SHOW RESPONDENT PROMPT CARD TWO AND THREE – *MODE OF TRANSPORTATION*] Looking at the cards can you indicate which beaches you visited, how many times and what mode of transportation you used to visit each beach?

For example, if you visited Pigeon Point five times on your last visit, you may have done so twice by walking and three times by rented car.

Name of Beach		Number of Times and Mode of Transportation									
		OC	**FC**	**RC**	**W**	**B**	**M**	**T**	**BT**	**O**	**Total**
1	Store Beach										
2	Milford Beach										
3	Pigeon Point										
4	Sheerbird's Point/										
5	Buccoo Beach										
6	Grange Beach										
7	Mt. Irvine Beach										
8	Back Beach										
9	Stonehaven Beach/										
10	Turtle Beach/Great Courland Bay										
11	Arnos Vale Beach										
12	Cullodden Beach										
13	King Peter 's Beach										

Name of Beach		Number of Times and Mode of Transportation									
		OC	FC	RC	W	B	M	T	BT	O	Total
14.	Cotton Beach										
15.	Castara Beach										
16.	Englishman's Bay										
17.	Parlatuvier Beach										
18	Bloody Beach										
19	Hermitage Beach										
20	Cambleton Beach										
21	Pirate's Bay										
22	Starwood Beach										
23	Bateaux Beach/Speyside Beach										
24	Tyrrels's Beach										
25	Lucy Vale Beach										
26	King's Beach										
27	Queen's Beach										
28	Prince's Beach										
29	Carapuse Beach										

Name of Beach		Number of Times and Mode of Transportation									
		OC	FC	RC	W	B	M	T	BT	O	Total
30.	Goldsbrough Beach										
31.	Pinfold Beach/Fort Granby										
32.	Barbados Beach										
33.	Hillsbrough Beach										
34.	Minster Bay/Big Bacolet Beach										
35	Bacolet Beach										
36	Rockly Beach										
37	Little Rockly Beach										
38	Petit Trou Beach										
39	Canoe Beach										
40	Kilgwyn Beach										
41	Sandy Point Beach										
42	Coconut Bay (CoCo)										
43	Other										

A11. [SHOW RESPONDENT PROMPT CARD FOUR – FREQUENCY SCALE] On your visits to the beach, can you please say if you participated in the following activities and if so, how frequently?

Ring Start	Activity	Always	Very Often	Fairly Often	Sometimes	Almost Never	Never
1.	Swimming or 'Bathing'	1	2	3	4	5	6
2.	Relaxing on Beach(lying or sitting on beach)	1	2	3	4	5	6
3.	Beachcombing	1	2	3	4	5	6
4.	Observing Nature on Beach (e.g. Turtle watching)	1	2	3	4	5	6
5.	Sunbathing	1	2	3	4	5	6
6.	Walking	1	2	3	4	5	6
7.	Picnicking or 'eating'.	1	2	3	4	5	6
8.	Snorkelling	1	2	3	4	5	6
9.	Diving	1	2	3	4	5	6
10.	Playing games	1	2	3	4	5	6
11.	Fishing	1	2	3	4	5	6
12.	Surfing	1	2	3	4	5	6
13.	Windsurfing	1	2	3	4	5	6
14.	Boating (Catamarans, power boats)	1	2	3	4	5	6
15.	Water skiing	1	2	3	4	5	6
16.	Jet skiing	1	2	3	4	5	6
17.	Sailing	1	2	3	4	5	6

A12. Is there another activity, you do at the beach?

1	Yes	If Yes, Ask A12
2	No	If No, Ask A13

A13. Can you say what activity you do and how often do you participate in this activity?

	Activity	Always	Very Often	Fairly Often	Sometimes	Almost Never	Never
1.		1	2	3	4	5	6

[GO TO→ → A14]

A14. Many factors can influence your decision to visit a beach in Tobago. I would like you to imagine that, you planned a trip to the beach on a particular day. [SHOW RESPONDENT PROMPT CARD FOUR – *List of Factors*]

a. Would you now look at this card and tell me which one factor on this list, would be *most important* to you in making your decision to visit a beach in Tobago? [CIRCLE ONE CODE IN COLUMN A]

b. Which factor comes next? [CIRCLE ONE CODE in COLUMN B]

c. Which is the third most important factor? [CIRCLE ONE CODE in COLUMN C]

d. Which is the fourth most important factor? [CIRCLE ONE CODE in COLUMN D]

	A Most	B Next	C Third	D Fourth
(1) Provision of Amenities (jetty, water sports options)	1	2	3	4
(2) Presence of Facilities (clean toilets, showers, changing rooms, food outlets)	1	2	3	4
(3) Water Quality (vertical visibility, risk of bathing in polluted water)	1	2	3	4
(4) Convenience of Location (access, parking)	1	2	3	4

A15. Are there any other factors that you can think of, would influence your decision to visit the beach?

..

[If Yes, please specify. If No, GO TO → → A16]

A16. [SHOW RESPONDENT PROMPT CARD FIVE- *SEMANTIC SCALE*]. As part of this research we are interested in what you think about certain aspects of the coastal zone, in particular the beaches and its environs. [READ EACH STATEMENT ALOUD, SHOWING PROMPT CARDS 6-11 AND RECORD RESPONSE]

	Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
(a) The quality of the water around the coast is affected by activities on the land	1	2	3	4	5
(b) Tourism is important for the economy of Tobago and to maintain a higher coastal water quality non national visitors should make a monetary contribution	1	2	3	4	5
(c) To maintain a higher coastal water quality nationals and residents should make a monetary contribution	1	2	3	4	5
(d) To maintain a higher coastal water quality nationals, residents and non nationals should make a monetary contribution	1	2	3	4	5
(e) The government is fully responsible for the maintenance of coastal water quality and the state of the beaches in Tobago	1	2	3	4	5
(f) Everyone can benefit from better coastal water quality and we should do our part to keep it clean	1	2	3	4	5

[STATEMENT F. TO BE READ INTERCHANGEABLY BEFORE A AND AFTER

B. VALUATION SECTION

B1. Now as part of this research **I would like to know what factors are important to you when visiting a beach to engage in any of the activities you usually do and what you would like to see improved.**

But, I would like to focus on **factors relating to the water *versus* non water related factors** such as parking facilities or availability of food to buy on the beach. The water related factors are as follows.

In order to achieve higher coastal water standards and to ensure that we have *better beaches*, this requires financial support. This financial support could be given to non profit beach organization and some of the improvements or policies that could be made are:

1. **Ensuring that there is a properly working sewage treatment plant.**
2. **Setting in place planning guidelines for hotels and residents to reduce the amount of runoff onto the coastal waters.**
3. **Making sure that there is no plastic debris on beaches.**
4. **Creation of more marine protected zones around the beaches.**
5. **Introducing restrictions on boat operators.**

I am going to show you these water related factors, with three levels of policy or programs development. The first level is a no policy option, Policy Option High and Policy Option Low. [EXPLAIN USING PROP ONE]

I would now like to you to think of having to decide to visit one of the number of beaches in Tobago. [SHOW WORKED EXAMPLE]

Each beach can have three different levels of policy that allows for different levels of factors.
If a factor is not important to you, then you may not mind choosing a beach that has no policy implemented for that factor Please consider all factors and price equally. Please consider whether the cost of the additional measures are worth it to your household.

ADMINISTER CHOICE CARDS TO RESPONDENT.

B2. In making your choices did you consider all the beach factors or did you focus on a particular factor or set of factors? [HAND RESPONDENT SHOWCARD EIGHTEEN]

[IF NO, RECORD IN TABLE]

I considered all factors	0

[IF YES, SHOW CARD TO RESPONDENT AND CIRCLE AS MANY AS APPLY]

NUMBER OF BOATS	NUMBER OF SNORKELLERS
WATER CLARITY	CORAL COVER
PLASTIC DEBRIS	AVERAGE WATER QUALITY
MARINE PROTECTED AREA	COST
COASTLINE DEVELOPMENT	
ABUNDANCE OF FISH	

C. FOLLOW UP QUESTIONS

C1.Which of these statements, if any, describe the main reason you are not willing to contribute for improvements to the current situation. [CIRCLE ONE ONLY]

I cannot afford to pay	1
These improvements are not important to me	2
The options are too expensive	3
The government should pay for these improvements	4
I do not believe the improvements would actually happen	5
I never use the beach.	6
I rarely use the beach	7
Some other reason (PROBE AND RECORD BELOW)	8

C2. [SHOW RESPONDENT PROMPT CARD TWENTY] Which of these statements if any, best describes you main reason for choosing your preferred beach scenarios?

I would like better beaches for myself and my family to enjoy.	1
I would like to improve the beach and coastal water quality for everyone to enjoy.	2
I would like to improve the beach and coastal water quality for future generations to enjoy.	3
I would like to improve the beach and coastal water quality to protect the marine wildlife	4
I would like to improve the appearance of the beaches	5
It is a good cause	6
None of the above	7

C. Snorkelling

C3. Is this the first time you are trying out snorkelling?

1	Yes	Yes, ask C5
2	No	If No, ask C4

C4.Can you tell me where have you snorkeled in the past five years?

....

....

....

C5. Where have you snorkeled in Tobago on this trip?

....

....

....

C6.Do you rent any of your snorkeling equipment?

1	Yes	If Yes, Go To C7
2	No	If No, Go to C8

C7. What equipment do you rent? [CIRCLE ALL THAT APPLY]

1.Mask	2. Snorkel	3. Fins

C8. What are the main reasons you snorkel? [CIRCLE ALL THAT APPLY]

1	To be with friends and relatives
2	For the adventure, fun, new experience
3	To view marine life in its natural environment
4	For photography
5	For being active and out doors
6	For the enjoyment of snorkeling itself
7	Other, Please specify

C9. Can you tell me what you think about the number of marine protected areas in Tobago?

Too few	1
One is just right	2
Don't Care	3

[If respondent indicated that they dive]

C10. How many dives have you logged on this trip to Tobago?

....

....

....

C11.Approximately, how many dives have you logged in total?

....

....

....

C12.Do you rent any of your diving equipment

1	Yes	
2	No	

D. FINAL SECTION

D1. In what year were you born?

....

D2. What is the sex of the person?

1	**Male**
2	**Female**

D3. [SHOW RESPONDENT PROMPT CARD 21]Can you tell me how many people in your household are:

Below five years old	
Between 5 and 13 years old	
Between 14 and 18 years old	
Between 18 and 60 years old.	
Over 60 years old	

D4. [SHOW RESPONDENT PROMPT CARD 22]. At what level did <u>you complete your education</u>? If still studying: which level best describes the highest level of education you have obtained until now. Circle ONE Only.

Primary	**1**
O Levels/C.X.C/GCSE	**2**
A Levels / Advanced Vocational Training	**3**
Professional qualification of degree levels	**4**
College/University/undergraduate degree level	**5**
Post-graduate education (MSc, PhD, etc)	**6**
Other, please specify	**7**

D5. Can you tell me what is your present occupation?

....

D6. [SHOW RESPONDENT PROMPT CARD 23]. What is your current work status? Circle One Answer Only.

Self employed	1
Employed full time (30 hours plus per week)	2
Employed part time (under 30 hours per week)	3
Student	4
Housewife	5
Retired	6
Unemployed	7
Unable to work due to sickness or disability	8

D7. Can you tell me which country are you a national of ?..................................

[IF TRINIDAD AND TOBAGO, THEN GO TO → → D9, IF OTHER COUNTRY, GO TO → → D8]

D8. In which of the two islands are you currently living in, Trinidad or Tobago?

1	Trinidad	If Trinidad, Go To D27
2	Tobago	If Tobago, Go to D30

D9 In which country are you currently living in ?

....

D10. [SHOW RESPONDENT PROMPT CARD 24]. What would you describe as the main purpose of your visit to Tobago?

1.	Business or Work
2.	Vacation
3.	Visiting family and friends
4.	Wedding/Honeymoon
5.	Diving
6.	Ecotourism
4.	Other, please specify

D11. [SHOW RESPONDENT PROMPT CARD 25]. What best describes where you stayed while in Tobago?

1	Hotel
2	Guest House
3	Friends or Family House
4	Villa
5.	Other, Please specify

D12. Can you tell me which town was your place of accommodation? [HAND RESPONDENT PROMPTCARD 26]

....

....

....

D13. Can you tell me which town you live in? [IF RESPONDENT RESIDES IN TOBAGO]

....

....

....

D14. Are you a member of an environmental organization or group?

1	Yes	If Yes, Please Specify
2	No	If No, Go to D10

D15. Could you tell me which category best describes your total personal income before deduction of tax, each week, each month or each year. [SHOW RESPONDENT PROMPT CARD 27 or 28 DEPENDING ON NATIONALITY]

	Gross Income per year(TT$)	Gross income per month (TT$)
A.	Under 12 000	Up to 1000
B.	12 000 – 36 000	Up to 3000
C.	36 000 – 60 000	Up to 5000
D.	60 000 – 84 000	Up to 7000
E.	84 000 – 108 000	Up to 9000
F.	108 000 – 121 000	Up to 11 000
G.	121 000 – 156 000	Up to 13 000
H.	156 000 – 180 000	Up to 15 000
I.	180 000 – 204 000	Up to 17 000
J.	Over 204 000	Over 17 000

	Gross Income per year (US$)	Gross income per month (US$)
A.	Under 12 000	Up to 1000
B.	12 000 – 36 000	Up to 3000
C.	36 000 – 60 000	Up to 5000
D.	60 000 – 84 000	Up to 7000
E.	84 000 – 108 000	Up to 9000
F.	108 000 – 121 000	Up to 11 000
G.	121 000 – 156 000	Up to 13 000
H.	156 000 – 180 000	Up to 15 000
I.	180 000 – 204 000	Up to 17 000
J.	Over 204 000	Over 17 000

D33. What do you think of this questionnaire? [PLEASE CIRCLE ONE]

1	The questionnaire was interesting
2	Difficult to Understand
3	It took a long time to think about the answers
4	Educational/Informative
5	Unrealistic
6	Other, Please specify ....

A DASH (-) represents that there is no program to control the levels of this factor at the beach

	BEACH A	BEACH B	NEITHER BEACH
Boats (near coastline)	-	2 Boats or less	I Choose to Visit Neither Beach
Marine Protected Area (absence or presence)	-	YES, TO VISIT ONLY, NO FISHING	
Coastline Development (hotels and homes)	Less than 25% developed	-	
Average Bathing Water Quality (chance of an ear infection)	Reduced chance	Increased chance	
Water Clarity (down to seabed)	Up to 10 meters	-	
Plastics (per 30meters of beach)	Less than 5 pieces	Up to 15 pieces	
Number of Snorkellers (per group)	-	Up to 15 per group	
Level of Coral Cover	Up to 45% coral cover	15% coral cover	
Abundance of Fish	Up to 60 fishes	-	
Contribution Fee (TT$)	TT$10.00	TT$25.00	TT$0
I would choose to visit	☐	☐	☐

TT$10.00 = US$1.40 = £0.90 **TT$25.00 = US$4.00 = £2.27**

A DASH (-) represents that there is no program to control the levels of this factor at the beach

	BEACH C	BEACH D	NEITHER BEACH
Boats (near coastline)	Up to 7 boats	2 Boats or less	I Choose to Visit Neither Beach
Marine Protected Area (absence or presence)	YES, TO VISIT ONLY, NO FISHING	-	
Coastline Development (hotels and homes)	Up to 75% developed	Less than 25% developed	
Average Bathing Water Quality (chance of an ear infection)	-	Increased chance	
Water Clarity (down to seabed)	-	Up to 10 meters	
Plastics (per 30meters of beach)	-	Up to 15 pieces	
Number of Snorkellers (per group)	-	Up to 15 per group	
Level of Coral Cover	Up to 45% coral cover	15% coral cover	
Abundance of Fish	Up to 60 fishes	Up to 10 fishes	
Contribution Fee (TT$)	TT$25.00	TT$10.00	TT$0
I would choose to visit	☐	☐	☐

TT$10.00 = US$1.40 = £0.90 **TT$25.00 = US$4.00 = £2.27**

A DASH (-) represents that there is no program to control the levels of this factor at the beach

	BEACH E	BEACH F	NEITHER BEACH
Boats (near coastline)	-	Up to 7 boats	I Choose to Visit Neither Beach
Marine Protected Area (absence or presence)	YES, TO VISIT ONLY, NO FISHING	-	
Coastline Development (hotels and homes)	-	Up to 75% developed	
Average Bathing Water Quality (chance of an ear infection)	Increased chance	Reduced chance	
Water Clarity (down to seabed)	-	Up to 10 meters	
Plastics (per 30meters of beach)	-	Up to 15 pieces	
Number of Snorkellers (per group)	5 or less per group	-	
Level of Coral Cover	Up to 45% coral cover	15% coral cover	
Abundance of Fish	Up to 10 fishes	-	
Contribution Fee (TT$)	TT$25.00	TT$10.00	TT$0
I would choose to visit	☐	☐	☐

TT$10.00 = US$1.40 = £0.90 **TT$25.00 = US$4.00 = £2.27**

A DASH (-) represents that there is no program to control the levels of this factor at the beach

	BEACH G	BEACH H	NEITHER BEACH
Boats (near coastline)	-	Up to 7 boats	I Choose to Visit Neither Beach
Marine Protected Area (absence or presence)	YES, TO VISIT & FISH	YES, TO VISIT ONLY, NO FISHING	
Coastline Development (hotels and homes)	Less than 25% developed	-	
Average Bathing Water Quality (chance of an ear infection)	Increased chance	Reduced chance	
Water Clarity (down to seabed)	5 meters or less	-	
Plastics (per 30meters of beach)	-	Up to 15 pieces	
Number of Snorkellers (per group)	5 or less per group	-	
Level of Coral Cover	-	Up to 45% coral cover	
Abundance of Fish	Up to 60 fishes	Up to 10 fishes	
Contribution Fee (TT$)	TT$25.00	TT$10.00	TT$0
I would choose to visit	☐	☐	☐

TT$10.00 = US$1.40 = £0.90 **TT$25.00 = US$4.00 = £2.27**

A DASH (-) represents that there is no program to control the levels of this factor at the beach

	BEACH I	BEACH J	NEITHER BEACH
Boats (near coastline)	2 Boats or less	-	I Choose to Visit Neither Beach
Marine Protected Area (absence or presence)	-	YES, TO VISIT & FISH	
Coastline Development (hotels and homes)	Less than 25% developed	-	
Average Bathing Water Quality (chance of an ear infection)	Increased chance	Reduced chance	
Water Clarity (down to seabed)	5 meters or less	-	
Plastics (per 30meters of beach)	Less than 5 pieces	-	
Number of Snorkellers (per group)	-	Up to 15 per group	
Level of Coral Cover	Up to 45% coral cover	15% coral cover	
Abundance of Fish	-	Up to 60 fishes	
Contribution Fee (TT$)	TT$25.00	TT$10.00	TT$0
I would choose to visit	☐	☐	☐

TT$10.00 = US$1.40 = £0.90 **TT$25.00 = US$4.00 = £2.27**

A DASH (-) represents that there is no program to control the levels of this factor at the beach

	BEACH K	BEACH L	NEITHER BEACH
Boats (near coastline)	-	Up to 7 boats	I Choose to Visit Neither Beach
Marine Protected Area (absence or presence)	-	YES, TO VISIT & FISH	
Coastline Development (hotels and homes)	Up to 75% developed	Less than 25% developed	
Average Bathing Water Quality (chance of an ear infection)	Increased chance	Reduced chance	
Water Clarity (down to seabed)	Up to 10 meters	5 meters or less	
Plastics (per 30meters of beach)	-	Up to 15 pieces	
Number of Snorkellers (per group)	5 or less per group	-	
Level of Coral Cover	15% coral cover	-	
Abundance of Fish	-	Up to 60 fishes	
Contribution Fee (TT$)	TT$25.00	TT$10.00	TT$0
I would choose to visit	☐	☐	☐

TT$10.00 = US$1.40 = £0.90 **TT$25.00 = US$4.00 = £2.27**

A DASH (-) represents that there is no program to control the levels of this factor at the beach

	BEACH M	BEACH N	NEITHER BEACH
Boats (near coastline)	2 Boats or less	-	I Choose to Visit Neither Beach
Marine Protected Area (absence or presence)	YES, TO VISIT ONLY, NO FISHING	-	
Coastline Development (hotels and homes)	Up to 75% developed	Less than 25% developed	
Average Bathing Water Quality (chance of an ear infection)	Increased chance	Reduced chance	
Water Clarity (down to seabed)	Up to 10 meters	5 meters or less	
Plastics (per 30meters of beach)	Less than 5 pieces	-	
Number of Snorkellers (per group)	-	Up to 15 per group	
Level of Coral Cover	-	Up to 45% coral cover	
Abundance of Fish	Up to 10 fishes	-	
Contribution Fee (TT$)	TT$25.00	TT$10.00	TT$0
I would choose to visit	☐	☐	☐

TT$10.00 = US$1.40 = £0.90 **TT$25.00 = US$4.00 = £2.27**

A DASH (-) represents that there is no program to control the levels of this factor at the beach

	BEACH O	BEACH P	NEITHER BEACH
Boats (near coastline)	Up to 7 boats	2 Boats or less	I Choose to Visit Neither Beach
Marine Protected Area (absence or presence)	YES, TO VISIT & FISH	YES, TO VISIT ONLY, NO FISHING	
Coastline Development (hotels and homes)	-	Up to 75% developed	
Average Bathing Water Quality (chance of an ear infection)	-	Increased chance	
Water Clarity (down to seabed)	5 meters or less	-	
Plastics (per 30meters of beach)	-	Up to 15 pieces	
Number of Snorkellers (per group)	-	Up to 15 per group	
Level of Coral Cover	-	Up to 45% coral cover	
Abundance of Fish	-	Up to 60 fishes	
Contribution Fee (TT$)	TT$25.00	TT$10.00	TT$0
I would choose to visit	☐	☐	☐

TT$10.00 = US$1.40 = £0.90 **TT$25.00 = US$4.00 = £2.27**

A DASH (-) represents that there is no program to control the levels of this factor at the beach

	BEACH Q	BEACH R	NEITHER BEACH
Boats (near coastline)	2 Boats or less	-	I Choose to Visit Neither Beach
Marine Protected Area (absence or presence)	-	YES, TO VISIT & FISH	
Coastline Development (hotels and homes)	-	Up to 75% developed	
Average Bathing Water Quality (chance of an ear infection)	Reduced chance	-	
Water Clarity (down to seabed)	Up to 10 meters	5 meters or less	
Plastics (per 30meters of beach)	-	Up to 15 pieces	
Number of Snorkellers (per group)	Up to 15 per group	5 or less per group	
Level of Coral Cover	15% coral cover	-	
Abundance of Fish	Up to 60 fishes	Up to 10 fishes	
Contribution Fee (TT$)	TT$25.00	TT$10.00	TT$0
I would choose to visit	☐	☐	☐

TT$10.00 = US$1.40 = £0.90 **TT$25.00 = US$4.00 = £2.27**

A DASH (-) represents that there is no program to control the levels of this factor at the beach

	BEACH S	BEACH T	NEITHER BEACH
Boats (near coastline)	Up to 7 boats	2 Boats or less	I Choose to Visit Neither Beach
Marine Protected Area (absence or presence)	YES, TO VISIT & FISH	YES, TO VISIT ONLY, NO FISHING	
Coastline Development (hotels and homes)	Less than 25% developed	-	
Average Bathing Water Quality (chance of an ear infection)	Reduced chance	-	
Water Clarity (down to seabed)	-	Up to 10 meters	
Plastics (per 30meters of beach)	Less than 5 pieces	-	
Number of Snorkellers (per group)	5 or less per group	-	
Level of Coral Cover	15% coral cover	-	
Abundance of Fish	Up to 10 fishes	-	
Contribution Fee (TT$)	TT$25.00	TT$10.00	TT$0
I would choose to visit	☐	☐	☐

TT$10.00 = US$1.40 = £0.90 **TT$25.00 = US$4.00 = £2.27**

A DASH (-) represents that there is no program to control the levels of this factor at the beach

	BEACH U	BEACH V	NEITHER BEACH
Boats (near coastline)	2 Boats or less	Up to 7 boats	I Choose to Visit Neither Beach
Marine Protected Area (absence or presence)	-	YES, TO VISIT ONLY, NO FISHING	
Coastline Development (hotels and homes)	Less than 25% developed	Up to 75% developed	
Average Bathing Water Quality (chance of an ear infection)	Increased chance	-	
Water Clarity (down to seabed)	Up to 10 meters	-	
Plastics (per 30meters of beach)	Up to 15 pieces	-	
Number of Snorkellers (per group)	Up to 15 per group	-	
Level of Coral Cover	15% coral cover	Up to 45% coral cover	
Abundance of Fish	Up to 10 fishes	Up to 60 fishes	
Contribution Fee (TT$)	TT$10.00	TT$25.00	TT$0
I would choose to visit	☐	☐	☐

TT$10.00 = US$1.40 = £0.90 TT$25.00 = US$4.00 = £2.27

Appendix B

Questionnaire for non-snorkellers and sample choice sets administered per respondent

Stated Preference Survey for Coastal Water Quality in Tobago

Environment Department
University of York
Heslington
United Kingdom

MAIN SURVEY

NON-SNORKELLERS

QUESTIONNAIRE NUMBER_________

DATE: ☐☐/☐☐/☐☐

INTERVIEW START TIME (24 HOUR CLOCK): ☐☐ : ☐☐

INTERVIEW FINISH TIME (24 HOUR CLOCK): ☐☐ : ☐☐

TOTAL TIME TAKEN: __________minutes

SAMPLING POINT...

TYPE OF INTERVIEW ....

Hello, my name is Nesha Beharry and I am a student from the University of York, carrying out research on the beaches of Tobago. You have been selected because I am asking persons in the airport after they have completed their vacation in Tobago and may be waiting for their departure flight.

This questionnaire will take approximately twenty minutes and I am sure you will find it very interesting. The answers will be used to make improvements to the beaches in Tobago.

Do you agree to conduct this interview?
If yes, thank and proceed.
If no, thank and withdraw

A. INTRODUCTION

A1. Do you live in Tobago?

1	Yes	If Yes, Ask A6
2	No	If No, Ask A2

A2. When did you arrive in Tobago?

☐☐ / ☐☐ / ☐☐

A3. When do you plan to leave?

☐☐ / ☐☐ / ☐☐

A4. Is this your first trip to Tobago? [CIRCLE ONE ANSWER]

1	Yes	If Yes, Ask A6
2	No	If No, Ask A5

A5. When were your previous visits and how long did you stay during those visits? [RECORD DATE(s) VISITED AND DURATION OF STAY]

....

....

....

[GO TO → → A6]

A6. [SHOW RESPONDENT PROMPT CARD ONE – *MAP OF BEACHES*] On your <u>most recent visit</u> to Tobago have you visited any of the beaches shown in the map for <u>leisure or doing some outdoor sport activity</u>?

1	**Yes**	**If Yes, Ask A10**
2	**No**	**If No, Ask A7**

A7. [SHOW RESPONDENT PROMPT CARD ONE – *MAP OF BEACHES*] In the past <u>twelve months</u> have you visited any of the beaches in Tobago shown in the map for <u>leisure or doing some outdoor sport activity</u>?

1	**Yes**	**If Yes, Ask A9**
2	**No**	**If No, Ask A8**

A8. Have you visited ever any of the beaches in Tobago?

1	**Yes**	**If Yes, Ask A9**
2	**No**	**If No, Ask A13**

A9. Can you tell me when was your most recent visit to a beach in Tobago? [SHOW RESPONDENT PROMPT CARD ONE]

1	**In the past twenty four months (two years)**
2	**Last 36 months (three years)**
3	**Last 48 months (four years)**
4	**Last five years**
5.	**Greater than five years.**
6.	**Other, Please specify**

A10. [SHOW RESPONDENT PROMPT CARD TWO AND THREE – *MODE OF TRANSPORTATION*] Looking at the cards can you indicate which beaches you visited, how many times and what mode of transportation you used to visit each beach?

For example, if you visited Pigeon Point five times on your last visit, you may have done so twice by walking and three times by rented car.

Name of Beach		Number of Times and Mode of Transportation									
		OC	FC	RC	W	B	M	T	BT	O	Total
1	Store Beach										
2	Milford Beach										
3	Pigeon Point										
4	Sheerbird's Point/										
5	Buccoo Beach										
6	Grange Beach										
7	Mt. Irvine Beach										
8	Back Beach										
9	Stonehaven Beach/										
10	Turtle Beach/Great Courland Bay										
11	Arnos Vale Beach										
12	Cullodden Beach										
13	King Peter 's Beach										

Name of Beach		Number of Times and Mode of Transportation									
		OC	FC	RC	W	B	M	T	BT	O	Total
14.	Cotton Beach										
15.	Castara Beach										
16.	Englishman's Bay										
17.	Parlatuvier Beach										
18	Bloody Beach										
19	Hermitage Beach										
20	Cambleton Beach										
21	Pirate's Bay										
22	Starwood Beach										
23	Bateaux Beach/Speyside Beach										
24	Tyrrels's Beach										
25	Lucy Vale Beach										
26	King's Beach										
27	Queen's Beach										
28	Prince's Beach										
29	Carapuse Beach										

Name of Beach		Number of Times and Mode of Transportation									
		OC	FC	RC	W	B	M	T	BT	O	Total
30.	Goldsbrough Beach										
31.	Pinfold Beach/Fort Granby										
32.	Barbados Beach										
33.	Hillsbrough Beach										
34.	Minster Bay/Big Bacolet Beach										
35	Bacolet Beach										
36	Rockly Beach										
37	Little Rockly Beach										
38	Petit Trou Beach										
39	Canoe Beach										
40	Kilgwyn Beach										
41	Sandy Point Beach										
42	Coconut Bay (CoCo)										
43	Other										

A11. [SHOW RESPONDENT PROMPT CARD FOUR – FREQUENCY SCALE] On your visits to the beach, can you please say if you participated in the following activities and if so, how frequently?

Ring Start	Activity	Always	Very Often	Fairly Often	Sometimes	Almost Never	Never
1.	Swimming or 'Bathing'	1	2	3	4	5	6
2.	Relaxing on Beach(lying or sitting on beach)	1	2	3	4	5	6
3.	Beachcombing	1	2	3	4	5	6
4.	Observing Nature on Beach (e.g. Turtle watching)	1	2	3	4	5	6
5.	Sunbathing	1	2	3	4	5	6
6.	Walking	1	2	3	4	5	6
7.	Picnicking or 'eating'.	1	2	3	4	5	6
8.	Snorkelling	1	2	3	4	5	6
9.	Diving	1	2	3	4	5	6
10.	Playing games	1	2	3	4	5	6
11.	Fishing	1	2	3	4	5	6
12.	Surfing	1	2	3	4	5	6
13.	Windsurfing	1	2	3	4	5	6
14.	Boating (Catamarans, power boats)	1	2	3	4	5	6
15.	Water skiing	1	2	3	4	5	6
16.	Jet skiing	1	2	3	4	5	6
17.	Sailing	1	2	3	4	5	6

A12. Is there another activity, you do at the beach?

1	Yes	If Yes, Ask A12
2	No	If No, Ask A13

A13. Can you say what activity you do and how often do you participate in this activity?

	Activity	Always	Very Often	Fairly Often	Sometimes	Almost Never	Never
1.		1	2	3	4	5	6

[GO TO→ → A14]

A14. Many factors can influence your decision to visit a beach in Tobago. I would like you to imagine that, you planned a trip to the beach on a particular day. [SHOW RESPONDENT PROMPT CARD FOUR – *List of Factors*]

a. Would you now look at this card and tell me which one factor on this list, would be *most important* to you in making your decision to visit a beach in Tobago? [CIRCLE ONE CODE IN COLUMN A]

b. Which factor comes next? [CIRCLE ONE CODE in COLUMN B]

c. Which is the third most important factor? [CIRCLE ONE CODE in COLUMN C]

d. Which is the fourth most important factor? [CIRCLE ONE CODE in COLUMN D]

	A Most	B Next	C Third	D Fourth
(1) Provision of Amenities (jetty, water sports options)	1	2	3	4
(2) Presence of Facilities (clean toilets, showers, changing rooms, food outlets)	1	2	3	4
(3) Water Quality (vertical visibility, risk of bathing in polluted water)	1	2	3	4
(4) Convenience of Location (access, parking)	1	2	3	4

A15. Are there any other factors that you can think of, would influence your decision to visit the beach?

...

[If Yes, please specify. If No, GO TO → → A16]

A16. [SHOW RESPONDENT PROMPT CARD FIVE- *SEMANTIC SCALE*]. As part of this research we are interested in what you think about certain aspects of the coastal zone, in particular the beaches and its environs. [READ EACH STATEMENT ALOUD, SHOWING PROMPT CARDS 6-11 AND RECORD RESPONSE]

	Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
(a) The quality of the water around the coast is affected by activities on the land	1	2	3	4	5
(b) Tourism is important for the economy of Tobago and to maintain a higher coastal water quality non national visitors should make a monetary contribution	1	2	3	4	5
(c) To maintain a higher coastal water quality nationals and residents should make a monetary contribution	1	2	3	4	5
(d) To maintain a higher coastal water quality nationals, residents and non nationals should make a monetary contribution	1	2	3	4	5
(e) The government is fully responsible for the maintenance of coastal water quality and the state of the beaches in Tobago	1	2	3	4	5
(f) Everyone can benefit from better coastal water quality and we should do our part to keep it clean	1	2	3	4	5

[STATEMENT F. TO BE READ INTERCHANGEABLY BEFORE A AND AFTER

B. VALUATION SECTION

B1. Now as part of this research **I would like to know what factors are important to you when visiting a beach to engage in any of the activities you usually do and what you would like to see improved.**

But, I would like to focus on **factors relating to the water *versus* non water related factors** such as parking facilities or availability of food to buy on the beach. The water related factors are as follows.

In order to achieve higher coastal water standards and to ensure that we have *better beaches*, this requires financial support. This financial support could be given to non profit beach organization and some of the improvements or policies that could be made are:

1. **Ensuring that there is a properly working sewage treatment plant.**
2. **Setting in place planning guidelines for hotels and residents to reduce the amount of runoff onto the coastal waters.**
3. **Making sure that there is no plastic debris on beaches.**
4. **Creation of more marine protected zones around the beaches.**
5. **Introducing restrictions on boat operators.**

I am going to show you these water related factors, with three levels of policy or programs development. The first level is a no policy option, Policy Option High and Policy Option Low. [EXPLAIN USING PROP ONE]

I would now like to you to think of having to decide to visit one of the number of beaches in Tobago. [SHOW WORKED EXAMPLE]

Each beach can have three different levels of policy that allows for different levels of factors.
If a factor is not important to you, then you may not mind choosing a beach that has no policy implemented for that factor Please consider all factors and price equally. Please consider whether the cost of the additional measures are worth it to your household.

ADMINISTER CHOICE CARDS TO RESPONDENT.

B2. In making your choices did you consider all the beach factors or did you focus on a particular factor or set of factors? [HAND RESPONDENT SHOWCARD EIGHTEEN]

[IF NO, RECORD IN TABLE]

I considered all factors	**0**

[IF YES, SHOW CARD TO RESPONDENT AND CIRCLE AS MANY AS APPLY]

NUMBER OF BOATS	**AVERAGE WATER QUALITY**
WATER CLARITY	**COST**
PLASTIC DEBRIS	
MARINE PROTECTED AREA	
COASTLINE DEVELOPMENT	

C. FOLLOW UP QUESTIONS

C1.Which of these statements, if any, describe the main reason you are not willing to contribute for improvements to the current situation. [CIRCLE ONE ONLY]

I cannot afford to pay	1
These improvements are not important to me	2
The options are too expensive	3
The government should pay for these improvements	4
I do not believe the improvements would actually happen	5
I never use the beach.	6
I rarely use the beach	7
Some other reason (PROBE AND RECORD BELOW)	8

C2. [SHOW RESPONDENT PROMPT CARD TWENTY] Which of these statements if any, best describes you main reason for choosing your preferred beach scenarios?

I would like better beaches for myself and my family to enjoy.	1
I would like to improve the beach and coastal water quality for everyone to enjoy.	2
I would like to improve the beach and coastal water quality for future generations to enjoy.	3
I would like to improve the beach and coastal water quality to protect the marine wildlife	4
I would like to improve the appearance of the beaches	5
It is a good cause	6
None of the above	7

D. FINAL SECTION

D1. In what year were you born?

....

D2. What is the sex of the person?

1	Male
2	Female

D3. [SHOW RESPONDENT PROMPT CARD 21]Can you tell me how many people in your household are:

Below five years old	
Between 5 and 13 years old	
Between 14 and 18 years old	
Between 18 and 60 years old.	
Over 60 years old	

D4. [SHOW RESPONDENT PROMPT CARD 22]. At what level did you complete your education? If still studying: which level best describes the highest level of education you have obtained until now. Circle ONE Only.

Primary	1
O Levels/C.X.C/GCSE	2
A Levels / Advanced Vocational Training	3
Professional qualification of degree levels	4
College/University/undergraduate degree level	5
Post-graduate education (MSc, PhD, etc)	6
Other, please specify	7

D5. Can you tell me what is your present occupation?

....

D6. [SHOW RESPONDENT PROMPT CARD 23]. What is your current work status? Circle One Answer Only.

Self employed	1
Employed full time (30 hours plus per week)	2
Employed part time (under 30 hours per week)	3
Student	4
Housewife	5
Retired	6
Unemployed	7
Unable to work due to sickness or disability	8

D7. Can you tell me which country are you a national of ?...................................

[IF TRINIDAD AND TOBAGO, THEN GO TO → → D9, IF OTHER COUNTRY, GO TO → → D8]

D8. In which of the two islands are you currently living in, Trinidad or Tobago?

1	Trinidad	If Trinidad, Go To D27
2	Tobago	If Tobago, Go to D30

D9 In which country are you currently living in ?

....

D10. [SHOW RESPONDENT PROMPT CARD 24]. What would you describe as the main purpose of your visit to Tobago?

1.	Business or Work
2.	Vacation
3.	Visiting family and friends
4.	Wedding/Honeymoon
5.	Diving
6.	Ecotourism
4.	Other, please specify

D11. [SHOW RESPONDENT PROMPT CARD 25]. What best describes where you stayed while in Tobago?

1	Hotel
2	Guest House
3	Friends or Family House
4	Villa
5.	Other, Please specify

D12. Can you tell me which town was your place of accommodation? [HAND RESPONDENT PROMPTCARD 26]

....

....

....

D13. Can you tell me which town you live in? [IF RESPONDENT RESIDES IN TOBAGO]

....

....

....

D14. Are you a member of an environmental organization or group?

1	Yes	If Yes, Please Specify
2	No	If No, Go to D10

D15. Could you tell me which category best describes your total personal income before deduction of tax, each week, each month or each year. [SHOW RESPONDENT PROMPT CARD 27 or 28 DEPENDING ON NATIONALITY]

	Gross Income per year(TT$)	Gross income per month (TT$)
A.	Under 12 000	Up to 1000
B.	12 000 – 36 000	Up to 3000
C.	36 000 – 60 000	Up to 5000
D.	60 000 – 84 000	Up to 7000
E.	84 000 – 108 000	Up to 9000
F.	108 000 – 121 000	Up to 11 000
G.	121 000 – 156 000	Up to 13 000
H.	156 000 – 180 000	Up to 15 000
I.	180 000 – 204 000	Up to 17 000
J.	Over 204 000	Over 17 000

	Gross Income per year (US$)	Gross income per month (US$)
A.	Under 12 000	Up to 1000
B.	12 000 – 36 000	Up to 3000
C.	36 000 – 60 000	Up to 5000
D.	60 000 – 84 000	Up to 7000
E.	84 000 – 108 000	Up to 9000
F.	108 000 – 121 000	Up to 11 000
G.	121 000 – 156 000	Up to 13 000
H.	156 000 – 180 000	Up to 15 000
I.	180 000 – 204 000	Up to 17 000
J.	Over 204 000	Over 17 000

D33. What do you think of this questionnaire? [PLEASE CIRCLE ONE]

1	The questionnaire was interesting
2	Difficult to Understand
3	It took a long time to think about the answers
4	Educational/Informative
5	Unrealistic
6	Other, Please specify ....

DASH (-) represents that there is no program to control the levels of this factor at the beach

	BEACH A	BEACH B	NEITHER BEACH
Boats (near coastline)	-	Up to 7 boats	I Choose to Visit Neither Beach
Marine Protected Area (absence or presence)	-	YES, TO VISIT ONLY, NO FISHING	
Coastline Development (hotels and homes)	Less than 25% developed	-	
Average Bathing Water Quality (chance of an ear infection)	*Reduced chance*	*Increased chance*	
Water Clarity (down to seabed)	Up to 10 meters	-	
Plastics (per 30 meters of beach)	Less than 5 pieces	-	
Contribution Fee (TT$)	TT$10.00	TT$25.00	
I would choose to visit	☐	☐	☐

TT$10.00 = US$1.40 = £0.90 **TT$25.00 = US$4.00 = £2.27**

DASH (-) represents that there is no program to control the levels of this factor at the beach

	BEACH C	BEACH D	NEITHER BEACH
Boats (near coastline)	-	Up to 7 boats	I Choose to Visit Neither Beach
Marine Protected Area (absence or presence)	-	YES, TO VISIT AND FISH	
Coastline Development (hotels and homes)	-	Up to 75% developed	
Average Bathing Water Quality (chance of an ear infection)	Increased chance	Reduced chance	
Water Clarity (down to seabed)	-	Up to 10 meters	
Plastics (per 30 meters of beach)	Less than 5 pieces	-	
Contribution Fee (TT$)	TT$25.00	TT$10.00	TT$0.00
I would choose to visit	☐	☐	☐

TT$10.00 = US$1.40 = £0.90 **TT$25.00 = US$4.00 = £2.27**

DASH (-) represents that there is no program to control the levels of this factor at the beach

	BEACH E	BEACH F	NEITHER BEACH
Boats (near coastline)	2 or less boats	-	I Choose to Visit Neither Beach
Marine Protected Area (absence or presence)	YES, TO VISIT ONLY, NO FISHING.	-	
Coastline Development (hotels and homes)	-	Up to 75% developed	
Average Bathing Water Quality (chance of an ear infection)	-	Increased chance	
Water Clarity (down to seabed)	-	Up to 10 meters	
Plastics (per 30 meters of beach)	Up to 15 pieces	Less than 5 pieces	
Contribution Fee (TT$)	TT$25.00	TT$10.00	TT$0.00
I would choose to visit	☐	☐	☐

TT$10.00 = US$1.40 = £0.90 **TT$25.00 = US$4.00 = £2.27**

DASH (-) represents that there is no program to control the levels of this factor at the beach

	BEACH G	BEACH H	NEITHER BEACH
Boats (near coastline)	2 or less boats	-	I Choose to Visit Neither Beach
Marine Protected Area (absence or presence)	YES, TO VISIT AND FISH	YES, TO VISIT ONLY, NO FISHING.	
Coastline Development (hotels and homes)	Up to 75% developed	Less than 25% developed	
Average Bathing Water Quality (chance of an ear infection)	-	Increased chance	
Water Clarity (down to seabed)	-	Up to 10 meters	
Plastics (per 30 meters of beach)	Less than 5 pieces	-	
Contribution Fee (TT$)	TT$25.00	TT$10.00	TT$0.00
I would choose to visit	☐	☐	☐

TT$10.00 = US$1.40 = £0.90 **TT$25.00 = US$4.00 = £2.27**

DASH (-) represents that there is no program to control the levels of this factor at the beach

	BEACH I	BEACH J	NEITHER BEACH
Boats (near coastline)	2 or less boats	-	I Choose to Visit Neither Beach
Marine Protected Area (absence or presence)	YES, TO VISIT ONLY, NO FISHING.	-	
Coastline Development (hotels and homes)	Less than 25% developed	-	
Average Bathing Water Quality (chance of an ear infection)	Increased chance	Reduced chance	
Water Clarity (down to seabed)	5 meters or less	-	
Plastics (per 30 meters of beach)	-	Up to 15 pieces	
Contribution Fee (TT$)	TT$25.00	TT$10.00	TT$0.00
I would choose to visit	☐	☐	☐

TT$10.00 = US$1.40 = £0.90 **TT$25.00 = US$4.00 = £2.27**

DASH (-) represents that there is no program to control the levels of this factor at the beach

	BEACH K	BEACH L	NEITHER BEACH
Boats (near coastline)	2 or less boats	-	I Choose to Visit Neither Beach
Marine Protected Area (absence or presence)	-	YES, TO VISIT AND FISH	
Coastline Development (hotels and homes)	Less than 25% developed	-	
Average Bathing Water Quality (chance of an ear infection)	Increased chance	Reduced chance	
Water Clarity (down to seabed)	Up to 10 meters	5 meters or less	
Plastics (per 30 meters of beach)	Less than 5 pieces	-	
Contribution Fee (TT$)	TT$25.00	TT$10.00	TT$0.00
I would choose to visit	☐	☐	☐

TT$10.00 = US$1.40 = £0.90 **TT$25.00 = US$4.00 = £2.27**

DASH (-) represents that there is no program to control the levels of this factor at the beach

	BEACH M	BEACH N	NEITHER BEACH
Boats (near coastline)	Up to 7 boats	2 or less boats	I Choose to Visit Neither Beach
Marine Protected Area (absence or presence)	-	YES, TO VISIT AND FISH	
Coastline Development (hotels and homes)	Less than 25% developed	-	
Average Bathing Water Quality (chance of an ear infection)	Reduced chance	-	
Water Clarity (down to seabed)	-	Up to 10 meters	
Plastics (per 30 meters of beach)	Up to 15 pieces	Less than 5 pieces	
Contribution Fee (TT$)	TT$25.00	TT$10.00	TT$0.00
I would choose to visit	☐	☐	☐

TT$10.00 = US$1.40 = £0.90 **TT$25.00 = US$4.00 = £2.27**

DASH (-) represents that there is no program to control the levels of this factor at the beach

	BEACH O	BEACH P	NEITHER BEACH
Boats (near coastline)	-	Up to 7 boats	I Choose to Visit Neither Beach
Marine Protected Area (absence or presence)	-	YES, TO VISIT AND FISH	
Coastline Development (hotels and homes)	Up to 75% developed	Less than 25% developed	
Average Bathing Water Quality (chance of an ear infection)	-	Increased chance	
Water Clarity (down to seabed)	Up to 10 meters	5 meters or less	
Plastics (per 30 meters of beach)	-	Up to 15 pieces	
Contribution Fee (TT$)	TT$25.00	TT$10.00	TT$0.00
I would choose to visit	☐	☐	☐

TT$10.00 = US$1.40 = £0.90 **TT$25.00 = US$4.00 = £2.27**

DASH (-) represents that there is no program to control the levels of this factor at the beach

	BEACH Q	BEACH R	NEITHER BEACH
Boats (near coastline)	2 or less boats	-	I Choose to Visit Neither Beach
Marine Protected Area (absence or presence)	-	YES, TO VISIT AND FISH	
Coastline Development (hotels and homes)	Up to 75% developed	Less than 25% developed	
Average Bathing Water Quality (chance of an ear infection)	Reduced chance	-	
Water Clarity (down to seabed)	5 meters or less	-	
Plastics (per 30 meters of beach)	Up to 15 pieces	Less than 5 pieces	
Contribution Fee (TT$)	TT$25.00	TT$10.00	TT$0.00
I would choose to visit	☐	☐	☐

TT$10.00 = US$1.40 = £0.90 **TT$25.00 = US$4.00 = £2.27**

DASH (-) represents that there is no program to control the levels of this factor at the beach

	BEACH S	BEACH T	NEITHER BEACH
Boats (near coastline)	-	Up to 7 boats	I Choose to Visit Neither Beach
Marine Protected Area (absence or presence)	YES, TO VISIT AND FISH	YES, TO VISIT ONLY, NO FISHING.	
Coastline Development (hotels and homes)	-	Up to 75% developed	
Average Bathing Water Quality (chance of an ear infection)	Increased chance	Reduced chance	
Water Clarity (down to seabed)	5 meters or less	-	
Plastics (per 30 meters of beach)	Up to 15 pieces	Less than 5 pieces	
Contribution Fee (TT$)	TT$25.00	TT$10.00	TT$0.00
I would choose to visit	☐	☐	☐

TT$10.00 = US$1.40 = £0.90 **TT$25.00 = US$4.00 = £2.27**

DASH (-) represents that there is no program to control the levels of this factor at the beach

	BEACH U	BEACH V	NEITHER BEACH
Boats (near coastline)	Up to 7 boats	-	I Choose to Visit Neither Beach
Marine Protected Area (absence or presence)	YES, TO VISIT AND FISH	-	
Coastline Development (hotels and homes)	Up to 75% developed	-	
Average Bathing Water Quality (chance of an ear infection)	Reduced chance	Increased chance	
Water Clarity (down to seabed)	Up to 10 meters	-	
Plastics (per 30 meters of beach)	-	Less than 5 pieces	
Contribution Fee (TT$)	TT$10.00	TT$25.00	
I would choose to visit	☐	☐	☐

TT$10.00 = US$1.40 = £0.90 **TT$25.00 = US$4.00 = £2.27**

Appendix C

Questionnaire for respondent-selected treatment and sample choice set material including (1) experimental design transfer sheets and (2) answer sheets

Stated Preference Survey for Coastal Water Quality in Tobago

Environment Department
University of York
Heslington
United Kingdom

MAIN SURVEY

SAMPLE-SELECTED

QUESTIONNAIRE NUMBER_________

DATE: [|] / [|] / [|]

INTERVIEW START TIME (24 HOUR CLOCK): [|] : [|]

INTERVIEW FINISH TIME (24 HOUR CLOCK): [|] : [|]

TOTAL TIME TAKEN: __________**minutes**

SAMPLING POINT...

TYPE OF INTERVIEW ....

Hello, my name is Nesha Beharry and I am a student from the University of York, carrying out research on the beaches of Tobago. You have been selected because I am asking persons in the airport after they have completed their vacation in Tobago and may be waiting for their departure flight.

This questionnaire will take approximately forty minutes and I am sure you will find it very interesting. The answers will be used to make improvements to the beaches in Tobago.

Do you agree to conduct this interview?
If yes, thank and proceed.
If no, thank and withdraw

A. INTRODUCTION

A1. Do you live in Tobago?

1	Yes	If Yes, Ask A6
2	No	If No, Ask A2

A2. When did you arrive in Tobago?

☐☐ / ☐☐ / ☐☐

A3. When do you plan to leave?

☐☐ / ☐☐ / ☐☐

A4. Is this your first trip to Tobago? [CIRCLE ONE ANSWER]

1	Yes	If Yes, Ask A6
2	No	If No, Ask A5

A5. When were your previous visits and how long did you stay during those visits? [RECORD DATE(s) VISITED AND DURATION OF STAY]

....

....

....

[GO TO → → A6]

A6. [SHOW RESPONDENT PROMPT CARD ONE – *MAP OF BEACHES*] On your most recent visit to Tobago have you visited any of the beaches shown in the map for leisure or doing some outdoor sport activity?

1	**Yes**	**If Yes, Ask A10**
2	**No**	**If No, Ask A7**

A7. **[SHOW RESPONDENT PROMPT CARD ONE – *MAP OF BEACHES*] In the past twelve months have you visited any of the beaches in Tobago shown in the map for leisure or doing some outdoor sport activity?**

1	**Yes**	**If Yes, Ask A9**
2	**No**	**If No, Ask A8**

A8. Have you visited ever any of the beaches in Tobago?

1	**Yes**	**If Yes, Ask A9**
2	**No**	**If No, Ask A13**

A9. Can you tell me when was your most recent visit to a beach in Tobago? [SHOW RESPONDENT PROMPT CARD ONE]

1	**In the past twenty four months (two years)**
2	**Last 36 months (three years)**
3	**Last 48 months (four years)**
4	**Last five years**
5.	**Greater than five years.**
6.	**Other, Please specify**

A10. [SHOW RESPONDENT PROMPT CARD TWO AND THREE - *MODE OF TRANSPORTATION*] Looking at the cards can you indicate which beaches you visited, how many times and what mode of transportation you used to visit each beach?

For example, if you visited Pigeon Point five times on your last visit, you may have done so twice by walking and three times by rented car.

Name of Beach		Number of Times and Mode of Transportation									
		OC	FC	RC	W	B	M	T	BT	O	Total
1	Store Beach										
2	Milford Beach										
3	Pigeon Point										
4	Sheerbird's Point/										
5	Buccoo Beach										
6	Grange Beach										
7	Mt. Irvine Beach										
8	Back Beach										
9	Stonehaven Beach/										
10	Turtle Beach/Great Courland Bay										
11	Arnos Vale Beach										
12	Cullodden Beach										
13	King Peter 's Beach										

Name of Beach		Number of Times and Mode of Transportation									
		OC	FC	RC	W	B	M	T	BT	O	Total
14.	Cotton Beach										
15.	Castara Beach										
16.	Englishman's Bay										
17.	Parlatuvier Beach										
18	Bloody Beach										
19	Hermitage Beach										
20	Cambleton Beach										
21	Pirate's Bay										
22	Starwood Beach										
23	Bateaux Beach/Speyside Beach										
24	Tyrrels's Beach										
25	Lucy Vale Beach										
26	King's Beach										
27	Queen's Beach										
28	Prince's Beach										
29	Carapuse Beach										

Name of Beach		Number of Times and Mode of Transportation									
		OC	FC	RC	W	B	M	T	BT	O	Total
30.	Goldsbrough Beach										
31.	Pinfold Beach/Fort Granby										
32.	Barbados Beach										
33.	Hillsbrough Beach										
34.	Minster Bay/Big Bacolet Beach										
35	Bacolet Beach										
36	Rockly Beach										
37	Little Rockly Beach										
38	Petit Trou Beach										
39	Canoe Beach										
40	Kilgwyn Beach										
41	Sandy Point Beach										
42	Coconut Bay (CoCo)										
43	Other										

A11. [SHOW RESPONDENT PROMPT CARD FOUR – FREQUENCY SCALE] On your visits to the beach, can you please say if you participated in the following activities and if so, how frequently?

Ring Start	Activity	Always	Very Often	Fairly Often	Sometimes	Almost Never	Never
1.	Swimming or 'Bathing'	1	2	3	4	5	6
2.	Relaxing on Beach(lying or sitting on beach)	1	2	3	4	5	6
3.	Beachcombing	1	2	3	4	5	6
4.	Observing Nature on Beach (e.g. Turtle watching)	1	2	3	4	5	6
5.	Sunbathing	1	2	3	4	5	6
6.	Walking	1	2	3	4	5	6
7.	Picnicking or 'eating'.	1	2	3	4	5	6
8.	Snorkelling	1	2	3	4	5	6
9.	Diving	1	2	3	4	5	6
10.	Playing games	1	2	3	4	5	6
11.	Fishing	1	2	3	4	5	6
12.	Surfing	1	2	3	4	5	6
13.	Windsurfing	1	2	3	4	5	6
14.	Boating (Catamarans, power boats)	1	2	3	4	5	6
15.	Water skiing	1	2	3	4	5	6
16.	Jet skiing	1	2	3	4	5	6
17.	Sailing	1	2	3	4	5	6

A12. Is there another activity, you do at the beach?

1	Yes	If Yes, Ask A12
2	No	If No, Ask A13

A13. Can you say what activity you do and how often do you participate in this activity?

	Activity	Always	Very Often	Fairly Often	Sometimes	Almost Never	Never
1.		1	2	3	4	5	6

[GO TO→ → A14]

A14. Many factors can influence your decision to visit a beach in Tobago. I would like you to imagine that, you planned a trip to the beach on a particular day. [SHOW RESPONDENT PROMPT CARD FOUR – *List of Factors*]

a. **Would you now look at this card and tell me which one factor on this list, would be *most important* to you in making your decision to visit a beach in Tobago? [CIRCLE ONE CODE IN COLUMN A]**
b. **Which factor comes next? [CIRCLE ONE CODE in COLUMN B]**
c. **Which is the third most important factor? [CIRCLE ONE CODE in COLUMN C]**
d. **Which is the fourth most important factor? [CIRCLE ONE CODE in COLUMN D]**

	A Most	B Next	C Third	D Fourth
(1) Provision of Amenities (jetty, water sports options)	1	2	3	4
(2) Presence of Facilities (clean toilets, showers, changing rooms, food outlets)	1	2	3	4
(3) Water Quality (vertical visibility, risk of bathing in polluted water)	1	2	3	4
(4) Convenience of Location (access, parking)	1	2	3	4

A15. Are there any other factors that you can think of, would influence your decision to visit the beach?

...

[If Yes, please specify. If No, GO TO → → A16]

A16. [SHOW RESPONDENT PROMPT CARD FIVE- *SEMANTIC SCALE*]. As part of this research we are interested in what you think about certain aspects of the coastal zone, in particular the beaches and its environs. [READ EACH STATEMENT ALOUD, SHOWING PROMPT CARDS 6-11 AND RECORD RESPONSE]

	Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
(a) The quality of the water around the coast is affected by activities on the land	1	2	3	4	5
(b) Tourism is important for the economy of Tobago and to maintain a higher coastal water quality non national visitors should make a monetary contribution	1	2	3	4	5
(c) To maintain a higher coastal water quality nationals and residents should make a monetary contribution	1	2	3	4	5
(d) To maintain a higher coastal water quality nationals, residents and non nationals should make a monetary contribution	1	2	3	4	5
(e) The government is fully responsible for the maintenance of coastal water quality and the state of the beaches in Tobago	1	2	3	4	5
(f) Everyone can benefit from better coastal water quality and we should do our part to keep it clean	1	2	3	4	5

[STATEMENT F. TO BE READ INTERCHANGEABLY BEFORE A AND AFTER

B. VALUATION SECTION

B1. Now as part of this research **I would like to know what factors are important to you when visiting a beach to engage in any of the activities you usually do and what you would like to see improved.**

But, I would like to focus on **factors relating to the water *versus* non water related factors** such as parking facilities or availability of food to buy on the beach. The water related factors are as follows.

In order to achieve higher coastal water standards and to ensure that we have *better beaches*, this requires financial support. This financial support could be given to non profit beach organization and some of the improvements or policies that could be made are:

1. **Ensuring that there is a properly working sewage treatment plant.**
2. **Setting in place planning guidelines for hotels and residents to reduce the amount of runoff onto the coastal waters.**
3. **Making sure that there is no plastic debris on beaches.**
4. **Creation of more marine protected zones around the beaches.**
5. **Introducing restrictions on boat operators.**

I am going to show you these water related factors, with three levels of policy or programs development. The first level is a no policy option, Policy Option High and Policy Option Low. [EXPLAIN USING PROP ONE]

B2. Can you tell me which of these factors would *not be as* important to you when you visit the beach to do your usual leisure or outdoor activities in which you engage in. You can choose any number of factors from just one to all six.

[RECORD NON IMPORTANT FACTORS]

1 ____________________

2 ____________________

3 ____________________

4 ____________________

5 ____________________

6 ____________________

B3. [RECORD REMAINING FACTORS], RANK DEPENDING ON NUMBER.

1 ____________________

2 ____________________

3 ____________________

4 ____________________

5 ____________________

6 ____________________

I would now like to you to think of having to decide to visit one of the number of beaches in Tobago. [SHOW WORKED EXAMPLE] [CONSTRUCT SETS]

Each beach can have three different levels of policy that allows for different levels of factors. If a factor is not important to you, then you may not mind choosing a beach that has no policy implemented for that factor Please consider all factors and price equally. Please consider whether the cost of the additional measures are worth it to your household.

B4. IF ALL FACTORS ARE IMPORTANT, THEN RANK THEM AND CHOOSE TOP 4

1 ---------------------------

2 ---------------------------

3 ---------------------------

4 ---------------------------

5 ---------------------------

6 ---------------------------

PERFORM CE, USING ANSWER SHEET

B5. [HAND PARTICIPANT INTERACTIVE BOARD WITH THE FACTORS THEY CHOSE, THESE WILL BE PLACED ON BOARD BY INTERVIEWER]

Looking at the factors, you considered when making your choices, can you indicate whether you considered all of factors equally?

1	Yes	If Yes, Ask B7
2	No	If No, Ask B6

C. FOLLOW UP QUESTIONS

C1.Which of these statements, if any, describe the main reason you are not willing to contribute for improvements to the current situation. [CIRCLE ONE ONLY]

I cannot afford to pay	**1**
These improvements are not important to me	**2**
The options are too expensive	**3**
The government should pay for these improvements	**4**
I do not believe the improvements would actually happen	**5**
I never use the beach.	**6**
I rarely use the beach	**7**
Some other reason (PROBE AND RECORD BELOW)	**8**

C2. [SHOW RESPONDENT PROMPT CARD TWENTY] Which of these statements if any, best describes you main reason for choosing your preferred beach scenarios?

I would like better beaches for myself and my family to enjoy.	**1**
I would like to improve the beach and coastal water quality for everyone to enjoy.	**2**
I would like to improve the beach and coastal water quality for future generations to enjoy.	**3**
I would like to improve the beach and coastal water quality to protect the marine wildlife	**4**
I would like to improve the appearance of the beaches	**5**
It is a good cause	**6**
None of the above	**7**

D. FINAL SECTION

D1. In what year were you born?

....

D2. What is the sex of the person?

1	**Male**
2	**Female**

D3. [SHOW RESPONDENT PROMPT CARD 21]Can you tell me how many people in your household are:

Below five years old	
Between 5 and 13 years old	
Between 14 and 18 years old	
Between 18 and 60 years old.	
Over 60 years old	

D4. [SHOW RESPONDENT PROMPT CARD 22]. At what level did <u>you complete your education</u>? If still studying: which level best describes the highest level of education you have obtained until now. Circle ONE Only.

Primary	**1**
O Levels/C.X.C/GCSE	**2**
A Levels / Advanced Vocational Training	**3**
Professional qualification of degree levels	**4**
College/University/undergraduate degree level	**5**
Post-graduate education (MSc, PhD, etc)	**6**
Other, please specify	**7**

D5. Can you tell me what is your present occupation?

....

D6. [SHOW RESPONDENT PROMPT CARD 23]. What is your current work status? Circle One Answer Only.

Self employed	1
Employed full time (30 hours plus per week)	2
Employed part time (under 30 hours per week)	3
Student	4
Housewife	5
Retired	6
Unemployed	7
Unable to work due to sickness or disability	8

D7. Can you tell me which country are you a national of ?..................................

[IF TRINIDAD AND TOBAGO, THEN GO TO → → D9, IF OTHER COUNTRY, GO TO → → D8]

D8. In which of the two islands are you currently living in, Trinidad or Tobago?

1	Trinidad	If Trinidad, Go To D27
2	Tobago	If Tobago, Go to D30

D9 In which country are you currently living in ?

....

D10. [SHOW RESPONDENT PROMPT CARD 24]. What would you describe as the main purpose of your visit to Tobago?

1.	Business or Work
2.	Vacation
3.	Visiting family and friends
4.	Wedding/Honeymoon
5.	Diving
6.	Ecotourism
4.	Other, please specify

D11. [SHOW RESPONDENT PROMPT CARD 25]. What best describes where you stayed while in Tobago?

1	Hotel
2	Guest House
3	Friends or Family House
4	Villa
5.	Other, Please specify

D12. Can you tell me which town was your place of accommodation? [HAND RESPONDENT PROMPTCARD 26]

....

....

....

D13. Can you tell me which town you live in? [IF RESPONDENT RESIDES IN TOBAGO]

....

....

....

D14. Are you a member of an environmental organization or group?

1	Yes	If Yes, Please Specify
2	No	If No, Go to D10

D15. Could you tell me which category best describes your total personal income before deduction of tax, each week, each month or each year. [SHOW RESPONDENT PROMPT CARD 27 or 28 DEPENDING ON NATIONALITY]

	Gross Income per year(TT$)	Gross income per month (TT$)
A.	Under 12 000	Up to 1000
B.	12 000 – 36 000	Up to 3000
C.	36 000 – 60 000	Up to 5000
D.	60 000 – 84 000	Up to 7000
E.	84 000 – 108 000	Up to 9000
F.	108 000 – 121 000	Up to 11 000
G.	121 000 – 156 000	Up to 13 000
H.	156 000 – 180 000	Up to 15 000
I.	180 000 – 204 000	Up to 17 000
J.	Over 204 000	Over 17 000

	Gross Income per year (US$)	Gross income per month (US$)
A.	Under 12 000	Up to 1000
B.	12 000 – 36 000	Up to 3000
C.	36 000 – 60 000	Up to 5000
D.	60 000 – 84 000	Up to 7000
E.	84 000 – 108 000	Up to 9000
F.	108 000 – 121 000	Up to 11 000
G.	121 000 – 156 000	Up to 13 000
H.	156 000 – 180 000	Up to 15 000
I.	180 000 – 204 000	Up to 17 000
J.	Over 204 000	Over 17 000

D33. What do you think of this questionnaire? [PLEASE CIRCLE ONE]

1	The questionnaire was interesting
2	Difficult to Understand
3	It took a long time to think about the answers
4	Educational/Informative
5	Unrealistic
6	Other, Please specify ....

TWO ATTRIBUTES

ONE	
-	1
1	Italic
25	10

TWO	
Italic	-
-	1
25	10

THREE	
-	1
Italic	-
25	10

FOUR	
1	Italic
Italic	-
25	10

TWO ATTRIBUTES

FIVE	
Italic	-
1	Italic
25	10

SIX m	
1	Italic
1	Italic
25	10

SEVEN	
1	Italic
-	1
25	10

THREE ATTRIBUTES

ONE	
Italic	-
Italic	-
-	1
10	25

TWO	
-	1
Italic	-
Italic	-
10	25

THREE	
Italic	-
1	Italic
Italic	-
10	25

THREE ATTRIBUTES

FOUR	
-	1
1	Italic
1	Italic
25	10

FIVE	
1	Italic
-	1
Italic	-
25	10

SIX	
1	Italic
1	Italic
-	1
25	10

THREE ATTRIBUTES

SEVEN	
1	Italic
Italic	-
1	Italic
25	10

EIGHT	
Italic	-
-	1
1	Italic
10	25

FOUR ATTRIBUTES

ONE	
-	1
1	Italic
Italic	-
-	1
10	30

TWO	
1	Italic
Italic	-
-	1
-	1
10	30

THREE	
Italic	-
-	1
1	Italic
-	1
10	30

FOUR ATTRIBUTES

FOUR	
1	Italic
1	Italic
1	Italic
1	Italic
10	30

FIVE	
Italic	-
1	Italic
-	1
Italic	-
10	30

SIX	
Italic	-
Italic	-
Italic	-
1	Italic
10	30

FOUR ATTRIBUTES

SEVEN	
-	1
Italic	-
1	Italic
Italic	-
10	30

EIGHT	
1	Italic
-	1
Italic	-
Italic	-
10	30

NINE	
-	1
-	1
-	1
1	Italic
10	30

CHOICE SHEET

	BEACH A	BEACH B	NEITHER BEACH
CARD 1	□	□	□
CARD 2	□	□	□
CARD 3	□	□	□
CARD 4	□	□	□
CARD 5	□	□	□
CARD 6	□	□	□
CARD 7	□	□	□
CARD 8	□	□	□
CARD 9	□	□	□
CARD 10	□	□	□
CARD 11	□	□	□

Please make only <u>one</u> tick ☑ for each card.

THANK YOU!

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