The Application of Choice Modelling Techniques to Guide the Management of Estuaries in South Africa – Case Studies at the Sundays, Kromme, Nahoon and Gonubie River Estuaries

Report to the
Water Research Commission

edited and compiled by

SG Hosking

based on contributions from

D Lee, G Chandler, M du Preez and JG Hosking
Department of Economics,
Nelson Mandela Metropolitan University

WRC Report No. 1924/1/12
ISBN 978-1 4312-0359-8

December 2012

OBTAINABLE FROM

Water Research Commission
Private Bag X03
Gezina 0031

orders@wrc.org.za or download from www.wrc.org.za

DISCLAIMER

This report has been reviewed by the Water Research Commission (WRC) and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the WRC, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

EXECUTIVE SUMMARY

There have developed two complementary schools of thought in South Africa on the management of its estuaries. One, motivated by the National Water Act of 1998, advocates Resource Directed Measures (RDM) and has its focus of attention on interventions to secure the minimum natural resource requirements for ecosystem functioning. The other, motivated by the pursuit of efficiency and welfare, advocates an economic approach to allocating and managing ecosystem goods and services. The latter views the generation of credible values for environmental goods as important guides to their social management.

WRC Project K5/1924 is a contribution to the economic school of thought on managing estuaries. It builds on and extends the research objectives of WRC Report 1413/1/10 and presumes an important management challenge of estuaries to be optimizing current social welfare values subject to constraints, for example, budget and other recreational options. While WRC Report 1413/1/10 estimated the economic value of river water inflows into South African estuaries for the purpose of guiding the management of these inflows toward efficient levels, the primary aim of WRC Project K5/1924 is to generate information that assists managers toward making efficient choices on matters identified to be of current demand interest. WRC Report 1413/1/10 had its focus of attention on a narrow range of estuary problems – undermined estuary habitats and recreational appeal due to reduced river water inflows. WRC Project K5/1924 makes the identification of the main problem areas part of the research brief. This goal was pursued by setting up focus groups of people and experts with interest and knowledge in selected estuaries and tasking them to identify and select strategies and investment/operational options on behalf of society – with the goal of improving the recreational appeal of these estuaries. The selected estuaries were the Sundays, Kromme, Nahoon and Gonubie River estuaries.

Having identified and defined strategies and investment/operational options for these estuaries:

- appropriate choice experiments were designed to guide on priorities in terms of recreational value,
- surveys were administered to elicit these choices,
- choice functions were estimated that explain choice in terms of the identified alternative strategies and investment/operational options, and
- estimates of these choice functions were used to calculate welfare changes related to different choices and conclusions are drawn.

The Project Report also makes recommendations on the merits of the choice modelling technique for addressing multi-faceted wetland management challenges in South Africa.

A secondary goal of WRC Project K5/1924 was to build up capacity in applying environmental valuation techniques. This objective was pursued by involving students in the application of the methods. Table 1 shows one Nelson Mandela Metropolitan University (NMMU) staff member, one Walter Sizulu University (WSU) staff member and one overseas staff member whose doctoral theses are based on their application of the relevant techniques developed during the course of the Project.

Table 1: Capacity building

Student Name	Employment	Degree (year awarded)	Title of thesis
Deborah Lee	Lecturer , NMMU, Port Elizabeth	PhD (2012)	An application of the choice experiment method to estimate willingness-to-pay for and guide management on estuarine recreational services
Geoff Chandler	Lecturer, WSU, East London	PhD (not yet submitted – health problems)	A market analysis of attributes of demand for the Nahoon and Gonubie estuaries
Radu Mihailescu	Lecturer, Stenden University, Port Alfred	PhD (not yet submitted)	The application of choice experiments to guide and optimise the tourism potential of selected South African estuaries

Of all the world’s ecosystems, estuaries have the highest total economic value per hectare. They are dynamic coastal biomes that provide a host of different goods and services to the surrounding terrestrial and aquatic environments and the people who utilize them. These goods and services include, *inter alia*, nursery areas for marine organisms, harvested natural resources (such as fish, shell-fish, bait organisms, reeds and mangroves), flood attenuation, water purification, nutrient and sediment sinks, waste disposal, transport, aesthetic beauty and areas for swimming, boating and fishing (see Chapter one).

Their service yield, however, has come under increasing demand pressure – not only for the services themselves but also with respect to the inputs that regulate the quality of the service yield. The demand pressure has forced more and more trade-offs to be made. Within the South African context, it has become clear that a number of the trade-offs associated with recreational demand require urgent policy and management guidance. One such trade-off is between the short-run and long-run (sustainable) human recreational predation demands for fish and bait in the estuary (both recreational and subsistence). Another is between demand for public spending on improvements in the recreational appeal of an estuary (say providing public access to the estuary and its various attractions) and demand for public spending on other services (like housing and health). Yet another is between the demand for access to an estuary area by the population of boat owners and the demand for this same area by other categories of users, like shore-based fishers and owners of other craft.

Four South African estuarine systems currently facing these type of recreational demand pressures and trade-offs are the Sundays, Kromme, Nahoon and Gonubie rivers. Over time, the lower reaches of all of these estuaries have been significantly developed for residential purposes, there has been increased sedimentation, and nursery habitats for fish have been undermined by reduced freshwater inflows (Chapters two and three). These developments, coupled with the popularity of the estuaries as fishing destinations, have resulted in sewage contamination, the over-exploitation of fish stocks and motorised boat congestion and external costs (from jet skis) during peak holiday seasons, but have not been equivalently compensated for by other investments, such as improved public access and facilities. As a result, the overall recreational appeal of these estuaries has been negatively affected.

One way of guiding management of the Sundays, Kromme, Nahoon and Gonubie estuaries for recreational purposes, is to compare the values users attach to the different recreational attributes of each estuary. The choice experiment (CE) approach has the potential to enable such a comparison because it allows for the estimation of the (trade-off) values of constituent parts of an estuary in a single application (Chapter four). These trade-off values reflect the relative importance people place on key parts of the composite recreational service provided by the estuary.

In order to determine and choose potential management strategies for the estuaries in question, focus group discussions were held. Estuary experts and users of the various estuaries made up these focus groups. Discussions by these groups revealed that a range of recreational use issues (attributes) were attracting current attention, including the physical size of the fish stocks, sedimentation and reduced navigable area, boat congestion, limited investment to support and open up recreational opportunity, safety of water for recreational use and security during recreation.

In light of the information supplied by the Sundays River Estuary focus group, the following management options were investigated – increasing the existing license fee structure in order to decrease fishing level efforts, the imposition of a supplementary tariff during times of peak demand (the price rationing instrument) to discourage congestion, and improving public access at the Sundays River Estuary through the development of a nature trail along the banks of the estuary.

In light of the information supplied by the Kromme River Estuary focus group, the following two management options were incorporated in the CE design for improving navigability in the estuary – increasing freshwater inflows and dredging. Also incorporated into the CE were alternative management arrangements for the use of jet skis and wet bikes on the Kromme River Estuary.

In light of the information supplied by the Nahoon River Estuary focus groups, management options were incorporated into the CE design relating to improving the health safety of the water, increasing protection from crime during recreation and increasing the provision of support services for recreational activity.

In light of the information supplied by the Gonubie River Estuary focus group, the following management options were investigated – improved quality of water, more restrictive control of development along the banks of the Gonubie River and increased protection from crime during recreation.

The Lee (2011) reference is used to denote information collected during the focus group discussions and the surveys at the Sundays and Kromme River estuaries with respect to these management options and the Chandler (2011) reference is used to denote material collected during the focus group discussions and during the surveys at the Nahoon and Gonubie River estuaries with respect to these options.

For all the above-mentioned options (specific to each estuary) marginal willingness-to-pay (WTP) values were calculated by applying the CE method[1]. The calculation is made from estimates of choice models. Three different choice model specifications were estimated for these estuaries: a conditional logit (CL) model, a heteroskedastic extreme value (HEV) model and a random parameters logit (RPL) model.

In the case of the Sundays River Estuary, the results from the RPL, HEV and CL models revealed that recreational users were willing to pay more for an estuary management strategy:

- the higher the physical size of the fish stock,
- the lower the amount of boat congestion, and
- the higher the amount of public access available.

Allowing preferences for recreational attributes to vary across respondents, through the application of the RPL model, showed that there was very little unexplained heterogeneity in respondent preferences. The implicit prices indicated that respondents valued most highly increased 'physical size of fish stock'. The differences in WTP among the three models were small.

[1] The application of the CE method to value natural resources, more specifically, estuarine attributes in South Africa, is not a new development. There are examples of applying the CE method to value estuarine attributes, for example Oliver (2010), but they have design and estimation limitations.

In the case of the Kromme River Estuary, the results from the RPL, HEV and CL models revealed that recreational users were willing to pay more for an estuary management strategy:

- the higher the level of navigability,
- the lower the amount of boat congestion, and
- the lower the amount of jet ski and wet bike access.

The RPL model indicated the presence of unobserved heterogeneity, but failed to explain the sources of the heterogeneity. In this case, complete reliance was placed on the fixed mean and standard deviation of the parameter estimates. The latter represented all sources of preference heterogeneity around the mean. The implicit prices indicated that respondents valued most highly improved 'navigability'. The differences in the WTP estimates among the four models were small, except for the WTP figures in the second RPL model.

In the case of the Nahoon and Gonubie River estuaries, the results from the RPL, HEV and CL models revealed that recreational users were willing to pay additional rates for improved water safety, protection from criminal activity and support services, but tests for multi-collinearity were positive, indicating the possibility that orthogonality of experimental design was compromised. For this reason, no conclusions for management intervention were drawn on the basis of these results, and demonstration of the application of the method to guide management interventions was restricted to the examples of the Sundays and Kromme River estuaries.

The results of the Sunday and Kromme River estuaries CEs, in particular, show how a profile of an estuary's recreational attributes can be valued through a single application of the CE method. The crux question with respect to drawing conclusions from this Report is whether these values can be used to address the recreational demand challenges facing this estuary?

We believe the answer to be **yes** – provided there is proper enforcement of the regulations.[2] To illustrate: the high levels of fishing effort at the Sundays River Estuary can potentially be controlled through an increase in the boat license fee. The choice analysis indicates a WTP in order to bring about improved fish stocks of an extra R150 per user per annum, taking the license fee up from R94 per annum in 2010 to R244 per annum. In order to meet demand to reduce boat congestion and increased public access further additional increases in the boat license fee above R244 per annum were indicated.

---

[2] Many current problems at estuaries are being aggravated by failures to enforce existing regulations. Changes to regulations and charges for licenses will have less than the desired effect under these circumstances because compliance with the regulation is a precondition for success.

Using the results of the CE, policy makers can develop specific management 'packages' that include all the attributes' preferred management options. When the marginal WTP values are added together, the overall additional levies recommended for each estuary are:

- R183 per annum for boat users of the Sundays River Estuary, taking the relevant boat license fee up from R94 to R277 (2010 price levels).
- R739 per annum for boat users of the Kromme River Estuary, taking the relevant boat license fee up from R169 to R908 (2010 price levels).

The particular management advice generated and reported above for the Sundays and Kromme River estuaries cannot be extrapolated to all other estuaries because the situations of each estuary differ. However, equivalent advice can readily be generated for other estuaries by applying similar CEs there, and this research team would argue the advice so generated is at least as constructive to managing the problem of increased demand for recreational services on South African estuaries as the advice being generated exclusively within the RDM inspired research framework.

Notwithstanding its virtues, the CE method is not a generally preferred valuation method. Where revealed preference valuation is possible, there are many advantages in selecting it over the CE method, *inter alia,* because strategic behaviour is less likely as a source of error. Similarly, the application of other stated preference methods, like the contingent valuation method (CVM), remain an attractive option when a particular (specific) environmental change is being valued, even though this method is also vulnerable to the distorting effects of strategic behaviour.

Keywords:
Estuary, demand management, recreational attributes, stated preference, random utility model, choice experiment, willingness-to-pay, conditional logit model, heterogeneity.

ACKNOWLEDGEMENTS

The guidance of the reference group and funding of the WRC are gratefully acknowledged, as are all the users of estuaries who kindly contributed through their willingness to respond to the questions put to them by the members of this research project team. The reference group responsible for this project was made up of the following members:

Dr GR Backeberg	Water Research Commission (Chairman)
Prof A Leiman	School of Economics, University of Cape Town
Mr A Matoti	Department of Environmental Affairs
Dr JK Turpie	Department of Zoology, University of Cape Town
Prof M Du Preez	Department of Economics, Nelson Mandela Metropolitan University
Prof JD Snowball	Department of Economics, Rhodes University
Prof GCG Fraser	Department of Economics, Rhodes University

In particular, the support of Dr Backeberg is acknowledged. In addition, valuable advice on the relevant estuaries was kindly and generously provided by Prof Tristan Wooldridge, Prof Janine Adams and Prof Paul Cowley.

Many people contributed to the collection and capture of the data – students, friends, family (especially Catherine Hosking), Judy Clarence and Bridget Zietkiewicz. The data on which the results, generated in this study, are based, are stored at the Department of Economics, Nelson Mandela Metropolitan University, and may be accessed through Prof Stephen Hosking.

The following students participated and are in the process of contributing doctoral theses on the topic: Deborah Lee, Geoff Chandler and Radu Mihailescu (see Appendix G).

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER ONE: A DEMAND CENTERED APPROACH TO MANAGING SOUTH AFRICA'S ESTUARIES

1.1 DEMAND MANAGEMENT AT SOUTH AFRICA'S ESTUARIES

Along South Africa's approximate 3 000 kilometre (km) coastline, stretching from the Orange River Mouth to Kosi Bay, there lie a number[3] of estuaries, most of which (excepting St Lucia) are fairly small. In total, the area covered by all of South Africa's estuaries is less than 600 km^2 (Baird, 2002). The biggest, St Lucia, with a water surface area of 300 km^2, accounts for 60 percent of the total area covered by estuaries in South Africa.

Small though this total area is, it constitutes a substantial natural resource recreational capital asset. The value of this capital is under threat. Many estuaries, including St Lucia, have been subject to sustained damaging human challenges to their (normal) functionality. These challenges have taken many forms, including bank and floodplain resettlement, rechanneling, resource harvesting and high recreation use (Day, 1980; Forbes, 1998; Turpie & Clarke, 2007; Hay, Hosking & McKenzie, 2008; Hosking, 2008).[4]

By the early 1970's only a small number of South African estuaries remained in their approximately 'natural' state (Heydorn, 1972) and it had become clear to the scientific community that something urgent needed to be done to 'protect' the estuaries. The result was a major research initiative aimed at assessing the condition of these estuaries (Turpie, 2004). These assessments were in terms of various elements, from ichthyofaunal diversity, water quality to aesthetics perspectives (Coetzee, Adams & Bate, 1997; Harrison, Cooper & Ramm, 2000; Colloty, 2000; Harrison & Whitfield, 2006). They were typically from a conservation significance perspective (Turpie, Adams, Joubert, Harrison, Colloty, Maree, Whitfield, Wooldridge, Lamberth, Taljaard & Van Niekerk, 2002; Turpie & Clarke, 2007; Department of Water Affairs (DWA), 2010). A key policy aim of this research initiative was providing guidance on the minimum water supply for an estuary (ecological reserve) required for it to maintain or improve ecological functionality.

[3] Hattingh, Whitfield, Van Driel, Archibald, Hay, Bate & Schumann (2002), argue that there are only 289 functional estuaries of a total of 465 (Baird, 2002). By way of comparison, the Delaware estuary on the USA Atlantic Coast on its own covers an area of 18 000 km^2 (30 times more). In total, estuaries in the USA cover an area of 107 722 km^2 along a 10 000 km coastline (Baird, 2002).

[4] The South African case has been part of a global trend. There has been a drastic and accelerated decline in the condition of the world's estuaries and coastal seas, most notably during the past 150 to 300 years (Lotze, Lenihan, Bourque, Bradbury, Cooke, Kay, Kidwell, Kirby, Peterson & Jackson, 2006).

The ecological reserve requirements of an estuary were assigned through the use of Resource Directed Measures (RDM); an approach that yielded many useful insights into the nature of the challenges to the functionality of South African estuaries. The strength of the RDM approach is its guidance on feasible targets of conservation effort.

However, it also was argued to be a complex and time consuming way of approaching the problem of estuary degradation (DWA, 2010) and left many gaps in guiding estuary management. Arguably, its greatest deficiency was that it provided little guidance on how to manage challenges to estuaries that have their roots in excess or competing demand (Hay *et al.* 2008; Hosking, 2011). For instance, the RDM approach has been thin on providing policy and management guidance on trade-offs such as:

- between short-run and long-run human recreational predation demand for fish, bait and mangroves in the estuary (both recreational and subsistence), also known as sustainability,
- between demand for abstraction of river inflows into estuaries and the human demand to maintain ecologically functional estuary habitats for bait, fish, birds and mangroves,
- between the demand for access to the estuary space among the population of boat owners and also the demand for use of the estuary space by other categories of users (shore based fishers, residents and owners of other craft),
- between demand for public spending on service provision enhancement of the recreational appeal of the estuary (providing public (open) access to estuary and its attractions, changing and ablution facilities and safety in and out of the water) and demand for public spending on other services (housing, health, roads and so on),
- between the demand by residents for exclusive access rights to the estuary and its banks and the demand by visitors for open access, and
- between the demand to dump human effluent and other chemicals into water that ends up in the area defined to make up the estuary and demand to use the estuary for recreation (Hosking, 2011).

This Report will argue that the way to overcome this deficiency is to manage the estuary assets as welfare generating ones; and generate guidance on how to best maximise the welfare or recreational value of the estuaries. Recreational value is generated through the satisfaction of demand for estuary services – by people making use of the water space (for boating, swimming and viewing) and exploiting of the many resources found in the estuary water.

The idea that estuary services generate value is widely accepted, even in South Africa. For the year 2001, estuarine (recreational) fisheries were estimated to contribute approximately R1.162 billion in value (Lamberth & Turpie, 2003). Additional resource values have been estimated from resources such as mangroves. The building material value of the mangroves was estimated for the year 2007 to be about R3.4 million for the Mngazana River Estuary alone (Hay *et al.* 2008). Globally, the significance of value in guiding conservation management is also widely acknowledged. Costanza, d'Arge, de Groot, Farber, Grasso, Hannon, Limburg, Naeem, O'Neill, Paruelo, Raskin, Sutton and van den Belt (1997) found that natural coastal environments, particularly those in estuarine systems, were among the most valuable on earth – they valued 17 ecosystem services for 16 biomes (Costanza *et al.* 1997).

With over-exploitation and abuse these values may decline. How should estuaries be managed in order to maximize the (recreational) value they generate? What is the optimum per annum yield over time and how can this optimum be sustained with informed management? These are some of the key demand challenges that face South African estuary managers.

How may advice and information on optimizing recreational values be generated? This Report proposes it be done through a marginal recreational value analysis of key attributes underlying the demand trade-offs at the estuaries. More specifically, it advocates management of the demand problems through the setting of use-pricing (license fees, etc.), where these prices are seen as instruments or control variables in an optimization management problem.

The Report will demonstrate how this may be accomplished through four case studies. In each case marginal values are calculated of key demand challenges through the choice experiment (CE) research technique. This technique is used to generate knowledge of specific willingnesses-to-pay for improvements to problems associated with conflicting and competing recreational demand at these four estuaries. This knowledge, in turn, will be used to generate guidance on the direction and scale of changes to demand regulating price instruments required in order to optimize recreational value.

The remainder of this Chapter describes the types of estuaries found in South Africa, the nature of the challenges facing them, existing policy available to manage these challenges and the scope for supplementation of this policy through demand management and analyses that generate information that can help estuary management aimed at maximizing recreational value.

1.2 THE SCIENTIFIC AND ECONOMIC CLASSIFICATION OF AN ESTUARY SERVICE

1.2.1 SCIENTIFIC CLASSIFICATION

During the 1960s, estuaries were thought of as “a semi-enclosed coastal body of water, which has a free connection with the open sea, and within which seawater is measurably diluted with fresh water derived from land drainage” (Pritchard, 1967). By the end of the Century, thinking had changed a bit – the requirement for a connection with the sea was relaxed, and included in the definition of estuaries were coastal bodies of water that were often not connected with the sea. The National Water Act of 1998 (NWA) defines an estuary as “a partially or fully enclosed body of water: (a) which is open to the sea permanently or periodically; and (b) within which the sea water can be diluted, to an extent that is measurable, with freshwater drained from inland”.

The scientific classification of estuaries is in terms of physiographic, hydrographic and salinity characteristics (Whitfield, 1992). The physiographic characteristic refers to the size of the tidal prism. The hydrographic characteristic refers to the fresh- and seawater mixing process. The salinity characteristic refers to mean salinity. The five types are described in Table 1.1 and the text below it.

Table 1.1: Types of estuaries based on Whitfield’s (1992) classification

Type	Tidal Prism	Mixing Process	Mean Salinity[1]
Estuarine Bay	Large (>10 x 10^6 m^3)	Tidal	20-35
Permanently Open	Moderate (1-10 x 10^6 m^3)	Tidal/Riverine	10- >35
River Mouth	Small (<1 x 10^6 m^3)	Riverine	<10
Estuarine Lake	Negligible (<0.1 x 10^6 m^3)	Wind	1- >35
Temporarily Open	Absent	Wind	1- >35

(1) Total amount of dissolved solids in water in parts per thousand by weight (seawater = ~35).

The majority of South African estuaries (70 percent) are temporarily closed for some period (Breen & McKenzie, 2001). The closure of estuaries is caused by numerous factors: climate changes, upstream water abstraction and urban development are contributing factors (Allanson & Baird, 1999; Hosking, Wooldridge, Dimopoulos, Mlangeni, Lin, Sale & Du Preez, 2004).

Estuarine bays have a large tidal prism with strong tidal exchange. As a result, these estuaries have continuously open mouths. High salinity levels are found in their lower reaches and, in the event of low freshwater inflows, near-marine conditions can extend into their upper reaches (Allanson & Baird, 1999; Breen & McKenzie, 2001; Hosking *et al.* 2004). The replacement of seawater in the lower and middle reaches takes place on a regular basis. The influence of the sea dominates that of the river as far as estuarine bay water temperatures are concerned. The primary mixing process is tidal. Estuarine bays are dominated by marine and estuarine organisms (Whitfield, 1992). Examples of these types of estuaries include Richards Bay, Durban Bay and Knysna (Breen & McKenzie, 2001). Figure 1.1 shows the Knysna Estuarine Bay.

Figure 1.1: The Knysna Estuarine Bay (CMS13)
Source: Whitfield, Bate, Colloty & Taylor (2011)

In most cases permanently open estuaries are relatively large systems with perennial rivers flowing into them and/or strong tidal exchanges with the sea (Allanson & Baird, 1999; Breen & McKenzie, 2001). During times of low river inflow conditions, the tidal exchange keeps the mouth open. Salinity values normally vary between 5 and 35 parts per 1000, but hyper saline conditions (> 35) occur during periods of high evaporation and low or no river inflow. A large number of these estuaries have catchment areas that exceed 500 km^2 and some exceed 1000 km^2. Wetlands often exist in these estuaries and are vegetated with salt marshes in more temperate areas and mangroves in tropical areas. Eelgrass (*Zostera capensis*) may be present sub-tidally, especially in the middle to lower reaches of these estuaries. Examples of these types of estuaries include the Breede, Mlalazi and Swartkops (Breen & McKenzie, 2001). Figure 1.2 shows the Swartkops Permanently Open Estuary.

Figure 1.2: The Swartkops Permanently Open Estuary (CSE3)
Source: Whitfield et al. (2011)

A river mouth exists for all rivers flowing into the ocean (Allanson & Baird, 1999; Breen & McKenzie, 2001), but an estuary classified as a river mouth displays additional characteristics to the mere presence of a mouth. River mouth estuaries are permanently open to the ocean, and typically have small tidal prisms (Whitfield, 1992). The physical processes that take place in these estuaries are dominated by river processes, and as a result, salinity values approach oligohaline (salinity < 5 parts per 1000) (Hosking *et al*. 2004). Seawater intrusion into the upper reaches of these estuaries is limited by river flow. Moreover, in some estuaries intrusion may even be limited to the lower reaches for most of the year (Breen & McKenzie, 2001). During strong flood conditions the sea salinity can be affected by the outflow being pushed offshore. The catchment areas of river mouth estuaries are normally large and the rivers usually transport a high silt load, and as a result, the mouths are normally shallow (< 2 m) (Hosking *et al*. 2004). The surface water temperatures in river mouth estuaries are strongly influenced by river inflow, whereas bottom water temperatures are influenced by the sea. Examples of these types of estuaries include the Orange, Mzimvubu and Thukela River Mouths (Breen & McKenzie, 2001). Figure 1.3 shows the Mzimvubu River Mouth Estuary.

Figure 1.3: The Mzimvubu River Mouth Estuary (TS63)
Source: Whitfield et al. (2011)

Estuarine lake systems are created by inundated river valleys that are filled in by modified sediments and are mostly detached from the ocean by vegetated sand dune systems. These systems are linked to the ocean via a channel of fluctuating width and length (Allanson & Baird, 1999; Breen & McKenzie, 2001). This link can be either permanently open or temporarily open. In some cases the dune system has completely isolated the lake resulting in its loss of estuarine characteristics. Highly variable salinity levels are found in these lakes due to the extent of freshwater inflows, the levels of evaporation and the relative size of the marine link (Breen & McKenzie, 2001). Salinity levels can range from oligohaline (salinity < 5 parts per 1000) to hyper saline (> 35 parts per 1000) depending on freshwater inputs (Hosking *et al*. 2004). Prevailing salinity conditions determine the nature of the estuarine, marine and freshwater organisms found in these systems (Whitfield, 1992). Water temperatures are mainly governed by solar heating and radiation. Since these systems are large and shallow, marine and river inputs play a small part in influencing temperatures. Examples of these types of estuaries include the Kosi, Swartvlei and St Lucia (Breen & McKenzie, 2001). Figure 1.4 shows the St Lucia Estuarine Lake.

Figure 1.4: The St Lucia Estuarine Lake (NN19)
Source: Whitfield et al. (2011)

Temporarily closed/open estuaries close off from the ocean, often for periods of many months per year, and sometimes for in excess of a year (Allanson & Baird, 1999). This closure is due to sandbar formation at the mouth (Hosking *et al*. 2004) and happens during periods of longshore sand movement in the marine nearshore, coupled with low or non-existent freshwater inputs. Small catchment areas (< 500 km^2) characterize these systems and only limited penetration of seawater takes place when the estuary mouth is open. The mouths of these systems usually open after periods of high precipitation. Hydrographic conditions are subject to frequent changes and substantial amounts of sediment are removed during flooding episodes. Gradually rising water levels may occur during times of mouth closure which ultimately overtop the sandbar at the mouth. Water levels normally recede rapidly which tends to expose previously flooded areas that sustained a high biomass of animal and plant life (Hosking *et al*. 2004). Hyper saline conditions dominate the temporarily closed/open estuary during drought periods. Both tidal and riverine inputs govern the water temperature when the mouth is open. Depending on the state of the mouth, both marine and freshwater organisms can be found in these systems (Whitfield, 1992). Examples of these types of estuaries include the Mhlanga, Groen and Van Stadens (Breen & McKenzie, 2001). Figure 1.5 shows the Van Stadens Temporarily Open/Closed Estuary.

Figure 1.5: The Van Stadens Temporarily Open/Closed Estuary (CMS49)
Source: Whitfield et al. (2011)

1.2.2 ECONOMIC CLASSIFICATION – EASE OF ACCESS

The economic classification of estuaries is arguably most useful in terms of their 'public good' character and related characteristic of ease of access. Following the definition of an estuary as a partially or fully enclosed wetland, it cannot be viewed as a pure public good because various degrees of excludability (limited access) are technically feasible. The Law and government policy is that there be ease of or open access, and given that access is usually easy from the sea side of the estuary most estuaries can be classed as open access natural resources. However, in some estuaries ownership of private land on the banks may undermine the degree of access. Access by the general public to certain parts of the estuary can be made very difficult (almost impossible) by exclusion from strategically located private land, and for that reason render parts of an estuary resource 'private'. Similarly, control and regulation of the land used to access the estuary access may fall under the control of a Conservation Park, and in that sense the estuary is best thought of as a limited public good (with access being dictated by the Park authority and exclusion very feasible).

1.3 THE STATE OF SOUTH AFRICAN ESTUARIES

1.3.1 THE STATE OF ESTUARIES

Estuaries not only have environmental appeal, but also aesthetic. For this reason, they form a natural attraction for tourism and recreational activities and the state they are in is important. This state is measured in South Africa in terms of various indices. These indices provide a framework for the collecting and disseminating of information by estuary so that it can be easily understood and used for comparative purposes (Breen & McKenzie, 2001). They allow complex information to be simplified into various measurements of estuary health. An example of such an index is the Estuarine Health Index (EHI). The EHI provides a detailed analysis of the condition of the estuary with respect to its geomorphology, the status of its fish species, the quality of its water, and its aesthetic appeal.

Estuaries are widely recognized as very important entities contributing to the coastal geomorphology of South Africa (Hosking *et al.* 2004). They hold an intermediary position between land and ocean, and, as such, are affected by many variations in the processes that occur in each. South African estuaries have been divided into three distinct biogeographic areas that characterise the coastline. There are the cool-temperate regions that stretch from the Gariep Estuary to Cape Agulhas, the warm-temperate regions that stretch from Cape Agulhas to the Mdumbi Estuary, and the subtropical region that spans from Mdumbi Estuary to Kosi Bay (Harrison *et al.* 2000).

Estuaries found in cool to temperate regions have relatively low fish species diversity and only 24 species are commonly found within this area (Whitfield, 1998). Estuaries within the warm to temperate region have about 78 commonly caught fish species in total. There are approximately 142 species commonly associated with estuaries found in the subtropical region (Whitfield, 1998). In terms of actual measurement, the health of estuaries in these regions has been assessed in terms of species richness, composition and relative abundance. Within the cool-temperate region, eight percent of estuaries have poor ratings, 42 percent are moderately rated, and the remaining 50 percent are rated to be in a good condition. Within the warm to temperate climatic region, eight percent of estuaries have a poor rating, 29 percent have a moderate rating and the remaining 63 percent have a good rating. In the subtropical region, five percent of estuaries are rated poorly, 36 percent have a moderate rating and the remaining 59 percent have a good rating.

The quality of water in an estuary is assessed in terms of three indicators. They are: suitability for aquatic life, suitability for human contact, and tropic status. Of those estuary systems sampled, 74 percent are classified as being in a ‘Fair’ or better condition. The remaining 26 percent are classified as being in a ‘Poor’ or ‘Very Poor’ condition. The best overall water quality is found largely on the South and South-East coasts of South Africa. Those estuaries on the Transkei coast and Kwazulu-Natal coast have a very high proportion of water systems rated as being in a poor condition (Harrison *et al.* 2000).

The aesthetic appeal of estuaries within South Africa is determined using 14 categories. These are: floodplain land-use, shoreline status, estuary surrounds, bridges, dams and weirs, mouth stabilization, litter and rubble, human use, algal growth, turbidity, odour, air pollution, noise, and lastly, invasive and exotic vegetation (Harrison *et al.* 2000). Each of these categories has been given a weighting based on a survey conducted by 25 coastal zone managers (Cooper, 1993). In this assessment, seven percent of the estuaries were rated poor, 35 percent moderate, and the rest (58 percent) good.

The baseline information for all estuaries in South Africa is deficient, with only 67 percent of estuaries having been surveyed to date (Adams, Bate & O'Callaghan, 1999; Whitfield, 2000). Of the 67 percent estuaries surveyed in South Africa, approximately 30 percent are in an 'Excellent' condition, approximately 31 percent are in a 'Good' condition, approximately 24 percent are in a 'Fair' condition, and the rest (approximately 15 percent) are in a 'Poor' condition (Whitfield, 2000)[5]. The geographic distribution of estuaries rated by health is shown in Figure 1.6.

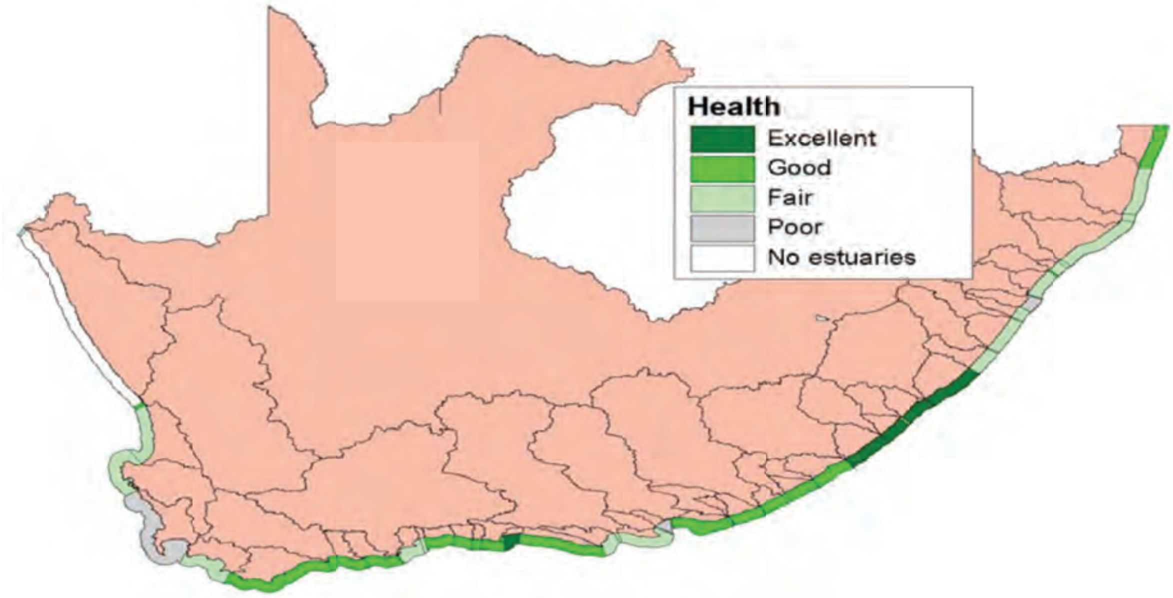

Figure 1.6: The geographical distribution of estuaries by health classification
Source: Whitfield (2000)

[5] 'Excellent' refers to estuaries that are unpolluted and in their natural state, i.e. nearly perfect conditions; 'Good' refers to estuaries where the catchment is not greatly affected in terms of sources of organic toxic wastes, erosion, and river regulations; 'Fair' refers to estuary conditions where there is a degree of noticeable ecological degradation as a result of environmental changes in areas that are close to the estuary, and; 'Poor' refers to estuaries where there is major ecological degradation due to a combination of anthropogenic influences.

1.3.2 DETERIORATION IN THE STATE OF ESTUARIES

Estuaries are under pressure from human exploitation all over the world, causing a drastic and accelerated decline in the condition of many of the world's estuaries and coastal seas, most notably during the past 150 to 300 years (Lotze *et al.* 2006). South African estuaries have not been spared. In particular, those estuaries that may be classed as open access have attracted rapidly increasing demand in South Africa and elsewhere, in some cases accompanied by undermining impacts on their potential service yield (Day, 1980; Forbes, 1998; Hosking, 2008) – prompting some authors to claim they are at the 'eye of the storm' (Hay *et al.* 2008). For this reason, there has arisen an urgent need to develop management policies suited to coping with the mounting 'storm' (burgeoning demand) with respect to the state of estuaries and the services they yield.

1.4 SOUTH AFRICAN ESTUARY MANAGEMENT POLICIES

Management policy on South African estuaries has followed insights provided by natural (estuarine) scientists into the state of the estuaries. The relevant policies for wetland management and conservation are articulated in the NWA, and, more specifically, the National Environmental Management: Integrated Coastal Management Act (Act 24 of 2008). The main objective of the NWA is to sustainably and equitably protect, use, develop, conserve and manage South Africa's water resources. This objective promotes the principles of (1) recognising basic human needs, (2) protecting and conserving the water resources within our country, and (3) developing the socio-economic aspects of South Africa through the use of water. In order to achieve its main objective, the NWA laid down a series of measures designed to protect all water resources in South Africa. The implementation of these measures should occur within different phases of the complex protection process. This process is divided into three stages, namely (1) the development of a management classification system for water resources, (2) the classification of water resources whilst meeting resource quality objectives, and (3) the determination of an ecological reserve (based on this classification). The policy is somewhat loosely known as the RDM approach, as this research initiative has been responsible for contributing many of its features.

The RDM approach was implemented in order to classify each water resource into its respective management class (MC). This facilitates the setting of the ecological reserve, i.e. the minimum freshwater level required to maintain natural levels of functionality of that specific resource system (Department of Water and Environmental Affairs (WEA), 2012).

The National Environmental Management: Integrated Coastal Management Act (ICMA), promulgated in December of 2009, requires coordinated and efficient management of estuaries in South Africa (National Environmental Management: Integrated Coastal Management Act (ICMA), 2008). It is the ICMA that guides the management of individual estuarine systems through their respective allocation into MC (I), (II), or (III). The classification process is guided by a National Estuarine Management Protocol (NEMP), as gazetted by the WEA in May of 2012 (WEA, 2012). This protocol will take the allocated MC into account when prioritising estuarine protection. Allocating water resources into their respective classes is a complex issue. A National Water Resources Classification System (NWRCS) was developed by Dollar, Brown, Turpie, Joubert, Nicolson & Manyaka (2006) to provide structure to this process. It consists of seven steps and may be broken down into three main procedures when applied to estuaries.

Firstly, a conservation importance index (CID) for each estuary must be determined. The variables selected for inclusion in the CID include estuary size, link with freshwater and marine environments, rarity of estuary type based on geographical position, habitat diversity and biodiversity importance (Turpie *et al.* 2002). Secondly, a preliminary management category must be assigned to each estuary based on their calculated CID and other socio-economic criteria. These management categories include (A) Unmodified or close to natural condition, (B) Largely natural with few modifications, (C) Moderately modified, (D) Largely modified, (E) Seriously modified, and (F) Critically modified. Categories (E) and (F) are not within the desired ecological range (DWA, 2010). The assigned preliminary management category should be based on current estuarine conditions relative to the status quo or stable baseline condition, and will range from category's (A) to (F). The final ecological management category is assigned taking into account the desired level of protection and management for that particular estuary into the future. Once the final ecological management category is assigned, the equivalent MC is determined through stakeholder evaluation and finalised by the Minister of Water and Environmental Affairs, or his/her designated authority (DWA, 2010). These management classes represent (I) water resources in a condition minimally altered from their pre-development state, i.e. 'minimally used', (II) water resources in a condition moderately altered from their pre-development state, i.e. 'moderately used', and (III) water resources in a condition significantly altered from their pre-development state, i.e. 'heavily used'. Following this management classification, resource quality objectives are determined and the ecological reserve level is assigned. This reserve refers to the minimum freshwater supply required by the estuary in order to maintain its ecological functionality (Turpie *et al.* 2002).

Measures used to record and monitor the health status of estuaries are referred to as indices. Indices provide a framework for the collecting and disseminating of information by estuary so that it can be easily understood and used for comparative purposes (Breen & McKenzie, 2001). These indices allow complex information to be simplified into various measurements of estuary health. Studies have been carried out to assess the quality of estuaries using different indices, namely fish indices (Harrison & Whitfield, 2006), estuarine health indices (Cooper, Ramm & Harrison, 1994; Harrison *et al.* 2000) and conservation indices (Turpie *et al.* 2002). Turpie *et al.'s* (2002) study, in particular, defined a CID by measuring various factors that are important to ecological diversity and functioning of the estuary. These factors were weighted during the index construction process. Conservation importance scores were derived for all South African estuaries. The interpretation of these scores is as follows: a '0-60' score implies average importance, a '61-80' score implies an above average importance, while a '81-100' score implies a high level of importance. The highest ranked estuaries were found to be mostly large systems, for example the Knysna Estuary and the Berg Estuary. The scores for the variables included in the index were re-estimated and updated by Turpie and Clarke (2007). Table 1.2 shows the conservation importance scores for selected estuaries in South Africa (Turpie *et al.* 2002; Turpie & Clarke, 2007).

Table 1.2: Conservation importance scores for selected estuaries in South Africa

Estuary (West to East)	**Conservation Importance Score *(Turpie et al. (2002) in brackets)***	**Conservation Ranking out of 250 functioning estuaries**
Berg (Groot)	98.4 *(97.5)*	3 *(2)*
Klein	97.0 *(95.3)*	5 *(9)*
Heuningnes	83.1 *(82.4)*	24 *(25)*
Knysna	100.0 *(99.8)*	1 *(1)*
Kromme	88.4 *(86.4)*	17 *(17)*
Sundays	77.8 *(77.4)*	42 *(39)*
Richard's Bay	69.3 *(81.8)*	67 *(26)*
St Lucia	96.6 *(96.6)*	9 *(5)*

Source: Turpie & Clarke (2007), updated from Turpie et al. (2002)

Most of the updated importance scores have increased, except for Richard's Bay, where the estuary has dropped in conservation importance. Its ranking dropped from 26th to 67th out of 250 estuaries. The Knysna Estuary is the most important in terms of conservation status in both rankings.

Once these scores have been estimated, factors comprising the CID, for example, habitat diversity and biodiversity importance, are then used to derive the Estuary Health Index (EHI). This index estimates the degree to which the estuary's current conservation status compares with those features representing the reference condition. The reference condition of an estuary refers to its pre-settlement and pre-development state (DWA, 2010). Once the EHI has been calculated, estuaries are assigned into their present ecological status (PES) categories. These categories cover six broad states of estuarine health (see Table 1.3).

Table 1.3: The classification of estuaries into their PES categories

EHI Score	PES	Description
100-91	A	Unmodified, natural
76-90	B	Largely natural, with few modifications
61-75	C	Moderately modified
41-60	D	Largely modified
21-40	E	Highly degraded
0-20	F	Critically degraded

Source: Taken from DWA (2010)

An estuary's recommended ecological status (RES) can only be determined once the PES, conservation importance score, and estuarine health score have been estimated. Recommended ecological categories are largely based on conservation importance scores, whilst taking the estuary's PES into account. An estuary's present condition can be represented by any category, but the recommended category for an estuary cannot be lower than 'D', as it is considered unfeasible to manage an estuary that has high to critically high levels of degradation (DWA, 2010). Table 1.4 provides the link between an estuary's PES, its RES (based on health and conservation importance scores), and its corresponding MC. This MC has to be assessed and finalized (approved) by the Minister of Water and Environmental Affairs.

Table 1.4: Link between an estuary's PES, RES and MC

<table>
<tr><th>EHI Score</th><th>PES</th><th>RES</th><th>Assigned MC</th></tr>
<tr><td>100-91</td><td>A</td><td>A</td><td>Minimally used</td></tr>
<tr><td>76-90</td><td>B</td><td>B</td><td>Moderately used</td></tr>
<tr><td>61-75</td><td>C</td><td>C</td><td rowspan="2">Heavily used</td></tr>
<tr><td>41-60</td><td>D</td><td>D</td></tr>
<tr><td>21-40</td><td>E</td><td rowspan="2">Not less than D</td><td rowspan="2">Assigned relevant class</td></tr>
<tr><td>0-20</td><td>F</td></tr>
</table>

Source: Adapted from DWA (2010)

Table 1.5 provides recommended ecological categories for all the estuaries selected in Table 1.2.

Table 1.5: Selected estuaries with RES and assigned MC

Estuary (West to East)	Present Ecological Category	Recommended Ecological Category	MC (I, II, or III)*
Berg (Groot)	D	C	III
Klein	C	B	II
Heuningnes	D	A or next best	I
Knysna	B	B	II
Kromme	D	C	III
Sundays	C	A or next best	I
Richard's Bay	C	A or next best	I
St Lucia	D	A	I

Source: DWA (2010)

* *The allocated MC will determine the assigned ecological reserve*

Once the recommended ecological category has been determined, a MC can be assigned. The MC determines the quantity and quality of water that should be allocated to each estuary in order to maintain that estuary's functionality, i.e. the ecological reserve. In terms of the RDM approach, the amount of water is calculated that management should supply to each estuary to allow either the maintenance of its current health status, or the implementation of measures to improve its health status into the future.

1.5 ADDING COMPLEMENTARY (DEMAND BASED) VALUATION METHODOLOGIES TO GUIDE MANAGEMENT

The RDM approach is primarily designed to guide what could be called 'supply side' estuary management, for example, the quantity of river water that should be allowed to flow into an estuary. It makes a very important contribution to informing targets to aim at – feasible long-run levels of functionality for South Africa's various estuaries. It is not an approach that addresses or helps inform management of the causing problem – rising and competing demand. So what methods should be used to guide estuary management in the face of demand challenges?

The development of adequate and cost effective methods to value demand trade-offs, such as those that occur with respect to estuary use, has been one of the major advances in Environmental and Resource Economics. The estimation of Rand values for the recreational and environmental attributes of estuaries is a complex task since these attributes are not traded in markets. Examples of valuation studies applied to South African estuaries abound (Hosking *et al.* 2004; Sale, 2007; Van der Westhuizen, 2007; Dikgang, 2007; Akoto, 2008; Chege, 2009; Nyaboga, 2011). All of these studies employed the contingent valuation method (CVM). The CVM has been widely applied to value environmental resources over the last thirty years

(Adamowicz, Boxall, Williams & Louviere, 1998; Adamowicz & Boxall, 2001; Bateman, Carson, Day, Hanemann, Hanley, Hett, Jones-Lee, Loomes, Mourato, Özdemiroglu, Pearce, Sugden & Swanson, 2002). It is a direct approach whereby the consumer is asked to make a hypothetical willingness-to-pay (WTP) bid for a defined good or service (Kahnemann & Knetsch, 1992). A set of general guidelines has been developed for the proper application of CVMs (see Arrow, Solow, Portney, Leamer, Radner & Schuman, 1993). Although the CVM is accepted as a non-market valuation technique, it suffers from several shortcomings. One of the most important shortcomings of the CVM is that it is incapable of "generating multiple value estimates from a single application" (Bennett & Blamey, 2001). The examples of South African estuary valuation studies listed above suffer from this shortcoming as they only valued one estuarine environmental service flow, namely freshwater inflow. This analysis is too narrow. A more comprehensive type of analysis is required for composite goods like estuaries to capture the broad range of factors that influence recreational choice and experience.

Conjoint analysis, also known as the choice modelling (CM) approach, is a technique capable of handling the analysis of composite goods. Four different types of CM studies can be conducted. First, individuals may be presented with a series of alternatives and asked to state their most preferred option (CE), second, individuals may be asked to rank the alternatives in order of preference (contingent ranking), third, individuals may be asked to choose the preferred alternative out of a set of two choices (paired comparisons), and lastly, individuals may be asked to rate the alternative on a cardinal scale (contingent rating) (Garrod & Willis, 1998; Foster & Mourato, 1999; Foster & Mourato, 2000; Haab & McConnell, 2002).

The CE is the preferred method if the *relative* values of characteristics (referred to as attributes) of a public good are to be analysed and valued. In addition, the method is also applicable in cases where the characteristics of the environmental good or service are somewhat unlike those possessed by traditional consumer goods, because the choice scenario employed in the method more closely resembles real-life market conditions. Despite this technique's apparent relevance and usefulness for the valuation of the attributes of composite goods, such as estuaries, there is a paucity of published studies on South African wetlands that apply this technique, but there are unpublished studies, for example, Oliver (2010).

The CE is a survey-based method that models preferences for goods and services, represented in terms of different levels of attributes. The CE approach to valuation was first proposed by Louviere and Hensher (1983). It shares a theoretical framework with dichotomous choice valuation in random utility models (McFadden, 1974) and utilizes the empirical framework of limited dependent variable statistical models (Greene, 1997). The CE technique was initially developed for the analysis of markets and transportation studies (Green & Srinivasan, 1978; Hensher & Johnson, 1981;

Green, 1984; McFadden, 1986; Louviere, 1988; Batsell & Louviere, 1992; Gan & Luzar, 1993; Holmes & Adamowicz, 2003), but further development allowed for the increased use of this technique to value non-market goods (Adamowicz, 1995; Boxall, Adamowicz, Swait, Williams & Louviere, 1996; Hanley, Macmillan, Wright, Bullock, Simpson, Parrison & Crabtree, 1998a; Hanley, Wright & Adamowicz, 1998b; Hanley, Mourato & Wright, 2001; Macmillan, Duff & Elston, 2001; Nunes & van den Bergh, 2001). The conceptual roots of this technique can be traced to Lancaster's (1966) characteristics theory of value. In this utility maximizing theory of choice, utility from consuming goods is decomposed into utilities from the attributes of the good. Applied to the modelling of choice, target populations are presented with alternative packages of attributes expressed by levels and asked to make a choice between these alternative packages. Their choices subtly reveal the trade-offs they make between the attributes.

For the purpose of estuarine recreational management, a CE is appropriate because the decision issues are typically multidimensional and inter-dependent. These types of decisions include, but are not limited to, the following: access to infrastructure, recreation activity management, and bank development. The composite good that results is the recreational experience of the user. By including cost as an attribute of the management set of options, recreational marginal value for the specific management interventions can be deduced, and utilized to assist to help prioritize management effort.

1.6 ORGANISATION OF THE REPORT

While Chapter one introduced selected recreational management challenges facing South African estuaries and a methodology for guiding management on them, Chapter two describes the features of and key recreational challenges at the four estuaries selected for deeper analysis. Chapter three provides a policy perspective on managing recreational demand at these estuaries. Chapter four overviews the CE method, and discusses its suitability for valuing the attributes (parts) of a composite good (estuary). Chapter five discusses the design and implementation of the CEs for the selected estuaries. Chapter six estimates predictive models for the selected estuaries using maximum likelihood estimation and reports the results. Lastly, conclusions are drawn and recommendations made (Chapter seven).

1.7 CONCLUSION

South Africa's many and varied estuaries are facing a demand-induced crisis. *Inter alia*, freshwater demand upstream is depriving them of freshwater inflow, they are being polluted, the immediate environments are being increasingly and often recklessly imposed upon by demand for services, and an ever increasing number of people are using them. In the face of this demand, local government support service and conservation are often inadequate. The result is increasing competition and sometimes even conflict in recreational demand.

An enormous challenge faces the authorities responsible for managing these demand problems. What information and policy are they to use to respond to this challenge?

This Report will argue that the CE analysis has the potential to yield some of the management information needed. Four CE analyses will be reported (for the Sundays, Kromme, Nahoon and Gonubie estuaries) and it will be shown how the results of at least two of these analyses can guide management of recreational demand for the services of estuaries.

The ICMA is in the process of developing a NEMP which will be responsible for the development of individual estuarine management plans (ICMA, 2008). It is envisaged that these management plans will provide balance between the demand for physical processes within the estuary and the demand for recreational use of the estuary (WEA, 2012). The NWA has set out four regulating activities to ensure optimal and balanced use of South Africa’s water resources (NWA, 1998). The use of RDM defines a minimum reserve requirement (water supply) for each estuary, thereby setting inflow quantity and quality objectives.

In order to accomplish the demand side management objectives of the ICMA, there will be a need for better information on key instruments of demand management, such as registration fees, permits, levies and/or fees, and this is where the methods advocated by this Report will be informative.

CHAPTER TWO: FOUR CASE STUDY SITES AND THE RECREATIONAL CHALLENGES FACED AT THEM

2.1 INTRODUCTION AND STUDY SITE SELECTION

In order to demonstrate the methodology and management approach advocated by Chapter one, four estuaries were selected as case studies – the Sundays, Kromme, Nahoon and Gonubie River estuaries. All lie in the Eastern Cape (EC) province on the south eastern seaboard of South Africa. It covers approximately 13.9 percent of South Africa's land mass and is home to more than half of the estuaries situated in South Africa, about 213 in total (Council for Scientific and Industrial Research (CSIR), 2004). Its estuaries range from large permanently open systems, like the Swartkops River Estuary, to smaller temporarily open/closed systems, like the Van Stadens River Estuary, and suffer varying degrees of degradation (see Table 2.1).

Table 2.1: Health of EC Estuaries

State of Estuaries	**Number of Estuaries**	**Percentage**
No Information	78	36
Fair Condition	18	9
Good Condition	44	21
Excellent Condition	73	34
Total	213	100

Source: Whitfield (2000)

The selection of case study estuaries took this health analysis into account, and was done in consultation with members serving on the WRC Project No: K5/1924 steering committee. The four estuaries chosen face direct and indirect pressures, such as habitat alteration, over-exploitation, reduction in freshwater inputs and pollution. These pressures have led to adverse economic consequences through the loss of environmental service flows.

A description of each selected estuary is provided below, as well as a background to the identified recreational challenges facing each of them.

2.2 BIOTIC AND ABIOTIC FEATURES OF THE SUNDAYS RIVER AND KROMME RIVER ESTUARIES

2.2.1 THE SUNDAYS RIVER ESTUARY

The Sundays River Estuary (33°43'S, 25°25'E) is situated in the EC, approximately 40 km northeast of Port Elizabeth. The estuary is approximately 20 km long, is permanently open and discharges into Algoa Bay, in the Indian Ocean (MacKay & Schumann, 1990). Figure 2.1 shows an aerial photograph of the Sundays River Estuary.

Figure 2.1: An aerial photograph of the Sundays River Estuary
Source: Whitfield et al. (2011)

The Sundays River's headwaters can be found in the catchment of the Nqweba Dam (formerly the Van Rynevelds Pass Dam) at Graaff Reinet.

In the summer rainfall area, annual rainfall fluctuates between 250 millimetres (mm) to 500 mm per annum. In the south, this figure lies between 400 mm and 1000 mm per annum. This categorizes the catchment as semi-arid. The prevailing wind in the catchment area is southwesterly. In terms of temperature variations, it fluctuates from 17°C in mid-winter to 24°C in mid-summer (Scharler, Baird & Winter, 1998). The Sundays River has a catchment area of approximately 22 000 km^2 and has no tributaries (Scharler & Baird, 2003). The estuary's average depth and width, respectively, are 2 metres (m) and 50 m. The overall surface area covers approximately 156 hectares (ha) (Scharler & Baird, 2003).

The mean annual runoff (MAR) is approximately $186x10^6$ m^3. The two dams constructed in the catchment area have a combined storage of about 140 percent of the MAR (Reddering & Esterhuysen, 1981). A significant part of the freshwater inflow for the Sundays River comes from one of the largest rivers in South Africa, the Orange River. This occurs via an inter-basin water transfer scheme which provides water for irrigation purposes for the extensive citrus farming community found in the Sundays River catchment area. This inter-basin water transfer scheme provides the Sundays River Estuary with a regular inflow of freshwater, leading to an unnatural dilution of the saline balance in the estuary (Emmerson, 1989).

Sheep farming and citrus cultivation are the main activities in the catchment and along the entire river, which is about 310 km in length. Agricultural enterprises within the Sundays River system mostly consist of commercial land and commercial irrigated activities. This portion, however, represents only 3 percent of the catchment land-cover in total. There is also a very small percentage (1 percent) of residential developments in the catchment. The main activities that occur on the estuary are recreational activities. These include high levels of fishing and lots of motorised boating during peak periods. The main town in the Sundays River system is Graaff Reinet. It is situated in the upper catchment. Smaller towns, such as Kirkwood, Jansenville and Pearston, are located in the middle to upper catchment.

The estuary contains approximately 3 percent degraded shrubland and bushland. The majority of the estuary is considered to be in a natural state (94 percent). The fauna of the estuary is relatively limited.

2.2.2 THE KROMME RIVER ESTUARY

The Kromme River Estuary (34°08’S, 24°5’E) is located in the EC approximately 80 km west of Port Elizabeth (see Figure 2.2) (Scharler & Baird, 2003; Sale, 2007). The estuary flows into St Francis Bay, in the Indian Ocean. This estuary is considered to be one of the larger estuaries situated in the EC province and is classified as permanently open. It also lays claim to a relatively undisturbed catchment area (Heymans, 1992). The Kromme River originates in the Tsitsikamma Mountains.

Figure 2.2: An aerial photograph of the Kromme River Estuary
Source: Whitfield et al. (2011)

The Kromme River Estuary experiences rainfall throughout the year. Annual rainfall varies from 700 mm to 1200 mm (Baird, Marais & Bate, 1992). Temperatures in the area range from 14°C in mid-winter to 24°C in summer (Day, 1980). Rainfall in the catchment area occurs throughout the year, but maximums are usually recorded in autumn and spring. January and February are the months that have the lowest average rainfall (Bickerton & Pierce, 1988).

The catchment area of the Kromme system is between 936 km^2 (Baird *et al.* 1992) and 1085 km^2 (Day, 1980), and drains a large part of the Langkloof. This valley lies between the Tsitsikamma Mountains and the landward Kouga Range. The system's biggest tributary, the Geelhoutboom tributary, joins the river approximately 7 km from the tidal head (Scharler & Baird, 2003).

The Kromme River runs for approximately 95 km, with the last 14 km of the river regarded as estuarine (Heymans, 1992). This estuarine system has a total surface area of approximately 172 ha (Colloty, 2000). The average depth at low spring tide is about 2.8 m (Scharler & Baird, 2003). The estuary is a relatively narrow one, with the average width being approximately 80 m.

The mean annual runoff (MAR) for the Kromme River Estuary was estimated at $105.5x10^6$ m^3 by Reddering and Esterhuysen (1983). Bickerton and Pierce (1988), however, estimated it closer to $116.8x10^6$ m^3. The high runoff is due to various key geomorphologic characteristics of the Kromme River catchment, namely the high relief, rocky slopes and sparse vegetation.

The Kromme River Estuary occurs in a relatively undisturbed area and comprises approximately 11.73 km^2 of pristine forest, 79.6 km^2 of fynbos and 1462.05 km^2 of private farmland. Farmland activities include stock farming and grain cultivation (Heymans, 1992). Recently there have been a large number of residential developments along the banks of the estuary. There is also a marina canal system which has undergone numerous expansions over the years in order to accommodate more houses with water frontage, and there has also been construction of a bridge running over the estuary. Dams have been constructed on the upper reaches of the estuary leading to a reduction in freshwater inflows.

2.2.3 THE NAHOON RIVER ESTUARY

The Nahoon River Estuary (32°59'S, 27°57'E) has been described as an important environmental asset and recreational area (Heydorn, 1986). It is 5 km long, has a surface area of 5.4 ha (Reddering & Esterhuysen, 1987), and is located in a warm temperate region of South Africa (see Figure 2.3).

Figure 2.3: An aerial photograph of the Nahoon River Estuary
Source: Wooldridge (1986)

The catchment area of the Nahoon River system is 547-625 km^2 (Wiseman, Burns & Vernon, 1993). The shallow inlet channel has a rocky northern bank, which restricts migration of the inlet channel further to the north east. A sandpit, formed as a response to wave and tidal action, constitutes the western bank of the inlet. The one km long Nahoon Beach adjoins the estuary to the south. A slow accumulation of sand normally takes place in the river mouth and along the adjacent western bank of the estuary. This sand is removed periodically during floods (Wiseman *et al.* 1993).

The Nahoon has one impoundment with a capacity of 5.8 x 10^6 m^3, which captures 87 percent of the catchment area (Department of Water Affairs and Forestry (DWAF), 2004). According to Wooldridge (1986), more abstraction occurred thereafter. Five key problems were identified in the Nahoon River Estuary in the early 1990s: increased sedimentation due to reduced river floods, poor water quality, the reduced abundance and diversity of estuarine organisms, inappropriate development on the floodplain, and increasing demand for recreational resources (Wiseman *et al.* 1993). The key characteristics of the Nahoon River Estuary are summarised in Table 2.2.

Table 2.2: Key characteristics of the Nahoon River Estuary

Classification*	**Rank****	**Condition***	**Importance rating****		**MAR (x10^6 m^3)**	
Permanently open estuary (can close on rare occasions)	61	Fair	Size	80	Estuary (simulated)***	34
			Habitat	60	Catchment: sub-area Amatola[#]	559
			Zonal type rarity	20		
			Biodiversity importance score	88		
			Conservation importance score	71		

*Source: * Whitfield (2000); ** Turpie, Clark, Knox, Martin, Pemberton & Savy (2004); *** Wiseman et al. (1993); [#] Department of Water Affairs and Forestry (DWAF) (2003)*

2.2.4 THE GONUBIE (GQUNUBE) RIVER ESTUARY

The Gonubie River Estuary (32°55'S, 28°01'E) is located in the warm temperate region of South Africa (see Figure 2.4).

Figure 2.4: An aerial photograph of the Gonubie River Estuary

The catchment area of the Gonubie River system is 665 km^2 (CSIR, 1987) of which about 12 km^2 is covered by forest (Reddering & Esterhuysen, 1986). The length of the river is 108 km and flows to a permanently open, microtidal estuary, which is flood-tide dominated. As a result the system has a shallow, constricted tidal inlet and well developed flood-tidal deltas (Wooldridge, 1986). The estuary deepens from the flood tidal deltas upstream towards the head of tidal effect. The northern bank consists of rock and prevents the inlet from migrating. To the south, the adjacent 300 m wide beach merges laterally into the delta of the estuary (Wiseman *et al.*, 1993).

The Gonubie River catchment is the third largest within the Buffalo City Municipality (BCM) area. There are no large dams on the river and no water is supplied for urban use. Only small farm dams and weirs in the catchment supply water for irrigation and stock farmers. It would be possible to increase the yield from the catchment with the development of a large dam(s) on the Gonubie River. However, because of the relatively pristine nature of the river and its estuary, a comprehensive reserve determination would be required if considering this catchment as an additional water supply.

The other main coastal rivers of Kwelera and Kwenxura are also not regulated at present and are used mainly for run-of-river irrigation schemes. Current studies have identified the Nahoon, Gonubie and Kwelera Rivers within the sub-area, and the Keiskamma (Sandile and Binfield Park Dams) and Great Kei Rivers as possible future raw water supply sources for the BCM (DWAF, 2003). The key characteristics of the Gonubie River Estuary are summarised in Table 2.3.

Table 2.3: Key characteristics of the Gonubie River Estuary

Classification*	Rank**	Condition*	Importance rating**		MAR (x10^{6} m^{3})	
Permanently open estuary	79	Good	Size	70	Estuary (simulated)***	47
			Habitat	50	Catchment: sub-area Amatola#	559
			Zonal type rarity	20		
			Biodiversity importance score	84		
			Conservation importance score	63		

*Source: * Whitfield (2000); ** Turpie et al. (2004); *** CSIR (1987); # DWAF (2003)*

2.3 RECREATIONAL DEMAND CHALLENGES FACING THE SUNDAYS, KROMME, NAHOON AND GONUBIE RIVER ESTUARIES

2.3.1 FOCUS GROUP ASSESSMENTS

Estuaries are dynamic environments that provide a host of different services to the surrounding ecosystems. However, most face threats that can undermine their effectiveness in providing these services.

2.3.1.1 The Sundays River Estuary

Focus group discussions were held with Prof P Cowley, from Rhodes University, Prof TH Wooldridge, from NMMU, Prof J Adams, also from NMMU, Mr C Tunstead, the chairman of the Sundays River Ratepayers Association, and Mr J Moore, a member of the Sundays River Joint River Forum. The focus group found that the following recreational use issues merited immediate attention as far as management of the Sundays River Estuary was concerned: the physical size of the fish stocks, the level of boat congestion and the level of public access.

2.3.1.2 The Kromme River Estuary

Focus group discussions were held with Mr D Nel, the chairman of the St Francis Bay Riparian Association, Mr H Thorpe, the chairman of the Kromme River Trust, and Mr N Marais, the chairman of the Kromme River Joint River Forum as well as the chairman of the Kromme River Angling Club. The focus group identified that the following recreational use issues deserved immediate attention as far as management of the Kromme River Estuary was concerned: reduced navigability on the estuary due to sedimentation, the level of boat congestion and the use of jet skis/wet bikes on the estuary.

2.3.1.3 The Nahoon River Estuary

The attributes and levels identified for the Nahoon River Estuary were derived in consultation with the following focus group members: Mr D Schultz of the BCM Health Department, Dr G Howes, Chairman of the Nahoon Trust, Mr G Winch, Committee member of the Nahoon River Estuary Care Advisory Committee and Council Member of the BCM, Mr G Sorour, Border Aquatic Club member involved with boating control, Dr GV Price, Chairman of the Gonubie Estuary Management Forum (GEMF), Mr J Waterson, past Chairman of the GEMF, Mr P Fielding, marine biologist, Mr R Schutte, member of the Independent Estuary Management Unit (IEMU), and Mrs S Fergus, head of the IEMU. The focus group identified that the following recreational use issues deserved immediate attention as far as management of the Nahoon River Estuary was concerned: improved safety of the water in the estuary for recreation users, increased municipal maintenance and upgrading of supporting facilities for recreational activity, and increased protection against criminal activity afforded to recreational users of the estuary.

2.3.1.4 The Gonubie River Estuary

The attributes and levels identified for the Gonubie River Estuary were derived in consultation with the GEMF. This group is very active and up to date with the affairs related to the estuary. The committee members of this forum are: Dr GV Price, Chairman of the GEMF, Mr L Mellin, Vice Chairman of the GEMF, Mr J Waterson, Aesthetics Officer and Past Chairman of the GEMF, Mr P Fielding, Treasurer of the GEMF, Mrs A Ford, Secretary of the GEMF, Mrs L Jupp, Environmental Officer of the GEMF, Mr M Simms, committee member of the GEMF, and Mr K Menday, committee member of the GEMF. The focus group identified that the following recreational use issues deserved immediate attention as far as management of the Gonubie River Estuary was concerned: improved safety (quality) of the water in the estuary, more controlled and restrictive policy towards development of the banks of the estuary, and increased protection from crime afforded to people pursuing recreational activity at the estuary.

2.3.2 FOCUS GROUP FEEDBACK FOR QUESTIONNAIRE DEVELOPMENT

2.3.2.1 The Sundays River Estuary

a) The Sundays River Estuary fishery

The Sundays River Estuary fishery is a major tourist asset (Cowley, Childs & Bennett, 2009). Recreational use of the fishery dominates that of subsistence. Three fish species are actively targeted by recreational fishers in the Sundays River Estuary, namely spotted grunter (*Pomadasys commersonnii*), dusky kob (*Argyrosomus japonicas*) and white steenbras (*Lithognathus lithognathus*) (Wooldridge, 2010). These fish species are not being allowed to reach their adult size, due to over-fishing and high retention rates of undersized fish. The stock status is collapsed of two of these species, namely dusky kob and white steenbras (Cowley *et al.* 2009). The stock status is over-exploited of spotted grunter. The most recent research available on the adult dusky kob population suggests that it is between 1 and 4.5 percent of the non-impacted (original) population, a level that could be below the recovery threshold for this species (Griffiths, 1997).

Cowley *et al.* (2009) have estimated the total annual catch for the Sundays River Estuary to be 17 518 fish or 8.7 tons. Of the total tonnage caught, dusky kob makes up 3.5 tons, spotted grunter 2 tons, and white steenbras 310 kg. This estimate is based on a study by Cowley *et al.* (2009), which revealed that 19 different fish species were caught during the period January 2008 to December 2008. In total, 1 497 fish were caught by recreational as well as subsistence fishers. The recreational fishers were responsible for the highest catches of all species (taking into account both number and mass).

The catch composition recorded during the Cowley *et al*. (2009) survey was dominated by five species, namely Cape stumpnose (*Rhabdosargus holubi*), spotted grunter, dusky kob, white seacatfish (*Galeichthys feliceps*), and white steenbras. The five species are caught throughout the year, with a peak during the summer months (Cowley *et al.* 2009). Catches of dusky kob and spotted grunter peak during February, whilst catches of Cape stumpnose peak during November and December. Of the targeted recreational fish species, the spotted grunter was the most commonly caught during the survey (24 percent), followed by the dusky kob (21.8 percent) and the white steenbras (7.4 percent) (Cowley *et al.* 2009).

Overall, 25 percent of all fish caught during the survey period were kept. Subsistence fishers kept a higher proportion (71 percent) than the recreational fishers (22 percent). Of the targeted species, 32.8 percent of all spotted grunter caught were kept, 33.1 percent of the dusky kob and 26.6 percent of the white steenbras.

The average lengths of spotted grunter, dusky kob and white steenbras, respectively, caught during the survey period were 31.4 cm (0.5 kg), 35.9 cm (0.95 kg) and 25 cm (0.23 kg) (Cowley *et al.* 2009).

Of all those fish caught and subsequently kept, a large proportion were under the legal size limit. More specifically, 63 percent of the dusky kob were below the legal size limit, 100 percent of the white steenbras were below the legal size limit, and 30 percent of the spotted grunter were below the legal size limit (Cowley *et al*. 2009).

b) Boat congestion on the Sundays River Estuary

Current boating activities

The Lee (2011) survey found that the main recreational activities for the Sundays River Estuary were: recreational shore fishing (41 percent), recreational boat fishing (41 percent), speed boating (11 percent), water skiing (1 percent), paddling (2 percent), jet skiing (1 percent), swimming (1 percent) and bird watching (1 percent). By way of comparison, the main estuary activities observed by the Cowley *et al*. (2009) study were recreational shore fishing (32 percent), recreational boat fishing (18 percent), speed boating (11 percent), water skiing (3 percent), paddling (2 percent), and jet skiing (1 percent). Both of these assessments indicate that fishing and non-fishing motorised boating activities make up a large part of all activities that occur in the Sundays River Estuary. The number of boats registered to use the Pearson Park Resort slipway for the years 2007 and 2008 respectively, were 774 and 812. These numbers exclude the boats that made use of the public launching facilities under the new Mackay Bridge (between zones 4 and 5).

Recreational boating activities by estuary zone

The Cowley *et al.* (2009) study broke up the recreational boating area of the Sundays River Estuary into six zones (see Figure 2.5). These zones stretch for 12 km, starting at the mouth of the estuary and ending approximately 4.5 km beyond the N2 Bridge. Various recreational activities take place on this stretch of water, but some are focused within specific zones.

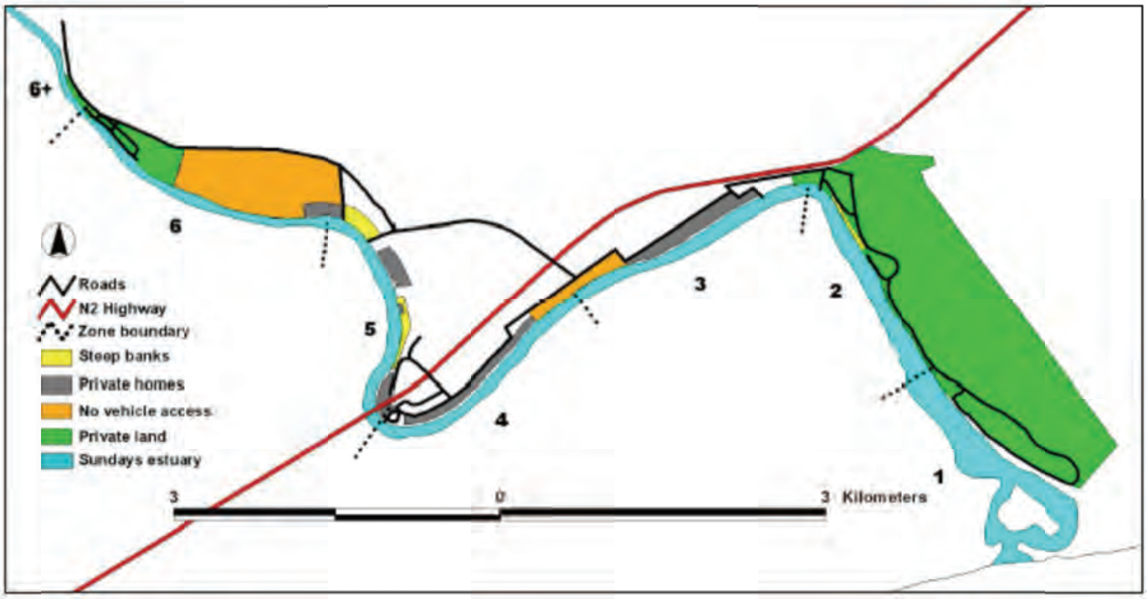

Figure 2.5: Spatial zones for the Sundays River Estuary
Source: Cowley et al. (2009)

Recreational boat[6] fishing is not confined to any particular part of the estuary, but is spread throughout. This type of fishing mostly takes place between 2 and 4 km from the estuary mouth. Motorised boating activities, excluding fishing, but including family outings, 'booze' cruises, leisure cruises and ferry trips, take place all along the estuary. The incidence of motorised boating activity is higher within 2 km on either side of each of the main two slipways (Cowley *et al.* 2009). Motorised boating activity related to water skiing, is mainly confined to the area between the two slipways. Non-ski motorised boating activity takes place anywhere in the estuary because no boundaries exist and there are no access restrictions limiting the movements of boats (Cowley *et al.* 2009). Table 2.4 summarizes the spatial distribution of recreational motorised boating activities (as described by Cowley *et al.* 2009).

Table 2.4: Spatial distribution of recreational motorised boating activities – Sundays River Estuary

Boating Activity	Zone	Zone(s) with most Activity
Recreational Boat Angling	1-6	2
Other Motorised Boating*	1-6	2, 3, 4, 5
Water Skiing	1-5	3, 4
Jet Skiing	2 and 4	2 and 4

Source: Cowley et al. (2009)
**This type of boating includes leisure cruises, 'booze-cruises', ferry trips and family outings.*

[6] Boats include motorised boats, canoes and kayaks.

General motorised boating activity (excluding fishing) peaks during the summer months. Cowley *et al.* (2009) found that a maximum of about 40 boats use the estuary at any one time (survey conducted between September 2007 and August 2008 – excluding jet skis/wet bikes). The summer peak is from October to January.

The development of space standards for recreational water activities have been advocated by Sowman and Fuggle (1987). Their space standards are displayed in Table 2.5.

Table 2.5: Space standards for recreational water activities

Recreational Activity	**Crafts per Hectare**
Boat Angling	0.25
Leisure Cruising	0.83
Water Skiing and Speed Boating	0.06-0.13 (avg. = 0.095)
Jet Skiing	Same as Water Skiing
Hobie Cats	1-3 (avg. = 2)
Dinghies	1-3 (avg. = 2)
Canoeing	Not Defined
Windsurfing	10
Bait Collecting	Not Defined
Swimming	Not Defined
Average	2.18

Sources: Sowman & Fuggle (1987); Forbes (1998)

If one takes the length of the Cowley *et al*. (2009) study area (12 km) and an average estuary width (between 50 m to 100 m with an average = 75 m), approximately 90 ha are available for recreational activities. Based on the above-mentioned space standards and the total number of hectares available, it is possible to determine the extent of the boat congestion in the Sundays River Estuary. According to the space standards defined above, the maximum number of motorised recreational angling boats using the Sundays River Estuary at any one time should not exceed 23, i.e. 90x0.25. There should also be no more than 75 leisure cruises taking place at any one time, i.e. 90x0.83, or 9 water skiers or speed boaters on the water, i.e. 90x0.095, and 9 jet skiers or wet bikers at any one time, i.e. 90x0.095. This standard assumes only one of these recreational activities is taking place at a time. The policy challenge at the Sundays River Estuary is to determine a simultaneous capacity limit covering all these activities. When this determination is done by weighting each of these boating activities proportionally[7], the capacity limit at any one time for the whole Sundays River Estuary is 55 boats.

[7] Total motorised craft per hectare equals 1.27, of which boat angling, leisure cruising, water skiing/speed boating and jet skiing represent 20 percent, 65 percent, 7.5 percent and 7.5 percent respectively. This implies 4.6 angling boats, 48.75 leisure boats, 0.675 water skiers or speed boaters

Within any given zone, the capacity limit is less. Recreational boat angling, for example, is focused mainly in zone 2 (2 to 4 km from the mouth of the estuary) (Cowley *et al.* 2009). Within the approximately 15 ha making up this zone, only 4 fishing boats should ideally be active, or less than this, if other activities also take place in this area.

By similar calculations, in the area within about 2 km on either side of each of the two main slipways (approximately 60 ha), no more than 50 leisure boats should be active at one time. Water skiing in the estuary is confined to zones 3 and 4 (the area situated between the two main slipways at Pearson Park Caravan Park and at the N2 New Mackay Bridge). This stretch has a surface area of approximately 22.5 ha. In terms of the space standards formula of Sowman and Fuggle (1987) and the available surface area, no more than 2 craft should be active. The same space standard applies to jet skis/wet bikes.

The level of boat congestion on the Sundays River Estuary

The Forbes (1998) study and a *status quo* assessment report of the Sundays River Estuary conducted by Afri-Coast engineers in 2004 argued that the recreational users at this estuary show a lower tolerance towards motorised activities than to non-motorised and shore-based activities (Forbes, 1998; Afri-Coast Engineers, 2004). A survey of recreational users showed that, with respect to motorised activities:

- The noise generated and the danger associated with the high speed of the craft were considered problematic,
- The neglect of regulations governing motorised craft use and reckless behaviour were problematic, and
- The high number of boats was a major problem (Forbes, 1998; Afri-Coast Engineers, 2004).

Although the Cowley *et al.* (2009) study did not ask respondents about their perceptions regarding motorised boat congestion, it did enquire about respondents' opinions of other estuary users. Speed boating was one of the main activities cited as problematic by the respondents, followed by jet skiing/wet biking and water skiing. A small percentage of respondents suggested that zoning[8] the estuary for different uses was necessary and that a speed limit should be implemented for motorised craft (Cowley *et al.* 2009).

and 0.675 jet skiers can make use of the estuary at one point in time. This represents a capacity limit for the Sundays River Estuary of 55 motorised craft at one point in time.

[8] The estuary is currently zoned for skiing, but there is little, if any, compliance to these zoning regulations (Cowley *et al.* 2009).

c) Public access at the Sundays River Estuary

Public access at the Sundays River Estuary is subject to a number of restrictions – some are natural barriers and others are man-made. The former includes steep, inaccessible banks. The latter includes private residential properties on land adjacent to the estuary's banks, private ownership of land adjacent to the estuary's banks and the paucity of roads to the estuary's banks (Cowley *et al.* 2009; Unit for Integrated Environmental and Coastal Management (IECM), 2010).

Public access to the west bank of the estuary is limited by privately-owned farms (no public access save for farm staff), the N2 national highway (this permits access to pedestrians only), and the Mackay Rail Bridge, which is currently closed (this permits bicycle and pedestrian access only) (Cowley *et al.* 2009).

Access to the east bank of the estuary, from the estuary mouth up to the Pearson Park caravan park, is mainly restricted due to the presence of privately-owned land. Estuary users can only access this bank if they are prepared to pay an access fee. Access to this bank is further hampered by the existence of a steep, rocky cliff situated at the northern end of the east bank. This makes shore access difficult and dangerous during low tides and impossible during high tides (Cowley *et al.* 2009). Vehicle access does exist on the east bank, with the exception of the area beyond the parking lot, to the south of the ablutions.

The north bank of the estuary, between the N2 Bridge and the Pearson Park caravan park, is largely residential. The estuary banks and riparian zone on this bank are frequented mostly by residents, but the area is accessible to the general public via a wide open grass space between the residential dwellings and the estuary. Vehicle access to the estuary is restricted to two distinct points: one near the petrol station (north-east corner of estuary), and the other at the slipway located adjacent to the N2. Except for these two access points, there are virtually no other vehicle access points along this stretch of the estuary (Cowley *et al.* 2009).

The estuary bank to the north of the N2 highway is accessible by vehicle, but is restricted to the road that leads up to the Mackay Rail Bridge. The east bank to the north of the N2 Bridge is mainly occupied by residential properties. The estuary banks along this stretch are also steep and inaccessible (Cowley *et al.* 2009). Most of the area to the north of the Mackay Rail Bridge has no road access to it.

In the vicinity of Colchester and Cannonville private jetties have proliferated in an ad-hoc manner along the northern bank of the Sundays River Estuary. Most of these jetties have been constructed on Municipal Public Open Space without authorisation. Although most of the jetties are situated on Municipal land, access to them is controlled by those who erected them.

2.3.2.2 The Kromme River Estuary

a) Navigability on the Kromme River Estuary

The level of navigability in the Kromme River Estuary is closely linked to the extent of *in-situ* sedimentation taking place (Thorpe, 2010). Increased levels of sedimentation lead to the constriction of the river channel, both in terms of width and depth. The constriction of the river channel makes navigation difficult. This is unfortunate because the Kromme River Estuary is a "natural sediment trap", with sediment entering the estuary from both the tidal head and inlet. As a result of the sediment build up navigation can be rendered virtually impossible in some areas during low tide.

In an unmodified system, the net long term rate of sediment buildup would have been relatively slow as periodic freshwater floods would have scoured the channels and removed accumulated sediment out to sea (Reddering & Esterhuysen, 1983). However, this clearing process has been disrupted through artificial modifications to the estuarine system (Reddering & Esterhuysen, 1983; Bickerton & Pierce, 1988). The construction of the Churchill Dam in 1943, and the later completion of the Mpofu Dam (previously named the CW Malan Dam) in 1982, has over time, reduced the freshwater discharge passing through the Kromme River Estuary (Reddering & Esterhuysen, 1983; Baird & Pereyra-Lago, 1992). These dams have a combined storage capacity of approximately 133 percent of mean annual runoff of the Kromme River. They supply water to both Nelson Mandela Bay and agricultural users. The effect of these dams has been to reduce the natural scouring power of periodic freshwater floods (Heymans, 1992). Shoaling (the creation of an underwater sandbank) associated with this level of sedimentation leads to reduced navigability in the estuary (Reddering & Esterhuysen, 1983).

Another source of sediment for the Kromme River Estuary is the Sand River[9]. It begins approximately two kilometres upstream from the mouth and deposits a small amount of sand into the estuary on the southern bank. This deposit is spread upstream and downstream in the estuary by the tidal currents. This increased sedimentation has been exacerbated by the creation of a large 'sand spit' which provides protection to the marina from strong south easterly gales (Bickerton & Pierce, 1988).

Channel constriction due to sedimentation build-up is mainly a problem in the lower part of the estuary – an area of approximately 70.63 ha or 706 300 m^2, stretching from the mouth to the confluence of the Kromme and the Geelhoutboom Rivers (Forbes, 1998).

[9] There is some evidence suggesting that the Sand River initially opened directly into St. Francis Bay. Later, it opened into the marshlands on the south bank of the mouth. More recently, however, these original outlets have been cut off by dune stabilisation and the development of the Marina Glades (Bickerton & Pierce, 1988).

The mean annual run-off for the Kromme River has been estimated at between 105.5 million m^3 (Reddering & Esterhuysen, 1983) and 116.8 million m^3 (Bickerton & Pierce, 1988). Upstream water abstraction (damming) and resultant sedimentation buildup has reduced the actual annual freshwater inflow into the estuary to approximately 0.011 million m^3 (Baird *et al.* 1992). This system is, therefore, almost totally denied freshwater input (Baird *et al.* 1992).

b) Boat congestion on the Kromme River Estuary

Current recreational activities

The Lee (2011) survey found the main recreational activities for the Kromme River Estuary to be: recreational shore fishing (38 percent), recreational boat fishing (18 percent), speed boating (13 percent), water skiing (6 percent), paddling (6 percent), jet skiing (1 percent), swimming (16 percent) and bird watching (1 percent). By way of comparison, the main estuary activities observed by Forbes (1998), were recreational fishing (34 percent), speed boating (23 percent), water skiing (23 percent), paddling (2 percent), and swimming (30 percent). Both of these assessments indicate that fishing and non-fishing motorised boating activities make up a large part of activities that occur in the Kromme River Estuary.

Recreational boating activities by estuary zone

The Forbes (1998) study broke up the recreational boating area of the Kromme River Estuary into four zones as illustrated in Figure 2.6. These zones, starting from the mouth of the estuary, stretch for approximately 8 km. Various recreational activities take place on this stretch of water, but some are focused within specific zones. Forbes's (1998) demarcation of these activities into the specified categories is not necessarily logical, but nevertheless represents the only available zoning information for the estuary.

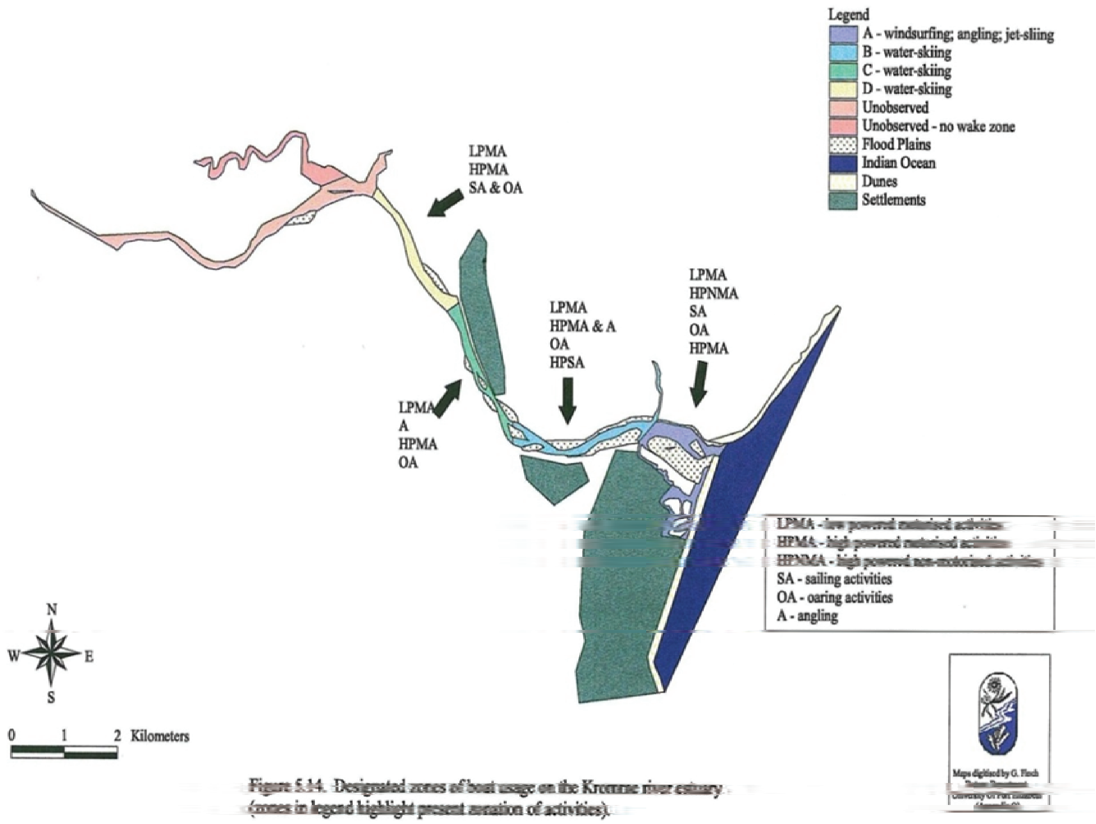

Figure 2.6: Recreational zones in the Kromme River Estuary
Source: Forbes (1998)

The different forms of boat usage identified by Forbes (1998) were:

- High powered motorised activities (HPMA) – high engine output motorised activities, for example, water skiing and jet skiing;
- High powered non-motorised activities (HPNMA) – windsurfing;
- Low powered motorised activities (LPMA) – motorised activities with low speed, for example, leisure cruising;
- Oaring activities (OA) – rowing, canoeing or paddle skiing;
- Sailing activities (SA) – non-motorised activities which use wind power, for example, sailing; and
- Recreational boat angling (A).

In zone A, the following activities were observed to take place, namely LPMA, HPNMA, SA, OA, and HPMA, in zone B, LPMA, HPMA, A, OA, and HPNMA, in zone C, LPMA, A, HPMA, and OA, and in zone D, LPMA, HPMA, SA and OA. Motorised boating activity occurs in all the estuary zones, but is most intense in zone D.

The most popular type of motorised watercraft is a cabin boat, followed by a speed boat (Forbes, 1998). Most of the boats' length range from 3 to 5 m, and are powered by 25-50 hp engines (Forbes, 1998).

The extent of boating on the Kromme River Estuary

The Kromme River Estuary is a popular tourist destination and heavily used for recreational purposes. Recreational use is concentrated over relatively short peak holiday periods, i.e. less than 30 days. Approximately 65 percent of people using the estuary own some form of water craft, and the most popular recreational activities include leisure cruising and water skiing (Forbes, 1998). In the 2009/2010 year the number of motorised water craft registered for use on the Kromme River Estuary was 1 100 boats. Added to this number must be the boats that obtain temporary registration for water craft usage on the estuary during peak periods.

In 1987 it was estimated that 8 950 people visited the Kromme River Estuary (Sowman, 1987). A decade later annual visitation levels had almost doubled (Forbes, 1998). In 1998, it was estimated that 1 400 residents and 13 500 visitors made use of the estuary for recreational purposes (Forbes, 1998). Yet another decade later the resident figure had almost doubled again. In 2010 approximately 4 200 households resided in the St Francis Bay area (Red Cap Investments (RCI), 2010). The number of recreational visitors to the estuary has risen exponentially since 1998. Approximately 35 000 visitors were recorded in the peak holiday month of December 2010 alone (RCI, 2010). Given these large increases in the number of residents and visitors to the estuary, as well as the problem of increased sedimentation and reduced navigability in the estuary, the occurrence of conflict between boat users of the estuary was inevitable.

Table 2.6 shows the area of each of the four zones, the average number of motorised craft using each zone according to the Forbes (1998) study, a 2010 estimate of the current number of motorised craft using each zone, and two estimates (a low and high estimate) of the recommended number of motorised craft per zone according to the Sowman and Fuggle (1987) formula (see Table 2.6). The Forbes (1998) study estimates for the number of motorised craft on the estuary were revised upwards by multiplying the given number by a percentage, representative of the increase in motorised water-based activity since 1998 (RCI, 2010). These estimates are conservative because the growth in visitor population since 1998 was not taken into account in its calculation.

Table 2.6: Motorised activity per zone for the Kromme River Estuary

Zone	Estimated Area (ha)[1]	Observed Motorised Activity[2]: Forbes (1998) Estimate	Motorised Activity[3]: Lee (2011) Study	Recommended Space Standard (RSS) (Sowman & Fuggle, 1987)[4] – Low Estimate	Recommended Space Standard (RSS) (Sowman & Fuggle, 1987)[5] – High Estimate	Excess Boat Use/ha
A	10.64	2.62	6.03	1.01	2.66	3.37
B	21.33	1.64	3.77	2.03	17.70	-
C	18.66	1.71	3.93	1.77	15.49	-
D	20.00	7.43	17.09	1.90	16.60	0.49

Notes:

(1) Estimated using an average estuary width of 80 metres (Forbes, 1998). This width is a high estimate because the levels of sedimentation have increased substantially since 1998.

(2) Motorised watercraft includes power boats, rubber ducks, sea boats and jet skis.

(3) The Lee (2011) study estimate is derived by multiplying the percentage increase in the residential population (200 percent) by the percentage of recreationists that according to Forbes (1998) own motorised watercraft, i.e. 65 percent. The Forbes (1998) estimate was adjusted upward by this percentage.

(4) The RSS for each zone was calculated taking into account the present zonation of activities and the activity with the most conservative RSS. In this case, zones B to D are zoned for water skiing only (RSS of 0.095/ha), while zone A is zoned for jet skiing only (RSS of 0.095/ha).

(5) The RSS for each zone was calculated taking into account the present zonation of activities and the activity with the highest RSS. In this case, zones B to D are zoned for leisure cruising only (RSS of 0.83/ha), while zone A is zoned for boat angling only (RSS of 0.25/ha).

As can be seen in Table 2.6, the estimated activity by Forbes (1998) exceeds the low estimate RSS in two zones, namely A and D. When compared to the high estimate RSS, the activity estimated by Forbes (1998) is very low in all four zones. The revised estimates of motorised activity in the current study exceed the low estimate RSS in all four zones. However, when compared to the high estimate RSS, motorised activity in only two of the zones is higher, namely A and D. It is important to note that the RSS applied above assumes only one motorised recreational activity is taking place per zone at one time. In reality, there is a mix of activities taking place at any one time in each zone. Moreover, the different activities taking place in each zone are very often conflicting ones. It is therefore necessary to determine a physical and social carrying capacity that allows different forms of motorised activity to take place in each zone at the same time. The concept physical carrying capacity refers to activity limits that are based on the sizes of each zone, whereas the concept social carrying capacity refers to activity limits that are based on users' perceptions of the size of each zone and potential conflicting activities therein. These issues of carrying capacity are discussed further below.

Boat carrying capacity of the Kromme River Estuary

i) Physical carrying capacity

An initial assessment of the recreational carrying capacity of the Kromme River Estuary found that the level of recreational use of the estuary by speed boats and sailing craft did not exceed the physical capacity limit (Environmental Evaluation Unit (EEU), 1986). A later study reassessed the physical carrying capacity of the estuary, and also found that the level of water-based recreational activity did not exceed the physical carrying capacity (Forbes, 1998). Total physical carrying capacity for the studied zones in the estuary in 1998 was calculated to be 295 water craft (Forbes, 1998). This figure included both motorised and non-motorised water craft. Forbes (1998) estimated the limit for water-based recreational activity to be approximately 115 craft at any given time. In order to calculate a physical carrying capacity that relates to motorised recreational activities only, a few adjustments need to be made to the information presented in Table 2.6 above. Table 2.7 below shows the physical carrying capacity per zone for motorised activities only.

Table 2.7: Physical carrying capacity for motorised activities – Kromme River Estuary

Zone	Estimated Size (ha)	RSS (Forbes, 1998) per ha[1]	RSS (Forbes, 1998) per Zone	Current Motorised Usage per Zone
A	10.64	0.055	0.59	6.03
B	21.33	0.06	1.28	3.77
C	18.66	0.11	2.10	3.93
D	20.00	0.316	6.32	17.09
Total	70.63	0.148[2]	10.29	30.82

Notes:

(1) *These figures were the current mean estimates of physical carrying capacity for the different motorised activities occurring within the designated zones (Forbes, 1998). The motorised activities were leisure cruising, water skiing, jet skiing and boat fishing.*

(2) *This value represents a weighted total based on estimated zone size.*

The total physical carrying capacity for all zones is calculated by adding up the recommended physical carrying capacity for each zone. This calculation is that there should be no more than a maximum of 10.29 motorised water craft on the estuary at any given point in time. The revised estimates of motorised craft usage for the current study (see Table 2.7) indicate that the total physical carrying capacity was exceeded by approximately 20 motorised water craft in 2010. All zones indicate an exceeded physical carrying capacity, but the excess is worst in zones A and D.

ii) Social carrying capacity

There are a wide range of recreational activities that can be accommodated on the Kromme River Estuary, but some of these activities interfere with the level of enjoyment of other users. A study conducted by Sowman and Fuggle (1987) considered user perceptions of various recreational activities conducted on the estuary in order to determine whether these activities could be supported without creating negative externalities for other users. The study found that approximately 73 percent of users felt that the social carrying capacity of the estuary was already exceeded, particularly over peak holiday periods (Forbes, 1998). This finding implies that the majority of the recreational users of the estuary believed that it is overcrowded and that any increase in recreational activities on the water would worsen the situation.

The level of boat congestion on the Kromme River Estuary

The Forbes (1998) study found that respondents considered motorised activities problematic in terms of the noise generated, and the danger associated with the high speed of the crafts. Also criticized, were the attitudes of water craft users'. It was felt that these users neglect boating regulations and were reckless. Respondents also were critical of the high number of motorised activities (Forbes, 1998). The vast majority of respondents (68.5 percent) felt that boat congestion constituted a serious threat to the quality of the recreational services provided by the estuary (Forbes, 1998).

c) The potential use of jet skis and wet bikes on the Kromme River Estuary

All jet skis/wet bikes that operate in the area controlled by the Kouga Municipality (St Francis Bay Marina, St Francis Bay Beach, Cape St Francis) or by the Western District Council (Kromme River) must be registered for that recreational purpose. The registration fee is the same as that paid by owners of standard motorised water craft, namely R169 per annum (pertaining to 2009/2010). Access to the Kromme River Estuary for the purposes of jet skiing or wet biking is, however, limited. The use of jet skis and wet bikes on the Kromme River Estuary is currently banned (St Francis Bay Ratepayers Association (SFBRA), 2011), partly because these motorised vehicles are noisy, and partly because this group have been blamed for a high proportion of irresponsible and reckless driving events in the estuary and for disturbing those swimming, fishing or waterskiing. They may, however, traverse through zone A (see Forbes (1998) study) for the sole purpose of accessing the open ocean through the estuary mouth.

The current status of jet ski and wet bike access

The recreational population are divided on whether jet skis/wet bikes should have complete access to the Kromme River Estuary. The Forbes (1998) study found that recreationists on the Kromme River Estuary were not in favour of jet ski/wet bike activities. Due to the negative social impacts of high noise levels, high travelling speeds, reckless behaviour and wide scale disregard for regulations, the majority of the respondents suggested that they remain in excess of 80 m away from other recreational users at all times (Forbes, 1998). Statistics from the California Department of Boating and Waterways in the United States of America (USA) revealed that about half of the recreational boating accidents were caused by jet skis, whilst only accounting for 11 percent of all motorised craft registrations (Forbes, 1998). This negative sentiment towards jet skiers and wet bikers was also evident in the Lee (2011) survey, with approximately 61 percent of respondents believing that the use of jet skis/wet bikes were a threat to the quality of the recreational services provided by the estuary.

Effort by concerned jet skiers/wet bikers to have these craft reinstated on the Kromme River Estuary has taken two forms. First, a jet ski club was formed, which is affiliated to the Port St Francis Ski Boat and Yacht Club. Second, a proposal was tabled at a Kromme River Joint River Forum meeting to reinstate the use of jet skis and wet bikes on the Kromme River Estuary (see Appendix A). They proposed that all jet ski/wet bike owners who wish to operate on the estuary must be fully paid up members of the jet ski club, all members be issued with a club identification number and each member be expected to adhere to the rules of conduct as set out by the jet ski club. In addition, they proposed that all jet skis and wet bikes be subject to an annual safety inspection by an accredited safety officer, and all jet-propelled craft owners must hold a valid skipper's license. Along with the rules of conduct, a disciplinary code was also developed to punish those who don't abide by the rules of conduct. At the time of writing, this proposal had yet to be accepted.

2.3.2.3 The Nahoon River Estuary

a) The issue of water quality

The relevant focus group felt that water quality in the Nahoon River Estuary had been compromised due to:

- Under-capacity of the sewerage infrastructure,
- Inadequate management and maintenance of the storm water and sewerage transfer infrastructure,
- Pollution by the local population and failed refuse collection, which ultimately leads to this refuse finding its way into the storm water system, and
- An inadequate volume of water flowing from upstream, i.e. poor instream inflow.

The group argued that reduced water quality makes swimming, boating and fishing hazardous, but felt that with improved municipal management of the sewage that improved quality was readily achievable. With this in mind, they identified the following three levels for water quality as feasible management options for the estuary: Not safe for any activity involving skin contact with water, nor eating fish; Safe for all recreation activities except ones with high water contact, for example swimming; and Safe for all recreation activities (through appropriate improved management of the pollutants).

b) Municipal support for recreation in the form of supporting facilities

The relevant focus group felt that the recreational attractiveness of the Nahoon River Estuary had been compromised due to: steep banks, private land ownership and poorly planned and maintained facilities. In order to enhance the recreational experience, they argued that the municipality could improve public access, develop a waterfront nature trail, possibly on both sides of the estuary banks, and restore the Nahoon campsite and surrounding facilities.

With this in mind, they identified the following three levels for improved municipal support facilities for recreation in the estuary: Leave the public recreational facilities as they are; Improve public facilities by upgrading and restoring the camping and other recreational facilities at the mouth of the estuary; and upgrade and restore the camping and other recreational facilities at the mouth of the Nahoon Estuary and improve public access to walkers along the banks by developing a waterfront nature trail on both sides of the estuary banks.

c) Protection from crime (personal security during recreation)

The focus group felt that the level of security and support services at the mouth of the estuary has deteriorated over time, with the result that recreational users of the estuary are subject to increased levels of criminal activity. They pointed out that the attractiveness of the public facilities and land was not maintained and a blind eye was being turned by the municipality to vagrancy in the estuary area. These 'seedy' trends correlated with an increase in incidences of opportunistic criminal activity. This detracting crime feature can be reduced through increased policing.

With this in mind, they identified the following two levels of crime protection and deterrence effort in the area: Leave the personal security service levels as they are (current police and municipal service level plus supplementation by volunteer contributions); and Increase personal security services at the Nahoon Estuary Mouth area, by, for example, reducing the scope for vagrancy and increasing patrolling by security personnel.

2.3.2.4 The Gonubie River Estuary

a) The issue of water quality

Similar to the Nahoon River Estuary focus group discussions, the Gonubie River Estuary focus group felt that the safety of the water in the estuary has been compromised. An additional cause of concern was inadequate control of agricultural fertilizer and farmland soil erosion discharging into the estuary. This reduction in water quality makes swimming, boating and fishing hazardous. With this in mind, they identified the following three levels for water quality as options for the Gonubie River Estuary: Not safe for any activity involving skin contact with water or eating fish; Safe for all recreation activities except ones with high water contact, for example, swimming (status quo); and Safe for all recreation activities.

b) Control and restriction on development of the banks
The Gonubie River Estuary is a small estuary and has a limited recreational space available for the use of speed boating recreational activity. The views and setting along the estuary are naturally beautiful and the serenity of this setting, its tranquillity and calm aura are in themselves natural recreational assets. In order to enhance the recreational experience, the focus group felt that the key management decision was how much and how far future development should be allowed to take place away from the estuary.

With this in mind, the focus group identified the following three levels for development along the banks of the estuary: Allow no further development along the Gonubie River Estuary (status quo); Allow limited further development on the estuary only if thoroughly analysed and approved / authorised; and cease to regulate development along the banks of the Gonubie River Estuary (a situation equivalent to normal building restrictions, but nothing extra to protect the estuary recreation experience).

c) Protection of recreational users of the estuary from crime
The focus group felt that the level of security and support services at the mouth of the Gonubie River Estuary had deteriorated over time. They argued that the area looks uncared for, the boardwalk is neglected and an increase in vagrants in the estuary area. This neglect has correlated with an increase in incidence of opportunistic criminal activity, and this has deterred recreational activity and business. With this in mind, the focus group identified the following two levels for the security services of the area: Leave the personal security service levels as they are (current police and municipal service level plus supplementation by volunteer contributions) – status quo; Increase personal security services at the Gonubie Estuary Mouth area, by, for example, reducing the scope for vagrancy and increasing patrolling by security personnel; and Ensure complete personal security through permanent visible policing and high-tech surveillance monitoring.

2.4 CONCLUSION

There are a number of recreational challenges facing South African estuaries (Chapter one), some of which are also concerns at the Sundays, Kromme, Nahoon and Gonubie River estuaries. In the case of the Sundays River Estuary, over-fishing, coupled with high retention rates of undersized fish has led to concerns with regard to the sustainability of fish stocks into the long-run (Cowley *et al.* 2009). The high levels of demand for use of the estuary space by motorised boat users has led to congestion costs being imposed on other estuary users, for example, yachtsmen, sailboarders and canoeists (Cowley *et al.* 2009). Public access is also limited, with a demand for investment in projects aimed at improving the recreational appeal of the estuary banks (Cowley *et al*. 2009).

In the case of the Kromme River Estuary, navigability was found to be decreasing due to, *inter alia,* increased sedimentation. The sedimentation balance has been disrupted through the abstraction of freshwater inflows (Scharler & Baird, 2003). This estuary also suffers from high levels of demand for use of the estuary space by motorised boat users, and the imposition of congestion costs on other estuary users by new (extra) entrants, especially during peak holiday season (Forbes, 1998; Lee, 2011). The use of jet skis and wet bikes on the estuary also has the potential to impose external costs on users of other types of water craft (Forbes, 1998).

In the case of the Nahoon and Gonubie River estuaries, safety of the water for recreational use and the adequacy of protection of recreational users from criminal activity have been identified as key recreational concerns. In addition, at the Nahoon River Estuary the commitment of the municipality to providing and maintaining supporting facilities for recreation is a major concern, and at the Gonubie River Estuary the policy towards the development of the banks is a major concern.

Through appropriate interventions it would seem possible for management to improve the recreational experience of the users of these estuaries. How may Economics be used to manage these challenges? Chapter three explores the ways in which these challenges can be managed through the adjustment of key economic control variables.

CHAPTER THREE: MANAGING DEMAND CHALLENGES THROUGH ECONOMIC CONTROL INSTRUMENTS

3.1 INTRODUCTION

The principle players in the recreational demand challenges facing estuary managers are property owners, boat owners and fishers, and the principle instruments with which they have to manage are with respect to the rights of property owners, education campaigns and social persuasion and command and control regulation.

Chapter three explains how these control variables can be used to bring about targeted welfare improvements, in the context of specific demand challenge examples. The examples of management challenges selected for case study are: exploitation of fish stocks in the Sundays River Estuary, motorised boat congestion on both the Sundays and Kromme River estuaries, public access at the Sundays River Estuary, navigability at the Kromme River Estuary, and the use of jet skis/wet bikes at the Kromme River Estuary. The selection of these examples was (in part) motivated by knowledge of which CE results were found to be valid (as reported later in Chapter six)

3.2 THE OVER-EXPLOITATION PROBLEM

Estuaries can be thought of as common property resources – a class of resources for which exclusion is difficult and joint use involves substractability (Berkes & Farrer, 1989). A common property resource can also be defined as one held by an identifiable community of interdependent users (community members). These users have a right to exclude others (non-members) from using the resource and have rights and duties with respect to the use of the resource (Fenny, Berkes, McCay & Acheson, 1998). Non-members have a duty to adhere to the exclusion.

In the case of open access resources, there are no defined users or owners, i.e. there are no property rights. As such, individuals have a privilege, but no right to use the resource, and benefit streams from the common pool resource are available to anyone (Bromley, 1991). No user has the right to preclude use by any other party – a situation that can lead to the "tragedy of the commons" (Hardin, 1968).

There are three complementary "schools of thought" on how to avert the tragedy of the commons (Johnson, 1972). One school advocates the use of private property rights (Demsetz, 1967; Smith, 1981). Another school advocates social education toward voluntary compliance with sustainable use (Wade, 1987; Chopra, Kadekodi & Murthy, 1989) and yet another in (command and) control regulation by government organizations.

The open access nature of many estuaries means that the scope for control through the (private) property right mechanism is limited – by Law there are no formal property rights over the estuary resources *in situ*. A physical unit of a resource like fish stocks cannot be owned. However, this does not mean private property rights do not limit use – they frequently do – by virtue of the land being privately owned through which there is access to certain parts of the estuary.

The use of social awareness advertising campaigns is common and probably effective, at least in the long-run. However, given the dire situation the resources at some estuaries are in there is also a need for implementing instruments that can achieve positive results in the short-run as well as long-run. For this reason regulation be government organizations would seem essential. The government has various control instruments available to it. One type is limiting the type of activity that may take place in a given area, e.g., by declaring it a marine protected areas (MPA), closed area and national park. These measures are governed largely by the Marine Living Resources Act (Act No. 18 of 1998). In the case of MPAs, no fishing, construction work, pollution, or any form of disturbance is allowed unless written permission has been granted by the Minister. In closed areas, fishing is restricted or prohibited entirely. National parks can also include marine areas like estuaries. Only a handful of South African estuaries are MPAs or closed areas or in national parks. Overwhelming most estuaries along the South African coastline are administered by municipalities, where there has been a long tradition of open access and exploitation. In these other types of control instrument are more feasible – zoning areas for different uses, provision of recreational support services and the application of use charges and license fees.

The remainder of Chapter three considers case studies where mixes of the latter type of control instruments are applied.

3.3 THE EXPLOITATION OF FISH STOCKS IN THE SUNDAYS RIVER ESTUARY

Like other goods, recreational fisheries provide utility to individuals and resource owners. Unlike many other goods, however, recreational fisheries constitute common pool resources whereby one angler's catch of fish reduces the harvest potential for other anglers (Kahn, 1998). Recreational fisheries share the open access externality problem with commercial fisheries.

3.3.1 CURRENT LEGISLATION GOVERNING THE SUNDAYS RIVER ESTUARY FISHERY

The Sundays River Estuary fishery lies within two local authorities, namely, the Nelson Mandela Bay Municipality (NMBM) and the Sundays River Municipality (SRM) (Afri-Coast Engineers, 2004). The Sundays River Estuary fishery, as with all other saltwater fisheries in South Africa, is managed through the issuing of fishing permits and the enforcement of bag and size limit regulations. The current bag and size limits for the three main species of interest are shown in Table 3.1.

Table 3.1: Bag and size limits for the Sundays River Estuary fishery

Recreational Fish	Bag Limit (Number of Fish per Day)	Size Limit (Minimum Size in cm)
Dusky Kob	1	60
White Steenbras	1	70
Spotted Grunter	4	40

Source: Cowley et al. (2009)

Of all the fish kept, 47 percent were below the legal size limit (Cowley *et al*. 2009). Of the dusky kob kept, 63 percent were below the size limit, of the white steenbras kept, 100 percent were below the size limit, and of the spotted grunter kept, 30 percent were below the size limit.

In 2009, adherence to daily bag limits per fisher outing was 2.6 percent for dusky kob, and 0.1 percent for spotted grunter. No white steenbras larger than the legal size were caught during the period monitored by Cowley *et al.* (2009).

Part of the reason for the disregard for bag and size limits is ignorance – 87 percent of respondents in the Cowley *et al.* (2009) survey did not know the regulations. Another equally important reason is lack of law enforcement effort – only 71 percent of respondents said they had acquired a fishing permit for the survey period in question, and almost 60 percent of all respondents reported that they had never before had their catches inspected. Law enforcement officers were only encountered once before by 11 percent of the respondents (Cowley *et al.* 2009). Law enforcement at the Sundays River Estuary is the responsibility of the NMBM because the estuary is located within the boundaries of the municipality. All the policing of the Sundays River Estuary is carried out by one conservation officer.

3.3.2 A THEORETICAL MODEL FOR THE RECREATIONAL FISHERY

When analysing a recreational fishery, it is important to conduct both short-run and long-run analyses. The difference between the two time periods relates to the effects anglers have on the fish stocks (Flaaten, 2010). In the short-run, there is often a negligible effect on the fish stock, whereas in the long-run there may be a sizeable effect.

3.3.2.1 Short-run analysis

A conventional linear downward sloping demand curve is assumed, where:

$$p = p(D,Q) = \alpha - \beta D + \gamma Q \text{, for } Q > Q^0 \tag{3.1}$$

where:

- D is the demand for fishing, measured by days of fishing (number of licenses issued daily),
- p is the price of a fishing license,
- Q is the quality of the fishing experience, defined as the quantity of fish caught per day of fishing (Q^0 represents the lowest level of quality that attracts anglers to this fishery),
- α is the constant of the linear demand function,
- β is the slope of the linear demand function representing the marginal WTP for an angler day, and
- γ is the quality constant of the linear demand function representing the marginal WTP for quality (Flaaten, 2010).

Total revenue (TR) is pD or $(\alpha - \beta D + \gamma Q)D$. The supply curve shows the total marginal cost of issuing and handling licenses. Total cost is:

$$C(D) = cD \tag{3.2}$$

and marginal cost:

$$\frac{\partial C(D)}{\partial D} = c \tag{3.3}$$

Figure 3.1 shows the demand curves for two levels of quality, namely Q^1 and Q^2, with $Q^2 > Q^1$.

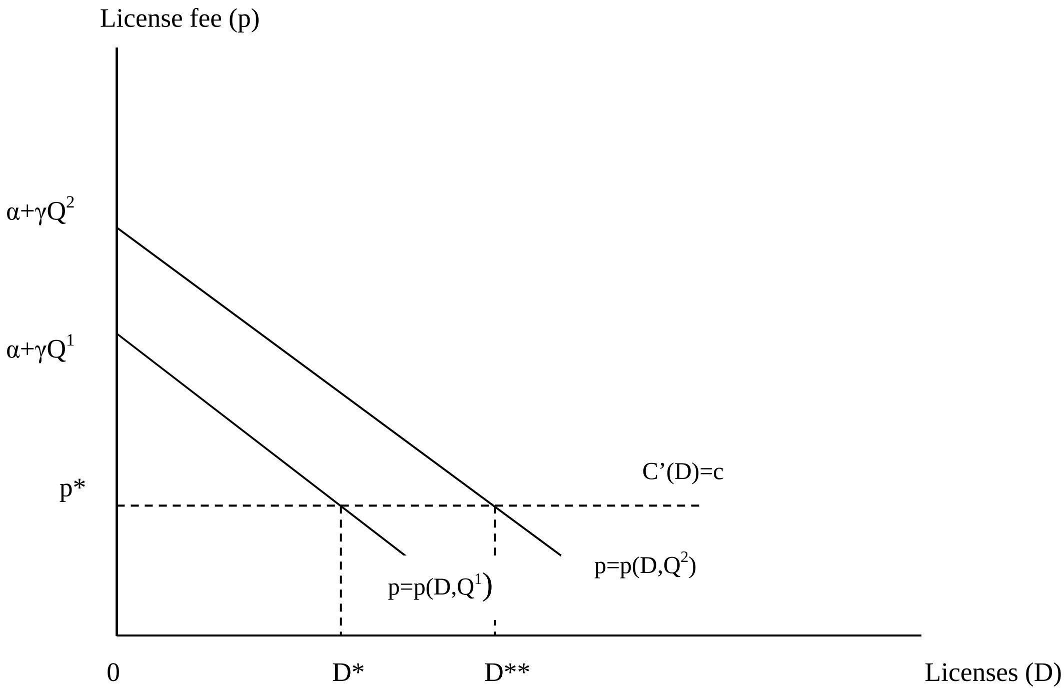

Figure 3.1: Demand and supply for daily angler licenses at two quality levels
Source: Adapted from Flaaten (2010)

In a competitive market for daily issued licenses, the market clearing price will establish where the marginal WTP equates to the marginal cost, c which is set at p*, a constant (see Figure 3.1 and Equation 3.4).

$$c = \alpha - \beta D + \gamma Q \tag{3.4}$$

or

$$\beta D = \alpha + \gamma Q - c\,.$$

So that the equilibrium number of angler days purchased/sold (D**) is:

$$D^{**} = \frac{\alpha + \gamma Q - c}{\beta} \tag{3.5}$$

In order to maximise profit (and resource rent) it is necessary to maximise:

$$\begin{aligned} \pi &= TR - cD \\ \pi &= D(\alpha - \beta D + \gamma Q) - cD \qquad (3.6) \\ \pi &= \alpha D - \beta D^2 + \gamma QD - cD\,. \end{aligned}$$

The necessary condition for maximising π with respect to D is:

$$\left(\frac{\partial \pi}{\partial D}\right) = \alpha - 2\beta D^{M} + \gamma Q - c = 0$$

or

$$c = \alpha + \gamma Q - 2\beta D^{M} \tag{3.7}$$

or

$$D^{M} = \frac{\alpha + \gamma Q - c}{2\beta} \tag{3.8}$$

Where

D^M is the profit (rent) maximising the number of angler days sold.

Figure 3.2 shows the profit maximising solution.

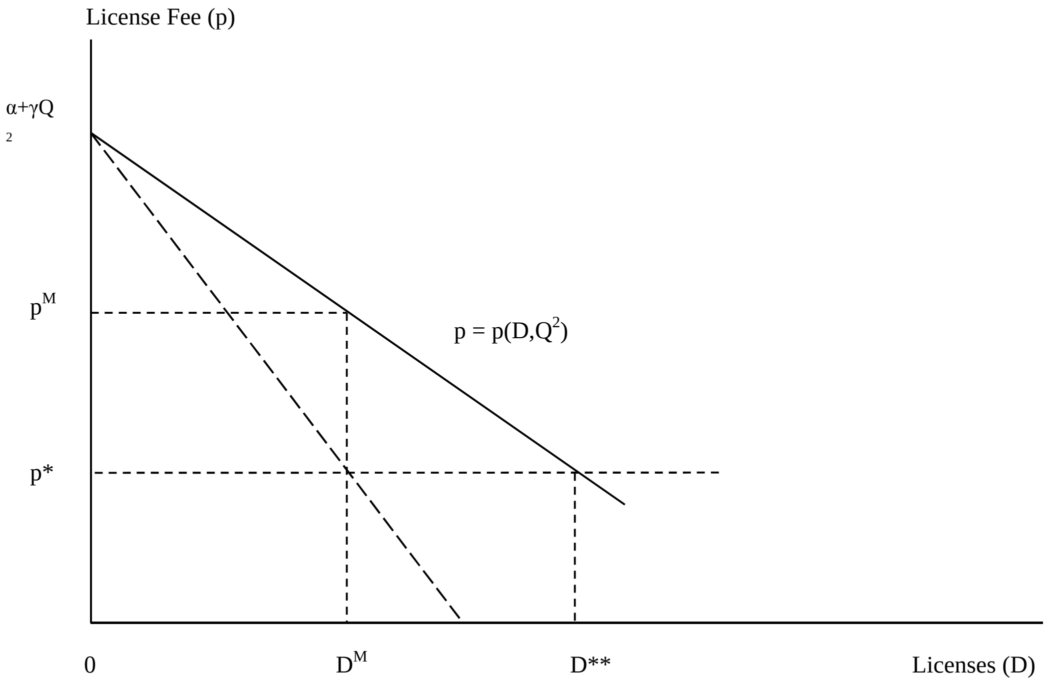

Figure 3.2: The monopolist's daily angler license model
Source: Adapted from Flaaten (2010)

The number of licenses purchased at a fixed price p*, namely D^{**}, is larger than would be issued in order to maximise profit (rent), namely D^M – double the number in this case (Flaaten, 2010).

3.3.2.2 Long-run analysis

The above analysis relates to the short-run and neglects the effect anglers' fishing might have on the fish resource. Increased angling pressure can negatively affect fish stocks, reducing the quality of the fishing. To incorporate this effect into the recreational fishing model, changes in quality (*Q*) are included in the analysis.

Quality changes take place over the long-run. A new resource adjusted angler demand curve (the long-run demand curve) can be derived to incorporate quality changes (Flaaten, 2010). To this end, a logistic growth model and an angler harvest function must be employed.

The logistic growth model takes the following form:

$$f(X) = rX(1 - \frac{X}{K}) \qquad (3.9)$$

where:

X = the fish stock level,

r = the maximum (intrinsic) growth rate, and

K = the carrying capacity for the fish stock (Field, 2001).

The angler harvest function is given by:

$$H = qDX \qquad (3.10)$$

where:

H = the total catch per year, and

q = the catchability coefficient of the fishery (Field, 2001).

The long-run productivity of the fishery will vary with the number of angler days (number of licenses issued):

$$Q = Q(D) = \frac{H}{D} = qK\left(1 - \frac{qD}{r}\right) \qquad (3.11)$$

Substituting for Q in Equation 3.11 into the inverse demand curve equation (3.1) yields:

$$p(D) = \alpha - \beta D + \gamma qK\left(1 - \frac{q}{r}D\right) = a - bD \qquad (3.12)$$

where:
$a = \alpha + \gamma qK$;

and

$$b = \beta + \frac{\frac{\gamma qK}{r}}{q}$$

Equation 3.12 is a resource adjusted demand curve. It is corrected for the negative effect fishing has on the resource stock and on catch per angler day. The resource adjusted demand curve and the short-run demand curves are illustrated in Figure 3.3 (Field, 2001; Flaaten, 2010).

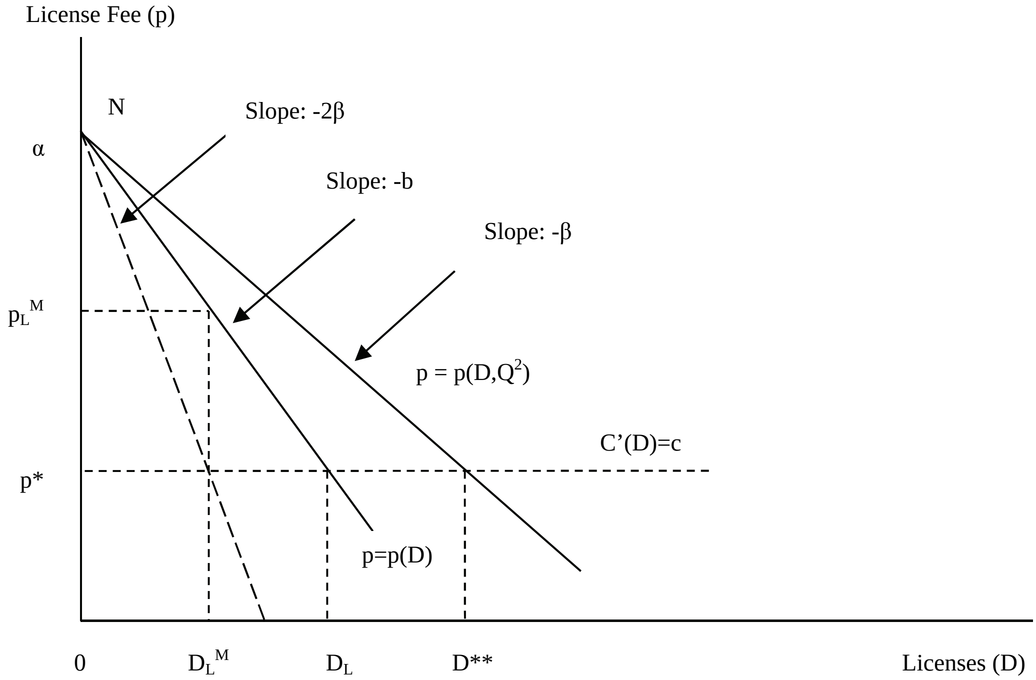

Figure 3.3: The short-run demand curve and the resource adjusted demand curve

Source: Adapted from Field (2001) and Flaaten (2010)

In Figure 3.3, the short-run demand curve in a competitive environment has a slope equal to –β. The short-run demand curve adapted for sole ownership is the steepest of the three curves and has a slope equal to -2β. The resource adjusted demand curve is positioned between the two short-run curves and has a slope equal to -*b*. As anglers' WTP for fishing quality (γ) and the catchability coefficient (*q*) increase, the difference between the competitive demand curve slope and the resource adjusted demand curve slope increases. The resource adjusted demand curve is also affected by the biological characteristics of the fish stock (*r* and *K* in Equation 3.12). The higher *r* and *K*, i.e. the more productive the resource, the higher the WTP for an angling day (p(D)).

3.3.3 AN ALTERNATIVE APPROACH TO FISHERY MANAGEMENT

Most fishery management initiatives are aimed at controlling effort levels through the use of command-and-control restrictions, the imposition of catch limits or the implementation of transferable catch quotas (Field, 2001). These initiatives relate to the management of a commercial fishery and not a recreational one. Initiatives specifically aimed at managing a recreational fishery are limited. For this reason an alternative management approach is necessary.

The recreational fishing model described above (see Figure 3.3) shows that as Q declines, so does the demand for angler days, but not in terms of the revenue yielded. Since recreational fishing is driven by utility considerations and not revenue ones, a decrease in fishing quality will not necessarily drive down effort levels. The stock of fish in the Sundays River Estuary is already negatively affected by recreational over-fishing (Cowley *et al.* 2009) and thus the quality of the fishing reduced (reduced the average catch per angler day). Falling stock levels and fishing quality, however, do not necessarily reduce the demand for fishing licenses by much because recreational fishing effort is not regulated by revenue yield – poor revenue yield does not automatically curtail fishing effort as it would in a commercial fishery.

Under normal circumstances, D_L licenses would be demanded per day at a price per license of p*. In the case of an over-exploited fishery, such as the Sundays River fishery, the quantity of licenses demanded will have to drop to the profit maximising level of D_L^M issued per day in order to restore stock levels. To get quantity demanded to drop to this level thereby reducing effort, the price per license will have to increase to P_L^M to reach equilibrium and sustainability in the long-run. How is this level to be determined?

As utility and demand is the reference for setting this price, it makes no sense to set the price with reference to the population biology of this fishery and the stock-yield and effort-yield functions. The price has to be set with reference to a utility maximizing model of choice.

3.4 CONGESTION AND RELATED TRADE-OFFS SPECIFIC TO THE SUNDAYS RIVER AND KROMME RIVER ESTUARIES

3.4.1 A THEORETICAL OVERVIEW OF CONGESTION EXTERNALITIES

People are often more an attraction than detraction in recreational activities, especially within the younger cohorts, because of the social element in recreation. For this reason, as a general rule, increased human recreational demand at any given estuary will not necessarily reduce the recreational appeal of that estuary. However, certain types of recreational activity are prone to negative crowding effects. One of these is motorised boat use.

In order to analyse the negative crowding effects associated with motorised boat use, a demand analysis of recreational boating is useful. This demand will be affected by changes in population, income, transportation services, as well as the existence of substitute or complementary sites in the surrounding area (see Figure 3.4).

When the costs of boat entry are non-zero because there are externally generated congestion costs, the socially optimal levels of boat entry onto the water at a specific point in time will differ from market regulated entry – it will be less (see Figure 3.4). The model shown in Figure 3.4 distinguishes two demands – a private demand (D_p) showing WTP for boat entry onto the estuary, where no externally generated congestion costs are included, and a social demand (D_s) showing the net social WTP after deduction of the externally generated congestion costs.

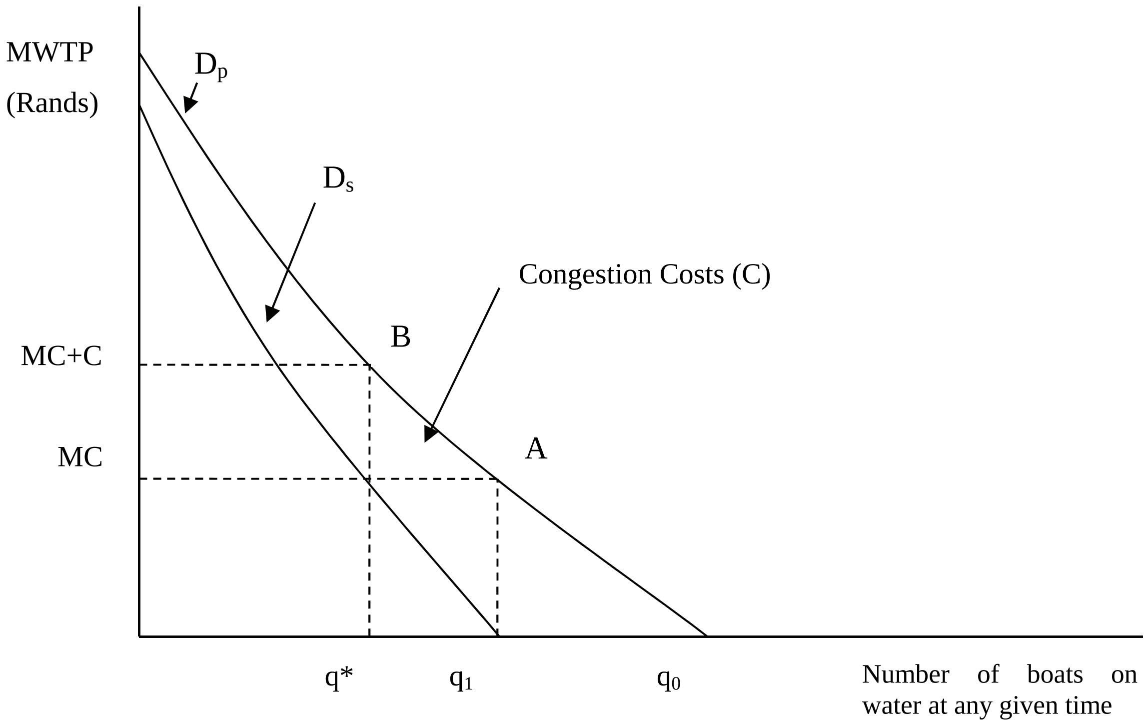

Figure 3.4: The socially efficient number of boats
Source: Field (2001)

Letting the entry fee for boating be MC, the demand for boat access is q_1, resulting in more boats (q_1- q*) on the estuary than would be socially optimal (where MC = D_s). The socially efficient (welfare maximizing) number of boats is q*. In order to discourage boat entry to the optimum level a supplementary levy on boats is required of C, the vertical difference between the two demand curves and also the marginal external congestion cost (Figure 3.4).

3.4.2 THE RULES GOVERNING BOAT USE ON THE SUNDAYS RIVER AND KROMME RIVER ESTUARIES

All powered craft used within the area controlled by a Municipality or Council must be registered, and the registration decal(s) displayed on the craft at all times. The Marine Notice No. 27 of 2008, released by the South African Maritime Safety Authority (SAMSA), requires that all skippers be in possession of a Certificate of Competence (CoC) and all vessels be in possession of a Local General Safety Certificate (LGSC) (SFBRA, 2011).

The Sundays River is controlled by the SRM. The area between the Pearson Park slipway and the public slipway adjacent to the Mackay Bridge (zones 3 and 4 in Figure 2.5) is zoned for jet skiing and water skiing. Apart from this zoning regulation, there are no other access restrictions limiting the movement of boats (Cowley *et al.* 2009), and hence, motorised boating activity is widely spread throughout the Sundays River Estuary.

The Kromme River Estuary waterways are controlled by two different authorities. The canals and a section of coastline from the low-water mark to 200 m offshore are controlled by the St Francis Bay Municipality. The Kromme River itself falls under the jurisdiction of the WDC. There are no access restrictions limiting the movements of boats through the Kromme River Estuary.

3.4.3 MANAGEMENT ALTERNATIVES

3.4.3.1 Formal regulation

a) Non-price rationing procedures

Open access to recreational areas has led to exploitation, congestion externalities and, in some cases, the general degradation of scarce natural resources (Field, 2001). One method of controlling use is by limiting access to these recreational areas. This limitation can be on the basis of ‘first-come-first-served’ or other methods. Once the limit of recreational users for that area has been reached, the entry points or permits are closed and no other user can legally gain access.

b) Price rationing procedures

A price rationing procedure is one that uses a fee to limit access to a recreational area (Field, 2001). This fee must be sufficiently high to reduce visitation to q* in Figure 3.4. This rationing mechanism not only limits the use of a scarce natural resource, but it also yields a revenue flow that can be used to manage recreation in the area. The effect of a higher fee on total revenue is dependent on the price elasticity of demand. From a revenue raising perspective, the implementation of a single access fee is sub-optimal for all users and for all periods. The external congestion cost is typically only incurred in peak demand periods. The WTP for use during a peak period is higher, and, *a priori*, the price elasticity of demand is lower (see Figure 3.5).

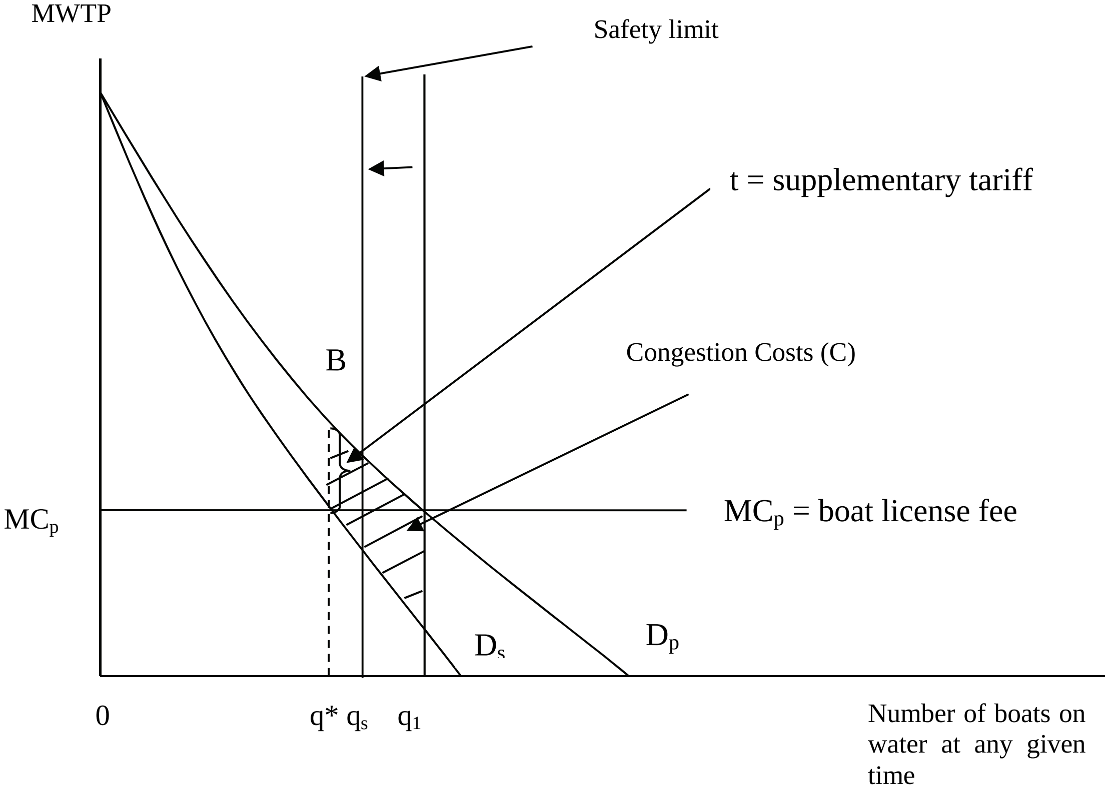

Figure 3.5: Peak period pricing for boat use

With no intervention, the boat use is q_1, where $MC_p = D_p$, but q_1 exceeds q_s, the safety limit, and also the boat users take no account of the external congestion cost (the vertical difference between the D_s and D_p curves). A welfare improvement in the situation is possible in this case by imposing a supplementary congestion cost tariff equal to the marginal congestion cost (MEC = t). As a result of this charge, demand declines from D_p to D_s, the number of boats on the water is reduced to $q^* < q_s$, a welfare gain of the shaded area is achieved and additional revenue is raised of (0q* x t). The key empirical question is what the appropriate tariff supplement should be.

3.4.3.2 No Regulation

If formal regulation is not applied, it is left to the market to resolve the issue of congestion. This approach assumes that the cost of congestion is internalised among the boat users and is not an externality in the traditional sense. The motivation for using the ‘no regulation’ option, is the belief that people use motorised craft according to their expected benefit gain, and this gain takes the presence of other boat users into account (rational expectations).

3.4.3.3 An assessment of the abovementioned management options

Rationing boat use through the implementation of a quota, or relying on self-regulation (automatic market resolution), are not generally considered as the most appropriate options for reducing boat congestion (Field, 2001; Flaaten, 2010). Quotas can be difficult to implement due to practical considerations, for example, prohibitively high costs and the need for competent physical enforcement (Field, 2001). Self-regulation will not work if one or a few of the boat users act selfishly and do not take other boat users into account. The use of peak load pricing has been effective, however, as (1) it provides users with economic incentives to use the resource during off-peak periods, and (2) it guarantees that the users that place the highest value on using this resource for boating purposes during peak periods are the individuals that are actually willing to pay for it (Van Kooten & Bulte, 2000).

Under these circumstances, the preferred management option is the use of prices to ration use. The correct price adjustment to make in this situation is to add a congestion cost (in the form of a supplementary tariff) to the existing boat license fee structure during peak use periods. The supplementary tariff required is the vertical difference between the demand curves in Figure 3.5.

3.5 PUBLIC ACCESS AT THE SUNDAYS RIVER ESTUARY

3.5.1 INVESTMENT IN THE IMPROVED RECREATIONAL APPEAL OF ESTUARIES

The theory and resultant policy relating to the demand for further investment in the recreational appeal of estuaries is limited, but follows the general demand and supply framework (Field, 2001). Figure 3.6 models the demand for and supply of improved recreational quality of estuary banks.

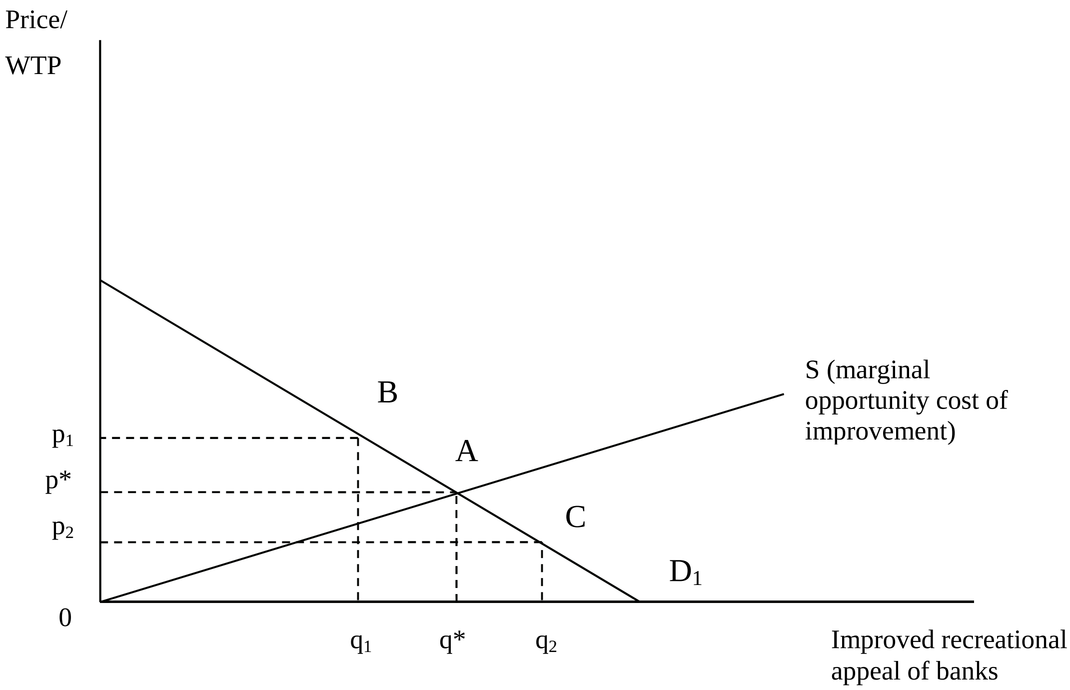

Figure 3.6: Proposed model for improved recreational appeal of estuary banks

The demand for improvement in the recreational appeal of estuary banks is given by demand curve D_1. Equilibrium is at point A in Figure 3.6, where private demand (D_1) equals the marginal opportunity cost of recreational improvements (S). Investments in improving the recreational appeal of the estuary banks are only efficient if the marginal benefit of this investment exceeds its marginal cost, such as an investment project located at point B. This project leads to improvements in banks of (q^*-q_1). For this project, the marginal benefit exceeds the marginal cost. In the case of an investment project located at point C, the recreational appeal of banks are improved from q^* to q_2. This project is inefficient because the marginal cost of this improvement exceeds its marginal benefit. The marginal WTP for a specific project can be estimated, for example, p_1 at q_1 can be estimated for a project located at point B, or p_2 at q_2 can be estimated for a project located at point C. Total WTP for a project located at point B will be equal to BAq_1q^*. This is an efficient project because total WTP exceeds TC. A project located at point C, however, will have a total WTP equal to ACq_2q^*. This is an inefficient project as TC exceeds total WTP. Without project cost information (MC) the researcher is unable to determine whether the quantity (q_1 or q_2) of a specified project is to the left (efficient) or right (inefficient) of q^*.

3.5.2 POLICY GOVERNING ACCESS TO AND USE OF ESTUARIES

The NWA governs public access to estuaries in South Africa, but is limited in terms of how this public access must be managed and conserved. More specifically, it states:

"A person may, subject to this Act— … (e) For recreational purposes – (i) use the water or the water surface of a water resource to which that person has lawful access; or (ii) portage any boat or canoe on any land adjacent to a watercourse…"

3.5.3 A PROJECT TO IMPROVE THE RECREATIONAL APPEAL OF THE SUNDAYS RIVER ESTUARY BANKS

In their status quo assessment report, Afri-Coast Engineers recommended that "… a continuous strip of green open space be preserved along the river banks (of the Sundays River Estuary) to form an aesthetic nature trail providing a valuable asset to the area for both local residents and tourists" (Afri-Coast Engineers, 2004). The green open space must constitute a sufficiently wide river frontage to allow for safe public access. It was further recommended that "… negotiations should be initiated with the private land owners who own private land along the river edges (of the Sundays River Estuary) to investigate a mutually beneficial partnership to conserve this ecologically valuable land" (Afri-Coast Engineers, 2004). It was also suggested that other privately-owned land be incorporated into conservancies, or bought by the NMBM, in order to conserve these areas and to incorporate them into the Nelson Mandela Metropolitan Open Space System (Afri-Coast Engineers, 2004).

The introduction of a nature trail fronting the banks of the Sundays River Estuary would improve the quality of the public land fronting the water's edge, and make it more appealing for recreational shore fishing, as well as provide further areas for other recreational activities, such as bird watching or walking. The marginal WTP at q_1 may be estimated with CM methods, i.e. p_1 in Figure 3.6, but the question of whether the project is efficient must remain unresolved in the absence of cost information for the proposed nature trail.

3.6 NAVIGABILITY ON THE KROMME RIVER ESTUARY

Navigability is a function of, *inter alia*, the amount of sedimentation that takes place over a period of time in a river bed. Sedimentation, in turn, is a function (in part) of the volume of instream flows. The less instream flows, the higher the buildup of instream sedimentation, and the less the navigability. Since the level of navigability is partly a result of the protection of instream flows, this study investigates the issue surrounding navigability of the Kromme River Estuary from an instream flow protection perspective.

3.6.1 NAVIGABILITY – THE THEORY

River water is in high demand in South Africa for urban and rural household consumption, inputs into production processes and agriculture (Sale, 2007). The abstraction of river water, has however, led to the degradation of estuarine environments in the form of habitat losses, and reduced recreational service yield. It is widely accepted that adequate instream flows protect the ecological and aesthetic values of the estuarine environment (Kahn, 1998; Field, 2001). They also provide the basis for many outdoor recreational activities, most notably, fishing, and boating. Instream flow water rights are governed by the NWA and the mandate to manage them is allocated to catchment management agencies. No such agency has yet been created for the Kromme River Estuaries. The amount of water that should be appropriated from a stream is dependent on the costs and benefits associated with these instream flows (Hosking, 2008). Figure 3.7 shows the costs and benefits of instream flows. The optimum freshwater level of instream flow for an estuary is defined as the level where the positive difference between the total benefit and total cost curves is maximised (Loomis, 1998).

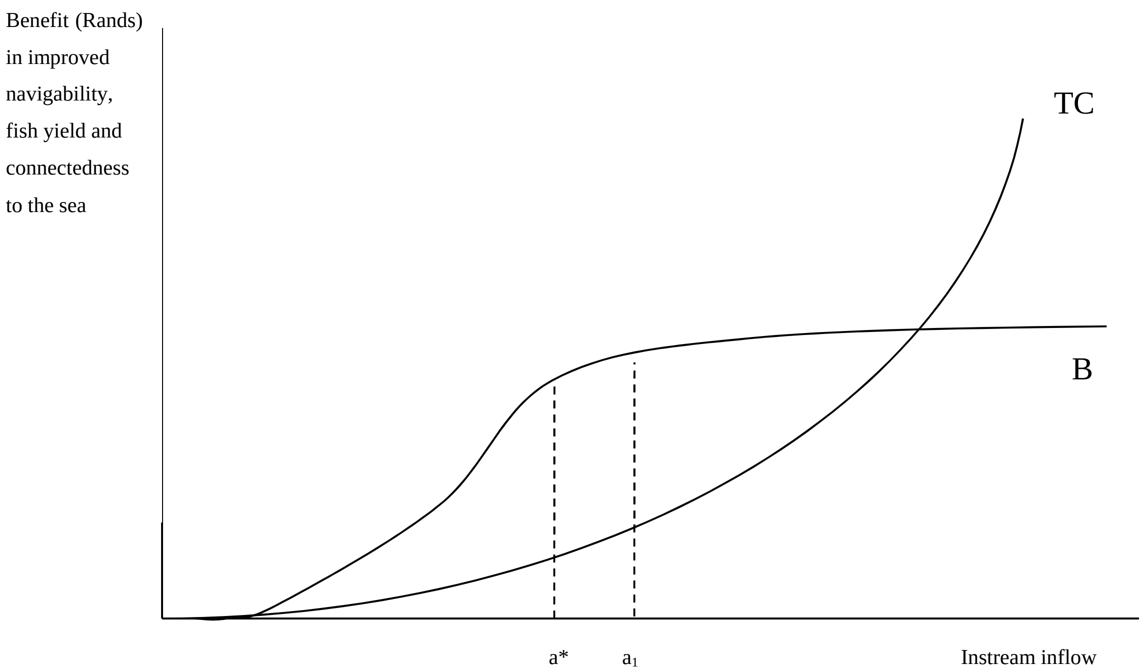

Figure 3.7: Benefits and costs of instream flows in an ideal model
Source: Field (2001)

The curve labelled B represents the total benefit curve. This curve begins on the x-axis, to the right of the origin, as a minimal amount of instream flows are required before any benefits can be accrued. In an ideal model, the benefit curve is initially steeply positive as instream flows yield substantial benefit and then levels out. The curve labelled TC is the cost curve. The slope of the curve is positive starting relatively flat and becoming steeper as instream flows increase along the x-axis. The cost of instream flows is the opportunity cost of this water not being abstracted upstream. It represents the value of the best alternative use forgone from water withdrawal. These values would depend on the purpose for which the water is withdrawn, i.e. urban consumption or irrigation for growing agricultural crops.

The instream flow that maximizes net benefits is a*. At point a*, marginal benefits are equal to marginal costs, i.e. the slopes of B and C are equal. This level of instream flows is economically efficient (net benefits are maximised).

This theory of instream flow protection is subject to a number of qualifications:
(1) The cost of instream flows will vary from estuarine system to estuarine system and across time;
(2) Since instream flows vary substantially from day to day, it is best to apply a mean annual figure in this type of analysis; and
(3) The benefit of instream flow protection will also vary from estuarine system to estuarine system.

3.6.2 POLICY GOVERNING THE ALLOCATION OF FRESHWATER FLOWS

The Department of Water Affairs and Forestry (DWAF) (currently known as the Department of Water and Environmental Affairs (WEA)) is re-examining the foundations underlying river water allocation in South Africa, with a view of incorporating conservation demand (Hosking, 2008). South Africa's Directorate of Marine and Coastal Management, which falls under the WEA, has, along with the local authorities, actively sought to formulate policies aimed at countering the degradation of estuaries.

3.6.3 MANAGEMENT OPTIONS FOR IMPROVING NAVIGABILITY ON THE KROMME RIVER ESTUARY – AS SUGGESTED USING ACTUAL VALUE INFORMATION

3.6.3.1 Increased instream flows

In a study conducted by Sale (2007), the value of freshwater inflows into the Kromme River Estuary was estimated by means of a contingent valuation (CV). Consultations with an estuarine expert, Prof T Wooldridge, suggested that an increase of 75.5 million m^3 per annum in freshwater inflows would lead to consequences of the following magnitudes: a 25 percent increase in angling fish that use the estuary, a 25 percent increase in the availability of mud prawn, and a 25 percent increase of foraging birds in the inter-tidal areas (Sale, 2007).

The results of the study showed that the median household WTP per annum for the suggested increase in freshwater inflows was R287. Taking into account the estimated number of households of 3 200, the total WTP amounted to R918 400 (Sale, 2007). This information can be used to generate the m^3 rand value of water flowing into the estuary. The specified change (75.5 million m^3 per annum) is divided by the total WTP figure, yielding a value of R0.012 per m^3 per annum (Sale, 2007) – R0.014 per m^3 per annum at 2010 price levels.

In order to establish a formal model of instream flow protection, Sale's (2007) benefit estimates must be compared to the costs of the best alternative use of this freshwater forgone. The correct cost of the freshwater is it's *in situ* price. The most conservative estimate of this price is the one paid by agricultural users and the best current estimate of the value of this water is the one charged by the Gamtoos Irrigation Board (GIB). The board charges an annual rate per scheduled hectare of R2 200. This entitles the user to a full water quota of 8 000 m^3 per ha per annum (Murray, 2011) and translates into an annual cost of R0.275 per m^3. The formal model, inclusive of actual benefit and cost estimates derived above, is shown in Figure 3.8. It is significantly different from the idealised model shown in Figure 3.7.

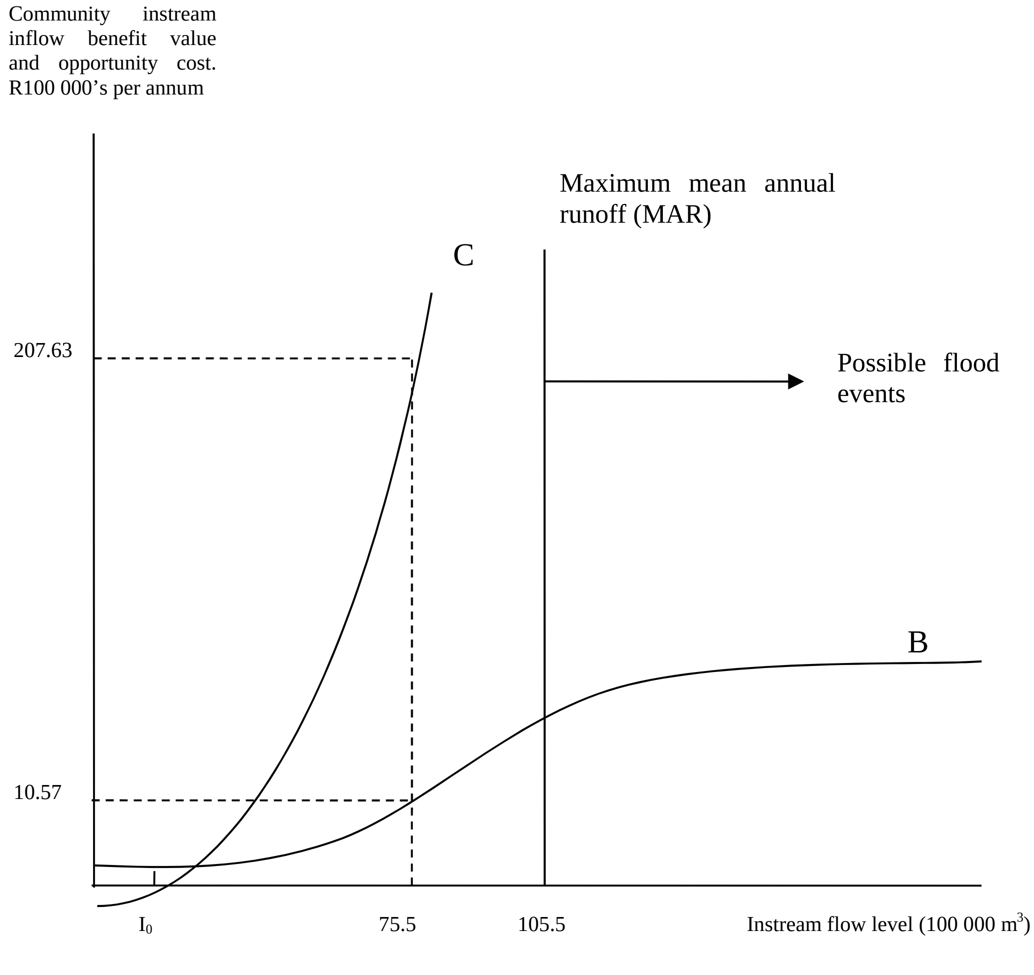

Figure 3.8: Costs and benefits of instream flow protection for the Kromme River Estuary

In Figure 3.8, the total benefit of instream flow protection in the Kromme River Estuary is above the total cost up to instream flow level I_0. This is because there is a small amount of freshwater inflow that keeps the estuary functioning – in the case of the Kromme River Estuary this amount of inflow is equal to approximately 11 000 m^3 per annum. The maximum MAR for the estuary is also indicated (105.5 million m^3). The benefit curve (B) slopes upward from the maximum MAR due to the positive effects caused by possible flood events. These positive effects are well documented in the literature (see Reddering & Esterhuysen, 1983; Heymans, 1992). Beyond I_0 the total benefit of instream flow protection is below the total cost at every instream flow level. More specifically, the total benefit of a 75.5 million m^3 increase in freshwater inflows (to secure a 25 percent increase in fish, mud prawn and foraging birds) equals R1 057 000, whereas the total value for an equivalent amount of water used upstream equals R20 762 500 (a net value surplus of R19 705 500).

The results of this study show that allocations based on marginal cost do not safeguard estuaries such as the Kromme River Estuary, because recreational demand tends not to be equivalent to (is increasing less than) urban and/or agricultural demand. An added complication to management through changing freshwater inflows is that feasible ones would have minimal effect on the estuary services provided to boaters. In other words, changing the amount of water that flows into the estuary is not a feasible option for changing the level of navigability of the estuary. Based on these cost and benefit considerations, a more economically feasible alternative to the release of freshwater to improve navigability is considered, namely dredging.

3.6.3.2 Dredging

An alternative way of improving navigability of the Kromme River Estuary is to dredge the channel bottom. Dredging involves the use of a machine equipped with a suction device which removes sand and silt from the channel bottom, deepening the waterway. Unfortunately it can come at a cost, for example, damaging prawn habitats. Currently, dredging activities are confined to the canal system in the marina. There are no immediate plans to extend the dredging to the main estuary channel (partly due to the environmental damage it can cause). A potential source for funding this dredging activity could take the form of an additional tariff imposed on recreational boat users of the estuary. In order to ensure holistic decision making by policy makers and the relevant stakeholders, a WTP amount should be compared to the costs of dredging. Assuming an area of 10 000 m^2 requires dredging, and a cost of hiring a dredging outfit of R30 per m^2 (SFBRA, 2011), the annual cost (excluding habitat damage) of dredging the main estuary channel would be R300 000. The total cost, including habitat damage, would be much higher.

3.7 THE USE OF JET SKIS/WET BIKES ON THE KROMME RIVER ESTUARY

3.7.1 THE ECONOMICS OF JET SKI/WET BIKE ACCESS

The model used in this study applies negative externality theory to explore non-jet ski/wet bike owners/users' views and perceptions of these personal water craft and their access to the estuary in question.

Figure 3.9 applies the negative externality theory to the jet ski/wet bike case.

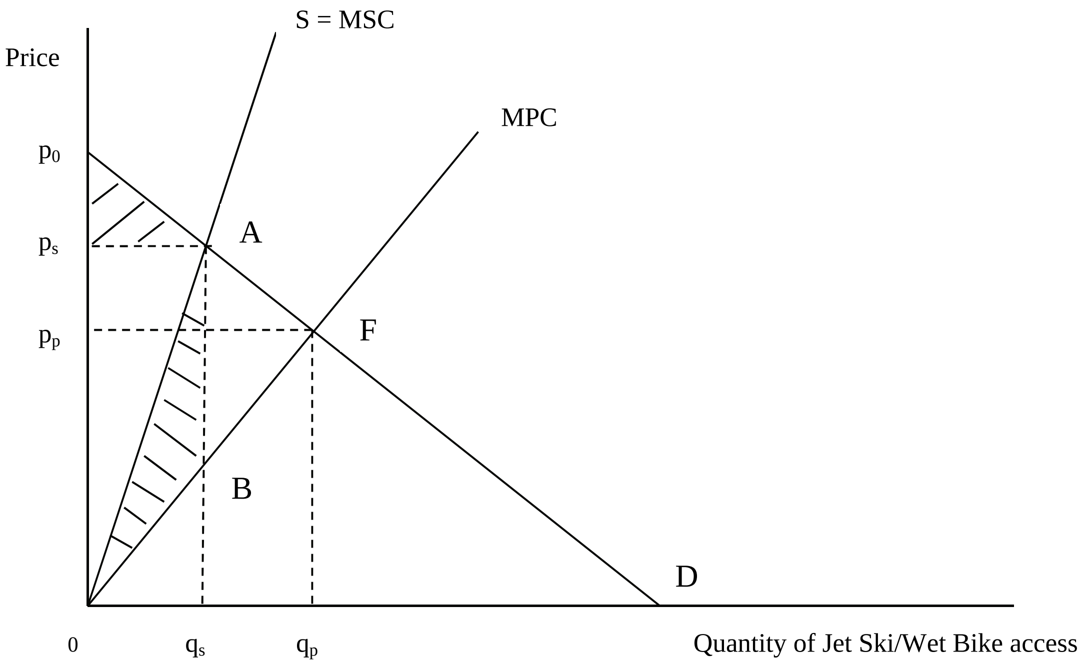

Figure 3.9: Negative externalities of jet ski/wet bike access

The socially efficient level of jet ski/wet bike access is q_s where MSC = D (point A). The right price for this access is p_s and the welfare benefit that could be gained by permitting access is the difference between the WTP for zero access (traversing allowed for accessing the sea only) and access based on social cost, namely p_sp_0A. The external cost imposed on others by this access (captured in the boat access fee) is AB0. It would be welfare improving to allow access at the access fee of p_s, but the gain accrues only to the jet skiers and wet bikers, namely shaded area p_sp_0A (WTP). The gain to jet skiers and wet bikers is also partly at an external cost to other users, namely shaded area AB0. These other users would have to be compensated (from the boat access fee collected) before this access could be considered efficient.

3.7.2 MANAGEMENT OF AND LAWS GOVERNING THE USE OF JET SKIS/WET BIKES ON THE KROMME RIVER ESTUARY

All jet skis/wet bikes that operate in the area controlled by the Kouga Municipality (St Francis Bay Marina, St Francis Bay Beach, Cape St Francis) or by the WDC (Kromme River) must be registered for that recreational purpose (SFBRA, 2011). The registration fee is the same as that paid by owners of standard motorised water craft, i.e. R169 per annum (pertaining to 2009/2010) ($p_s p_p$ less than welfare maximising – Figure 3.9). Access to the Kromme River Estuary for the purposes of jet skiing and/or wet biking is, however, limited. Currently, these jet-propelled craft are not allowed to operate on the Kromme River Estuary. They may, however, traverse through zone A (Forbes' 1998 study) for the sole purpose of accessing the open ocean through the estuary mouth.

In the absence of compensation being made to those imposed upon by the jet skiers, the welfare case for providing them with access rests on a comparison of gain ($p_0 p_s A$) with the uncompensated losses (0AB). This comparison is indeed something that the CM method is capable of informing.

3.8 CONCLUSIONS

There are a number of instruments available by which to restrain over-exploitation of South African estuaries, including private property right adjustments, education and social persuasion campaigns and government regulation. Given the dire situation prevailing at some of the open access estuaries, regulation would seem an essential element in the mix of control instruments employed.

Clearly, though there is some initial failure already taking place at this level. The laws and regulations relating to estuaries are often breached by the municipalities themselves and are often poorly monitored or enforced (Cowley *et al.* 2009). This lack of administrative effort results in a situation whereby the advantage of state interventions is not realised, and the problem of open access over-exploitation remains unresolved.

Chapter three discussed several case studies where the control variable license fees could be efficiently employed. With respect to over-fishing at the Sundays River Estuary, it was argued that this control instrument could contain recreational fishing effort, and that this merited further investigation into what adjustment in the boat license fee would be desirable from a welfare perspective.

With respect to boat congestion on the Sundays and Kromme River estuaries during peak periods, it was argued that it was also a feasible management option to use prices

– a supplementary tariff added to the existing boat license fee structure during peak use periods.

With respect to public access at the Sundays River Estuary, an investment project to improve access was proposed. The investment would entail the development of a nature trail fronting the banks of the estuary. To determine whether this project is efficient, information is required on users' WTP and costs involved for the projects implementation. In this case boat license fees are an inappropriate control variable because boat owners would not be the main beneficiaries of such a project.

Alternative approaches to improving the navigability of the Kromme River Estuary suggest that increased freshwater allocations may not be an attractive economic proposition, and that perhaps the use of dredging deserves further attention.

Economic control variables could be useful when they are applied to conflicts such as that over the use of jet skis and wet bikes on the Kromme River Estuary, but the current management regime does not approach the issue in a way that lends itself to optimising. Their use is prohibited in certain areas – so fee charging control is excluded as an option.

There would appear to be a number of demand challenges at the study sites selected where economic models suggest welfare improvements could be achieved through license fee adjustments. Chapter one argued that the calculation of such adjustments could be made through the application of the CE method. Chapter four overviews the CE method, while Chapters five and six apply it.

CHAPTER FOUR: THE CHOICE EXPERIMENT METHOD

4.1 INTRODUCTION

Additional license fees were advocated as an appropriate management control variable (instrument) for the Sundays and Kromme River estuaries (Chapter three), but how is this control to be affected? By how much should the licence fees be changed? If they are increased by too much, welfare (and recreational value) may actually decrease rather than increase. Chapter four will show how the CE method, a form of conjoint analysis, is suited to the task of generating information on the scale of change required in the control variable in order to bring about a welfare improvement. It also overviews and outlines the details of the CE method applied (a sub-objective of the Report).

4.2 A REVIEW OF SELECTED LOCAL AND INTERNATIONAL STUDIES

The CE method has been extensively used and developed for the valuation of environmental goods and services (Adamowicz, 1995; Boxall *et al.* 1996; Bennett & Adamowicz, 2001; Hanley *et al.* 2001; Hensher, Rose & Greene, 2005). Numerous international CE studies have been conducted into the valuation of wetland, estuary and river attributes in different countries, including Vietnam (Nam Do & Bennett, 2007), Sweden (Carlsson, Frykblom & Liljenstolpe, 2003; Eggert & Olsson, 2004), England and Wales (Economics for the Environment Consultancy (EFTEC)), 2002; Hanley, Adamowicz & Wright, 2002; Bateman, Cole, Georgiou & Hadley, 2005; Luisetti, Turner & Bateman, 2008), Greece (Birol, Karousakis & Koundouri, 2006a), Australia and Tasmania (Morrison & Bennett, 2004; Windle & Rolfe, 2004; Kragt, Bennett, Lloyd & Dumsday, 2007; Kragt & Bennett, 2009), and the United States of America and Canada (Opaluch, Grigalunas, Diamantides, Mazzotta & Johnston, 1999; Heberling, Shortle & Fisher, 2000; Smyth, Watzin & Manning, 2009).

Nam Do and Bennett (2007) estimated wetland biodiversity values by applying a choice model to the Mekong River Delta in Vietnam. Protection values were estimated for Tram Chim National Park, one of the many wetlands found in the Delta. The choice model employed five attributes, with four levels each, including a status quo option. The cost attribute was defined as a once-off change in the current monthly electricity bill. An orthogonal, main effects design was constructed for use in this study. The survey was conducted by means of personal interviews. In total, a sample of 917 respondents was interviewed from three main cities in the study area. The CE utilised the multinomial logit (MNL) model and random parameters logit (RPL) model to estimate implicit prices for the proposed wetland biodiversity plan. Total benefits were estimated at $3.9million. Nam Do and Bennett (2007) found that the benefits outweighed the costs of implementation, implying that social welfare would improve if more resources were allocated to the conservation of wetlands in Tram Chim.

Carlsson *et al.* (2003) conducted a CE in order to identify the characteristics of wetlands that individuals deem important. The study was conducted in a wetland area in Staffanstorp, located in southern Sweden. The majority of wetlands in this area have been eradicated due to urban and agricultural expansions. Individual WTP values were estimated in order to determine the value that individuals place on selected characteristics (attributes) of this wetland area. The choice model employed seven attributes, including a status quo option. Five attributes had two levels each and one attribute had three levels. The cost attribute had four levels and was defined as a once-off total cost per citizen falling within that specific municipality. The choice sets were created using a D-optimal design procedure. A random sample of 1 200 Staffanstorp citizens, aged between 18 and 75 years, was drawn from the Swedish census register. These citizens received the questionnaire through the mail and were sent one reminder after two weeks. In total, 468 questionnaires were used for the study. A RPL model was estimated using LIMDEP 7.0, and implicit prices were calculated for each attribute. Using these WTP values, it was found that biodiversity and walking areas were the greatest contributors to welfare, while introducing crayfish to the wetland and adding a 1 m fence to the waterline would actually decrease welfare.

Eggert and Olsson (2004) studied the economic benefits of improving coastal water quality in the coastal waters of the Swedish west coast. This improvement was investigated from a fishing, bathing water quality and biodiversity perspective. These three characteristics were set as the attributes and assigned three levels each. The additional cost variable (six levels) was defined as a user fee to be collected from all working age permanent citizens in the relevant municipalities. This amount would be paid on a monthly basis for a period of one year. A fractional factorial, main effects design was used to create the choice sets. Each respondent faced four choice set questions, and every choice set presented three possible alternatives, one of which was a status quo option. The sampling frame for the study was the Swedish Register of Inhabitants, and only respondents from the permanent population in the counties representing the southwest part of Sweden were randomly sampled. Questionnaires were sent out to 800 respondents via mail, of which 343 were returned, and 324 were deemed usable. The data was analysed using mixed MNL models. The calculated marginal WTP values revealed that respondents prioritise improvements in fishing stocks, and want increased efforts aimed at preventing biodiversity loss.

EFTEC (2002) conducted a CE study on the value of benefits that could be derived from a revised bathing water quality directive in England and Wales. The objective of this study was to determine people's WTP for improvements to water quality and other defined beach characteristics that could occur from the implementation of such a directive. Focus groups identified the following beach attributes, namely water quality, an advisory note system, litter/dog mess and safety and amenities. The additional cost attribute was defined as an increase in water charges per household per year. A fractional factorial main effects design produced eight different choice sets. Each respondent answered eight choice set questions which incorporated three alternatives each. Two alternatives represented improvements, while the third represented the base case or status quo alternative. A representative sample of 809 respondents was interviewed and the data from the usable questionnaires captured. The nested logit (NL) model was used to calculate marginal WTP values for each attribute. Most respondents preferred some level of improvement to the current situation. The most preferred changes based on WTP values were to eliminate dog mess and litter, and to introduce an advisory note system on bathing water quality.

Hanley *et al.* (2002) conducted a CE to estimate the value of improvements in the ecological status of the River Wear, in Durham, England. This CE was aimed at testing whether the levels of attributes used in the experimental design affected preference and welfare estimates. The use of focus groups helped identify the attributes used in the study, namely ecology, aesthetics, and river banks. These were each set at one of two levels, i.e. 'good' and 'poor'. The cost attribute was defined as higher water rates payments by households to the local water company. The choice sets were created using a fractional factorial design. Sampling occurred through a randomised quota-sampling approach and the questionnaires were then administered in-house by trained individuals. Each respondent answered eight choice questions, and each of these questions consisted of a choice between three alternatives, one of which was always the status quo. The captured data was analysed using conditional logit (CL) models. Implicit prices representing a change from a 'poor' status to a 'good' status were calculated for each attribute. It was found that people were indifferent as to which of the three attributes was improved. The difference in values between the three attributes was insignificant, indicating that all three attributes could have been viewed independently as good indicators of river health, i.e. they were almost perfect substitutes. It was also found that this CE was insensitive to the range of attributes used, once scale effects were accounted for.

Although not a CE study, Bateman *et al.* (2005) conducted a CV study and a contingent ranking (CR) study to look at the benefits of water quality improvements in the River Tame in Birmingham, England. The CR study, a CM derivative, was proposed as a more appropriate alternative for the valuation of public goods. The CV study presented respondents with a single open-ended WTP question, whereas the CR study presented respondents with a choice of different combinations of attributes. The CR study employed four attributes with three levels of improvements for each. The cost attribute represented an annual increase in council taxes. Face-to-face interviews were conducted in the Birmingham area at each respondent's place of residence. This elicited a total of 675 usable questionnaires. Three water quality improvement scenarios were given, with each providing different combinations of the attributes and their levels. An ordered logit model was estimated and WTP values calculated. The most notable result with regards to the CV study was the high proportion of respondents that could not provide a WTP amount (23 percent). In the CR exercise, approximately one-third of respondents assigned rankings that were consistent with the maximisation of water quality improvements. The most interesting result was the difference in response rates between the two techniques. The CR study exhibited a 98 percent response rate whereas the CV study exhibited a 77 percent rate of response. It was suggested that the CR study was conceptually easier for respondents to answer.

Luisetti *et al.* (2004) utilised an ecosystem approach to assess managed realignment coastal policies on the east coast of England. These coastal management strategies include managed realignment projects whereby sea defences are breached and the land flooded in order to restore salt marshes in the area. The CE was used in this case, as the value of salt marshes created by different managed realignments could be estimated in a single application. The project site was the Blackwater Estuary in Essex in the east of England. The choice model employed five attributes of which one had two levels, two had four levels, and one had eight levels. The fifth attribute (with four levels) was a cost variable, defined as an increase in the respondent's annual local council tax measured in Pounds (£) per household per annum. Choice sets were created by applying a fractional factorial design. Each respondent answered eight choice questions, with each choice set presenting two possible options. One of the pre-defined options presented in every choice set was the status quo. Non-probability sampling techniques were applied and the selected sample surveyed through face-to-face interviews. This resulted in a total of 508 usable questionnaires. A random effects binomial logit model was estimated, which allowed for the calculation of marginal WTP values. For this study an aggregated WTP value for a management policy creating new salt marshes in the estuary was calculated. The key finding of the study was that site specific value estimates derived through the use of the CE had yielded results in line with other previous managed realignment cost-benefit analyses, which lent support to the use of this approach for assessing future coastal policy strategies.

In Greece, a CE was applied by Birol *et al.* (2006a) to estimate the value of changes in different social, ecological and economic functions that the Cheimaditida wetland provides to the citizens. Five attributes considered significant to this wetland were identified, namely biodiversity, open-water surface area, education and research extraction, re-training of farmers and payment. Three of the attributes had two levels each while the fourth had four levels. The cost variable had four levels and was defined as a once-off payment that would be directed to the Cheimaditida Wetland Management Fund. An orthogonal main effects design was constructed, which resulted in each respondent answering eight choice questions with three options presented in each. One of these options was always the status quo. Face-to-face interviews were conducted which resulted in 407 completed questionnaires. In order to account for preference heterogeneity, two RPL models and a latent class model were estimated. Study results revealed a high degree of preference heterogeneity across the general public. The public also derived positive and significant values of enjoyment from the conservation and sustainable management of this wetland.

Morrison and Bennett (2004) conducted a number of CE studies to value certain rivers in New South Wales for possible use in benefit transfer. They investigated whether these WTP estimates could be used through benefit transfer to value similar improvements in the health of other rivers in the same region. Five river catchments were selected for valuation. The surveys were conducted within the catchment area only. This approach assumed, however, that only those living in the catchment area would derive benefits from improved river health. In order to account for those who derived benefits from improved river health but lived outside the catchment area, two more CE studies were conducted (on two of the five inland catchments) surveying only residents outside the particular catchment area. The seven different CE's employed five attributes, of which one had three levels, and three had four levels each. The fifth attribute, with four levels, represented the cost variable which was defined as a once-off payment levy on water rates. An orthogonal design was selected, which led to a total of 25 alternatives. This resulted in there being five versions of the questionnaire presented for each catchment. The samples for each catchment were randomly drawn from the 'Australia on disk' telephone directory on the basis of postal codes for that catchment. Questionnaires were mailed to a total of 900 respondents for each of the pre-defined catchment samples. The response rates for these surveys ranged from 30.4 to 45.9 percent. CL and NL models were estimated using LIMDEP 7.0. The estimated WTP values differed across catchments when inland residents were sampled, implying that benefit transfer can only occur in this case between similar inland rivers in the same region. It was also found that the WTP values from the two catchments, where outside residents were sampled, were statistically similar, implying that benefit transfer could occur between other outside catchment surveys.

In central Queensland, a CE study was conducted by Windle and Rolfe (2004) to assess community preferences for the protection of the Fitzroy Estuary using different payment options. This CE was part of a series of CE studies assessing the trade-offs between water resource development and environmental and social impacts in the Fitzroy basin. This study employed four attributes to represent various protection scenarios, namely healthy vegetation left in the floodplain, kilometres of waterways in good health, protection of aboriginal cultural heritage sites and health of the river estuary. The fifth attribute was a monetary variable representing the payment mechanism. This mechanism was defined in three ways. The first two definitions represented an increase in annual rate payments for a 20 year period, while the third represented a once-off lump-sum payment covering the cost over the whole 20 year period. An orthogonal experimental design generated 64 choice sets blocked into groups of eight, i.e. each respondent was presented with eight choice questions. Households were randomly selected and surveyed using the drop-off/pick-up method of data collection. The survey that used the first payment mechanism yielded 151 completed questionnaires. The survey that utilised the second payment mechanism as the cost variable yielded 152 completed questionnaires, while the survey that incorporated the third payment mechanism yielded 150 completed questionnaires. The data was analysed using MNL models and marginal WTP values were calculated for each of the three surveys representing the different payment mechanisms. It was concluded that the community places a high value on improvements in the health of the Fitzroy River Estuary. It was also found that the WTP values estimated using the CE technique were not sensitive to the levels used for the cost attribute, but the timeframe for the payment needs to be carefully considered and further researched.

In Victoria, Australia, a CE was applied by Kragt *et al.* (2007) to estimate benefits associated with improved health of the Goulburn River. Individual preferences were modelled with regards to marginal changes in different environmental attributes. This study employed four river health attributes, namely native fish, healthy riverside vegetation, native birds and fauna, and water quality. The fifth attribute was a cost variable and represented a once-off compulsory payment into a trust fund by all households in Victoria. An orthogonal fractional factorial main effects design was constructed providing 54 different river management outcomes. A mail-out-mail-back survey technique was applied. Each respondent received a questionnaire where they were requested to answer five choice questions. Each choice question included two management options, and a status quo or 'no action' management option. The data was used for CL and NL model estimation. The Hausman test was applied to the results of the CL model, which indicated a violation of the 'Independence of Irrelevant Alternatives' (IIA) assumption. The CL model was therefore not appropriate in this case. A more complex NL model was then estimated. Results indicated that individuals would pay for increased protection of fish species, birds, and native water animals, and for an improvement in riverside vegetation. These NL results, however, were statistically similar to the CL results, which implied that testing for the IIA violation required a more rigorous approach.

In north-eastern Tasmania, Kragt and Bennett (2009) applied the CE method in order to address catchment management issues in the George catchment. This report attempted to assess community preferences for different proposed management scenarios aimed at improving the quality of the catchment environment. The study employed three attributes relating to overall catchment health and the condition of the Georges Bay Estuary, namely native riverside vegetation, rare native animal and plant species, and the seagrass area. The fourth attribute was a payment attribute defined as a once-off levy on rates, payable by all Tasmanian households in 2009. Choice sets were generated through the use of a Bayesian D-efficient design technique. Each questionnaire included five choice questions with three alternatives, one being the no change, status quo option. This status quo scenario implied a slow degradation in catchment conditions, whilst the other two options represented management scenarios for improved catchment conditions. Of the 1432 respondents surveyed through the use of the drop off/pick up survey technique, only 933 were returned. A CL model was estimated but the Hausman test revealed that the IIA assumption had been violated. Additional mixed logit (ML) models were also estimated. Overall results from this study revealed that Tasmanians are willing to pay for increased protection of native riverside vegetation and rare native animal and plant species in the George catchment. It was suggested that more focus be given to catchment valuation studies that investigate preference heterogeneity amongst respondents.

A survey of public preferences for improvements in the natural resources of the Peconic Estuary System situated in the East End of Long Island was conducted by Opaluch *et al.* (1999) in August of 1995. Focus group discussions, interviews and pilot studies revealed five main attributes of interest, namely farmland, undeveloped land, wetland, safe shell fishing areas, and eelgrass. The sixth attribute, a cost attribute, was defined as an annual cost to households. An orthogonal design was constructed yielding sixty different choice sets. These choice sets were divided into twelve questionnaires with five choice set questions in each. Each choice set had three alternatives, with one representing a status quo or 'no new action' option. A convenience intercept sampling method was used whereby fieldworkers approached random individuals and asked them if they would be willing to participate in the survey. Personal interviews were conducted with willing respondents, which yielded 968 completed questionnaires at the end of the survey period. The study utilised a CL and a NL model. Results indicated similar preferences in terms of what attributes to protect. Respondents were willing to provide support for the protection of selected resources in the following order: farmland, eelgrass, wetlands, shell fish and undeveloped land. Using a 25-year time horizon and a seven percent discount rate, the estimated dollar value of farmland was $745 000 per acre, while that of undeveloped land was lowest at $14 000 per acre.

An important issue when using stated preference methods is the potential effect that the number of choice sets could have on response rates. Heberling *et al.* (2000) explored this issue by conducting a survey on the benefits of restoring streams that have been damaged by acid mine drainage in western and central Pennsylvania. Five attributes were identified through the use of focus groups, namely water quality, miles restored, travel time from home, and easy access points. The fifth attribute was defined as household cost in the form of increased water payments for the next ten years. An orthogonal main effects design was used to generate twenty choice sets containing three alternatives, one being the status quo. To examine non-response rates, four versions of the questionnaire included five choice sets each, while two versions of the questionnaire included ten choice sets each. Three random samples were drawn from different locations within the acid mine drainage area. In total, 2 208 questionnaires were mailed and 1 171 of those were return in a usable state giving an overall response rate of 60.2 percent. A CL model was estimated for each data group – one group included those that answered ten choice sets and the other group included those that answered five choice sets. In both models, respondents were willing to pay the most for an improvement in water quality. With the difficulty of the choice task measured in terms of number of choice sets answered per respondent, results indicated that survey responses do not differ across the number of choice sets. In other words, increasing choice sets per questionnaire does not decrease response rates.

Smyth *et al.* (2009) investigated public preferences for alternative management scenarios for Lake Champlain, situated in Vermont and New York, but also bordering on Quebec, Canada. Five attributes of interest were identified, namely water clarity, public beach closures, land use change, fish consumption advisories and the spread of water chestnut – an invasive plant. An orthogonal fractional factorial design was used to create management scenarios that varied across three levels. These scenarios were then paired and blocked, resulting in five versions of the questionnaire with nine choice questions in each. An existing mailing list of approximately 7 000 addresses in the Lake Champlain watershed was used as the target population. Questionnaires were mailed to a random sample of 2 000 resident addresses drawn from this mailing list. Each respondent faced nine choice questions involving a choice between two alternatives. A 'no change' or status quo option was not included thus forcing respondents to choose one of the two management scenarios. The response rate was estimated at 41 percent which yielded 6541 responses. The study utilised a binary logit model in order to estimate preferences for different management scenarios. Results indicated that although water quality and beach closures were important management issues, the public wanted policy measures aimed at improving the safety of fish consumption.

In South Africa, there have only been a few attribute valuation studies reported. The WRC commissioned a study in 2008 (Project K5/1413/2) to generate information on guiding the allocation of river water to South African estuaries and to investigate the factors that explain WTP for river inflows into South African estuaries (Oliver, 2010). This study applied a CE to the Bushmans River Estuary, in the EC, and compared the results with those of an application of a CV study done by Van Der Westhuizen (2007). Welfare measures derived from the CE study were about 30 percent less than the welfare measures derived from the CV study (Oliver, 2010). Reasons cited for this difference included different samples of users, as well as the possibility of embedding bias in the derived CV estimates. The Oliver (2010) study suffered from several deficiencies: too many attributes were included in the experimental design, and two cost attributes (instead of one) were included in the experimental design. An auxillary regression test revealed the presence of multicollinearity, implying that the orthogonality of the design was compromised, the sample size was small by international standards, and no attempt was made to test for possible sources of heterogeneity.

4.2.1 A SUMMARY OF CE DESIGN AND ANALYSIS TRENDS

The studies described above all dealt with the valuation of wetlands, including rivers, lakes, basins and estuaries. Only a few dealt with the specific valuation of estuaries. Common themes that have emerged from this literature review do not deal with attribute identification and policy issues, specifically, but rather with general CE design and analysis trends. The majority of studies cited above employed, on average, five attributes, with three levels each. Most studies included a status quo option. The most popular experimental design was a fractional factorial one. The average sample size for these studies was in excess of 500 respondents. In most cases, each respondent was required to answer five choice set questions. The choice data was analysed in most studies by means of an RPL model, but the basic CL model was always initially presented.

4.3 THE THEORETICAL BASIS FOR THE CE METHOD

The most frequently used tool for modelling the behaviour of individual choice is the discrete choice model based on the hypothesis of random utility (Blamey, Rolfe, Bennett & Morrison, 1997; Bateman *et al.* 2002; Hensher *et al.* 2005). These models are founded in classic economic consumer theory. In this section, a brief overview of the relevant economic consumer theory is presented, discrete choice theory is discussed and the fundamentals of the random utility choice model are outlined.

Consumers are typically assumed to be rational decision makers (Howard & Sheth, 1969; Howard, 1977; Engel & Blackwell, 1982; Abelson & Levy, 1985; Howard, 1989; Engel, Blackwell & Miniard, 1995), so that when they are faced with a set of possible consumption bundles of goods, they assign preferences to each of these bundles and then select the most preferred (utility maximising) bundle from the set of affordable alternatives. Using the properties of completeness[10], transitivity[11] and continuity[12], a continuous function exists which links a real number with each possible bundle, thereby summarising and ordering the consumers preferences. This function is known as a utility function (Ben-Akiva, 1973; Louviere, Hensher & Swait, 2000). The consumer behaves in such a manner as to choose the consumption bundle that maximises their utility subject to their budget constraint. This choice optimises

[10]Any two bundles can be compared i.e. *a* can be preferred to *b*, *b* can be preferred to *a*, or they can be equally preferred.
[11] If *a* is preferred to *b*, and *b* is preferred to *c*, then *a* is preferred to *c*.
[12] If *a* is preferred to *b*, and *c* is infinitely close to *a*, then *c* is also preferred to *b*.

the consumer's utility and provides the basis for the demand function and inferences of indirect utility enjoyed. The indirect utility function shows the maximum amount of utility that a consumer can achieve, given prices and income, and plays a key role in discrete CM.

Initially, consumer theory assumed that the goods being chosen were homogeneous (one car is the same as another) simplifying the utility function to one in quantities only. Later, following a seminal paper in which Lancaster (1966) argued that it was *the attributes* of a good that determined the utility derived from the good, the utility function concept was extended to incorporate the attributes of goods that were close but not perfect substitutes (Lancaster, 1966; Rosen, 1974). This consumer theory models behaviour in a deterministic manner.

To allow for statistical estimation, this extended utility function has to include a variable to incorporate random elements (see Thurstone, 1927; Luce, 1959; Marschak, 1960). The resultant function is called a random utility function. Within a random utility theory framework a consumer's behaviour is inherently probabilistic. Even if consumers can exercise discretion when making choices, they do not have complete information and for this reason there is an element of uncertainty that must be taken into account. The random utility function may be considered as the sum of two parts. The first part is the observed or measurable component, and the second part, the unobserved or random component. The random component captures the consequence for choice of uncertainty due to incomplete information. Manski (1977) identified four sources of uncertainty contributing to the unobserved component of utility: effects of unobserved alternative attributes, effects of unobserved consumer characteristics (or taste variations), measurement errors, and the use of imperfect proxy (or instrumental) variables. The random utility approach to model estimation is adopted, that is a model that provides for random (error) influences in addition to identified fixed ones (McFadden, 1974; McFadden, 1981; McFadden, 1984). More formally, total utility can be presented as:

$$U_{iq} = V_{iq} + \varepsilon_{iq} \qquad (4.1)$$

where:

U_{iq} represents utility derived for consumer q from option i,

V_{iq} is an attribute vector representing the observable component of utility from option i for consumer q, and

ε_{iq} is the unobservable component of latent utility derived for consumer q from option i (Nam Do & Bennett, 2007).

Assuming a linear additive form for the multidimensional deterministic attribute vector (V_{iq}):

$$Viq = \beta_{1i} f_1(s_{1iq}) + ... + \beta_{ki} f_k(s_{kiq}) \quad (4.2)$$

where:

β_{ki} are utility parameters for option *i*, and

s_{iq} represents 1 to *k* different attributes with differing levels,

Equation 4.1, is expanded to become:

$$U_{iq} = \beta_{1i} f_1(s_{1iq}) + ... + \beta_{ki} f_k(s_{kiq}) + \varepsilon_{iq} \quad (4.3)$$

This random utility model is converted into a choice model by recognising that an individual (*q*) will select alternative *i* if and only if (iff) U_{iq} is greater than the utility derived from any other alternative in the choice set. Alternative *i* is preferred to j iff $P[(V_{iq} + \varepsilon_{iq}) > (V_{jq} + \varepsilon_{jq})]$, and choice can be predicted by estimating the probability of individual (*q*) ranking alternative *i* higher than any other alternative *j* in the set of choices available (Louviere *et al.* 2000; Nam Do & Bennett, 2007).

The probability of consumer *q* choosing option *i* from a choice set may be estimated by means of the MLE approach, whereby estimates are obtained through the maximisation of a probabilistic function with respect to the parameters (Louviere *et al.* 2000; Hensher *et al.* 2005; Nam Do & Bennett, 2007). This estimation approach requires the random components (ε_{jq}) to be independently and identically distributed (IID) and this, in turn, requires the error term to be IIA. This type of statistical distribution is referred to as the extreme value type 1 distribution (EV1). Using the EV1 distribution, the unobserved random components associated with each alternative must be converted into a workable component of the probability expression. Once this is done, the model can be simplified whereby the random component is integrated out of the model. The resultant choice model only has unknowns relating to the utility parameters of each attribute within the observed component of the random utility expression, and is called the MNL or (more correctly) the CL choice model (for further details see section 4.4.6). A Gumbel or Weibull distribution is an example of an EV1 (Hanley *et al.* 2001; Hanley, Bergmann & Wright, 2004).

4.4 STEPS IN APPLYING A CE

4.4.1 DEFINE STUDY AIMS

Refining the research question is often a difficult task requiring the researcher to consult public interest from a wide range of perspectives, for example, the findings of others, statements made in the mass media, contributions from focus groups and pilot studies (Louviere *et al.* 2000).

4.4.2 THE USE OF FOCUS GROUPS

Focus groups are a convenient and commonly used method for gathering qualitative information on what the key public interest issues are (Morrison, Bennett & Blamey, 1997). Five to ten individuals are drawn from the target population and asked to participate in discussions on the study's preferred focus of attention. These discussions should provide inputs to the study in respect of the most important attributes and their levels, personal characteristics that affect choice behaviour, possible reasons for differences in utility, the number of alternatives in a choice set, and also whether different decision rules are used (Louviere *et al.* 2000; Birol *et al.* 2006a; Nam Do & Bennett, 2007). Focus groups may also assist in the description of attributes used in the study – suggesting words and phrases that are generally understood by the target population.

4.4.3 SAMPLE DESIGN

As with other survey-based research, the sample design strategy for CM exercises entails four distinct steps: selecting the target (sample) population, determining who to sample (the sample frame), determining the appropriate sample size and choosing the method of respondent selection and elicitation of response technique.

4.4.3.1 Target population

The target population comprises those individuals who receive benefits from, and who are subject to costs of, the effect being studied (Bateman *et al.* 2002). For geographically well-defined areas, such as estuaries, benefits can be derived by users as well as non-users. The population that bears the cost may not be so easy to define and imperfect secondary sources of information have to be used to guide sample design (Bateman *et al.* 2002). These secondary sources may include lists like rate payers and angling club members.

The user population for a well-defined geographical area is often easy to identify (Bateman *et al.* 2002), but for an estuary, this identification is complicated by visitors for recreational purposes. Identifying the population of non-users is also problematic. The following factors should be considered when attempting to identify the user and non-user population (Bateman *et al.* 2002):

- Resources with few substitutes are considered unique and hold the potential to exhibit high non-use values. Under these circumstances the sampling process should go beyond the user population.

- The greater the distance from the resource in question, the less familiar it will be to the respondents and the less likely they will be to make use of it. It is assumed that beyond ‘some’ distance there will be no use or non-use values.
- A change in the quality of a resource is more likely to affect use than non-use values, but a great change may well affect both.
- Those affected by the specified payment vehicle of the resource are by definition included in the sampling frame.

4.4.3.2 Sample frame

Drawing a representative sample from the target population should ideally be preceded by a process of clarification which entails the compilation of a sampling frame. It is defined as a complete, but finite, list of the decision makers (Louviere *et al.* 2000). An ideally specified sample frame is one where the decision makers are listed only once (Bateman *et al.* 2002). This listing allows a random sample to be selected from the sample frame without the concern for over- or under-sampling. The importance of a properly specified sampling frame is in the definition it provides of the people of interest – the sample selected should be representative of the sampling frame.

There is a trade-off involved between the representativeness of the sampling frame and the cost involved. Frequently, there are no readily available representative lists that can be used as a sampling frame. In some cases, it is not even possible to find a sample frame that lists the entire target population (Bateman *et al.* 2002). If no lists exist, a sample frame cannot be specified and sampling necessarily has to be carried out directly from the sample population. An example where this would be relevant could be the population of visitors to a specific beach. In this case, people would have to be sampled on site. This type of survey is known as an intercept survey (Bateman *et al.* 2002). The randomness of intercept surveys is questionable as the rate and nature of visitation is likely to differ during the different times of the year, and there might be numerous entrance and exit points to the beach in question. In order to improve the randomness and representativeness of this technique, sampling may be undertaken only during certain hours of the day, and during that time the n^{th} user is approached, as they arrive or leave (Bateman *et al.* 2002).

4.4.3.3 Sampling approaches and sample size determination

a) Sampling approaches

There are both probabilistic and non-probabilistic ways to determine sample size. With a probabilistic design, each unit of the population has a fixed probability of being chosen for the sample. With a non-probabilistic design, the discretion of the researcher is relied upon (Bateman *et al.* 2002).

Probability sampling techniques include simple random samples, systematic sampling and stratified random samples (Louviere *et al.* 2000; Bateman *et al.* 2002; Hensher *et al.* 2005). Simple random sampling is the most basic form of probabilistic sampling. Every unit within the sample frame is given an equal chance of being selected for the sample. Systematic sampling requires that the units within the sampling frame are numbered in a sequential manner, concluding with the last unit being equal to the size of the frame. Once the sampling fraction is calculated, i.e. the ratio of sample size to population size, a random number is selected within the sampling fraction and this forms the starting point for the sample. The sample is collected by moving sequentially through the sample frame in multiples of the random number. For stratified sampling, the target population is separated into non-overlapping strata. To ensure representivity, the proportions of the strata in the sample should be the same as in the population.

Non-probability sampling techniques include convenience sampling, judgement sampling and quota sampling (Bateman *et al.* 2002). Convenience sampling is the least preferred method of sampling. It involves choosing a sample at the convenience of the researcher rather than with reference to population representivity (Bateman *et al.* 2002). A judgment sample refers to a sample that has been judged to be representative of the target population. This judgment is subjective and non-random. Quota sampling involves a controlled selection of respondents by the interviewers, where the interviewers ensure that, within the sample, certain proportions of respondents (quotas) are included (Bateman *et al.* 2002).

b) Sample size determination

In the context of CM, sample size is often determined through the use of both probabilistic and non-probabilistic sampling techniques, known as *rule of thumb* approaches (Hensher *et al.* 2005).

A simple equation can be employed to determine the minimum acceptable sample size (n) for a simple random sample:

$$n \geq \frac{(1-p)}{pa^2}\left[\Phi^{-1}\left(1-\frac{\alpha}{2}\right)\right]^2 \qquad (4.4)$$

where:

p is the reported choice proportion of the relevant user population, i.e. the share of the total each alternative commands,

a is the level of allowable deviation of sample proportions from the reported population proportions, expressed as a percentage between $\hat{p}$ and p, and

$\Phi^{-1}\left(1-\frac{\alpha}{2}\right)$ is the inverse cumulative distribution function of a standard normal, i.e. N ~ (0, 1) taken at (1 - α/2), where α is the selected probability, for example, 0.90, 0.95, 0.99 (Louviere *et al.* 2000; Hensher *et al.* 2005).

Sample size increases as '*p*' decreases, '*a*' decreases and 'α' decreases. Systematic sampling is related to simple random sampling, but the population frame is in random order and every n^{th} unit is selected for the representative sample (Bateman *et al.* 2002). Stratified random sampling entails dividing the sample population into *G* mutually exclusive groups. Each of these groups represents a proportion of the total population, W_g (Hensher *et al.* 2005). This technique is based on the principle that samples are more representative and thus more accurate when the population from which they are selected is homogenous. The sample population is grouped into non-overlapping strata that are known to be more homogenous. In order to ensure the randomness of the sample, a random sample of respondents is surveyed within each stratum (Louviere *et al.* 2000; Hensher *et al.* 2005).

Equation 4.4, above can be employed to estimate the appropriate sample size for a stratified random sample. The total sample size can be estimated using Equation 4.4, and then partitioned into the *G* group. Alternatively, the sample size for each stratum can be estimated using Equation 4.4, and these can be summed to calculate the total sample size (Hensher *et al.* 2005).

Probabilistic sample size approaches are very often abandoned in favour of '*rule of thumb'* approaches due to practical considerations – budget and time constraints often supersede theoretical preference (Hensher *et al.* 2005). These approaches identify the minimum sample size that is required in order to estimate the model of choice (Hensher *et al.* 2005). Researchers commonly determine the minimum sample size as the number of observations needed to estimate "robust models" (Hensher *et al.* 2005). Since the standard CL model applied in this study uses only the recreational use attributes and their levels (as contained in the experimental design), and not the socio-economic characteristics of decision makers (non-design attributes), the variability of the data is less of an issue (Hensher *et al.* 2005). The variability of the collected data is even less important if the alternatives contained in the choice sets are unlabelled, since all parameters are generic across all alternatives (Hensher *et al.* 2005). A *rule of thumb*[13] that can be employed in the case where only design attributes are included in the analysis and only unlabelled alternatives are used, is that a sample size be selected of at least 50 respondents and each respondent be presented with 16 choice sets (Hensher *et al.* 2005).

[13] There are two other rules-of-thumb approaches that are frequently used: a sample size is selected whereby each alternative is given at least 30 times in the sample, and every choice set is presented to a minimum of 50 respondents (Bennett & Adamowicz, 2001).

4.4.4 SURVEY INSTRUMENT DESIGN

In most cases the design of a stated preference survey instrument includes the following four steps (Hasler, Lundhede, Martinsen, Neye & Schou, 2005):

(1) Provide introductory information for the study, as well as an explanation of the environmental issue being analysed. The institutional bodies charged with managing the environmental issue in question can also be identified.
(2) Set out the CE. This is done by providing detailed descriptions of the payment vehicle as well as the attributes of interest and their levels.
(3) Provide follow-up questions, which will allow for reliability and validity testing.
(4) Collect socio-demographic information about the respondent.

4.4.4.1 Introductory information and introductory questions – attitudes, opinions, knowledge and use

a) Introductory information and questions

Survey instruments begin with an introductory section which familiarises the respondent with the study good in question. These take the form of introductory questions, whereby the respondent is encouraged to critically think about the topic of interest and the study. In doing this the respondent is provided with necessary information, and discouraged from providing strategic rather than truthful answers (Bateman *et al.* 2002).

Providing introductory information is important if the respondent is unfamiliar with the good in question, but the amount provided should not be so great that it leads to respondent boredom and irritation. The amount of information required is less for choices the consumer is typically very familiar with, for example, water utilities (Centre for International Economics (CIE), 2001).

When providing a description of the good, neutral wording must be used. In other words, an understandable and unambiguous description of the good to be valued must be provided so that all respondents have the same level of basic information.

In the context of a CE survey, this introductory information should be followed by additional questions. These questions attempt to elicit respondents' attitudes to and their opinions of the good to be chosen. Questions relating to the general use of the good are also incorporated in this section.

b) Introductory questions – attitudes, opinions, knowledge and use

The questions in the CE questionnaire are placed at the beginning for three reasons: firstly, to 'warm up' the respondent to the task at hand, secondly, to allow the respondent time to think about the various important aspects of the choice problem, and thirdly, to provide the researcher with information which can be used to check for consistency and validity of later answers.

Included in the aspects the respondent needs to think about are the trade-offs between environmental policies and programmes (Hasler *et al.* 2005).

4.4.4.2 Setting up a CE questionnaire

a) The choice of a reliable payment vehicle

In a CE the respondents indirectly reveal their WTP by making choices, i.e. in the trade-offs they implicitly make between various alternatives. These alternatives comprise different attributes, as well as a price attribute. The inclusion of a price attribute allows for marginal WTP to be estimated, and thereby for welfare measures to be calculated. These measures are compensated and equivalent surplus, as measured by the amount taken from the consumer in order to hold their level of utility constant.

The choice of a payment vehicle needs to have a connection to the good being valued (Garrod & Willis, 1999). A payment vehicle can be coercive or voluntary in nature. Examples of coercive payment vehicles are an additional tax levied on the consumer and an annual sum added to a consumer's existing service statements. An example of a voluntary payment vehicle is a once-off voluntary donation to an environmental body tasked with the improvement of the environment. A coercive payment is preferred, as respondents have the incentive to free-ride if the payment is voluntary (Whitehead, 2006; Birol, Karousakis & Koundouri, 2006b). Whatever format the payment vehicle takes, it must be seen as being realistic, fair and equitable to all respondents.

b) The budget constraint and the concept of "cheap talk"

Once the payment vehicle has been selected, it is important that respondents understand its meaning and that they are aware of their households' budget constraints and substitution possibilities (Boxall *et al.* 1996). In order to make sure that the respondent is aware of their budgetary commitments, some CE studies include "cheap talk" (see for example, Abou-Ali & Carlsson, 2004; Birol *et al.* 2006b; Nam Do & Bennett, 2007). "Cheap talk" as defined in the literature, is "an attempt to eliminate hypothetical bias by including an explicit discussion of the problem" (Cummings & Taylor, 1999). The inclusion of "cheap talk" is said to induce valid and reliable responses from respondents, and also reduce the incidence of strategic behaviour (Cummings & Taylor, 1999; List, 2001).

The effect of various "cheap talk" designs has been investigated under different stated preference contexts, and the results have been mixed in respect of the CVM (Boxall *et al.* 1996; Poe, Clark, Rondeau & Schulze, 2002; Aadland & Caplan, 2003) and CM (Carlsson, Frykblom & Lagerkvist, 2004; List, Sinha & Taylor, 2006). The inclusion of "cheap talk" was found to have a positive effect by Cummings and Taylor (1999), List (2001), Murphy, Stevens and Weatherhead (2003) and Carlsson *et al*. (2004), but others found that the inclusion of "cheap talk" induced internal inconsistencies regarding respondents' preferences in stated preference valuations (Samnaliev, Stevens & More, 2003; Carlsson & Martinsson, 2006).

Even though the net-benefit of "cheap talk" is inconclusive, it is considered acceptable to include a short section within the survey instrument (Nam Do & Bennett, 2007). The "cheap talk" section should (1) inform respondents of their budgetary constraints, (2) specify that all consumers will be contributing in an equitable fashion (thus discouraging free-riding), and (3) stipulate the amounts that will be paid in addition to any current payments, whatever the good or service may be (Nam Do & Bennett, 2007).

c) Composition of the choice sets

Selection of attributes and their levels

In the CE survey, each alternative presented to the respondent corresponds to a different policy proposal concerning the future management of the resource in question. Each of these alternatives is characterised by differing levels of attributes (Boccara, 1989). In selecting the attributes and levels to include, the findings of other similar studies, policy relevance (Alpizar, Carlsson & Martinsson, 2001), as well as focus group discussions are useful (Louviere *et al.* 2000; Bateman *et al.* 2002; Birol *et al.* 2006a; Nam Do & Bennett, 2007). Minimum and maximum levels for each attribute should be established through focus group discussions. All attributes must pass the 'independence test', i.e. they must be able to be estimated independently from each other (Eggert & Olsson, 2004). The inclusion of a monetary attribute is usually relevant and has the added advantage of making it feasible to calculate monetary value trade-offs against non-money attributes.

The number of alternatives

The number of alternatives in a CE should be chosen once task complexity has been evaluated. Task complexity is determined by factors such as (1) the number of choice sets per respondent, (2) the number of alternatives per choice set, (3) the number of attributes in each alternative, and (4) the number of levels representing each of the attributes (Alpizar *et al.* 2001). Task complexity can negatively affect respondent decisions by increasing the amount of effort needed to make trade-offs between different alternatives. If the test is too complex, respondents could become 'fatigued' and pay less attention to the process of choice selection (Hanley, Wright & Koop, 2002). For this reason, most environmental valuation studies using CE designs, adopt only two to three alternatives per choice set (Hanley *et al.* 1998b; Adamowicz & Boxall, 2001; Bateman *et al.* 2002).

<u>The inclusion of a 'status quo' or 'opt-out' option</u>

A matter of special importance when calculating welfare measures is whether or not to include a base case (status quo) or 'opt-out' alternative (Alpizar *et al.* 2001). The generally accepted format for CE designs is to include a status quo alternative or an 'opt-out' alternative (see, for example, Adamowicz *et al.* 1998; Mallawaarachchi, Blamey, Morrison, Johnson & Bennett, 2001; Abou-Ali & Carlsson, 2004; Morrison & Bennett, 2004; Birol *et al.* 2006a; Nam Do & Bennett, 2007; Kragt & Bennett, 2008). If the option of status quo or 'opt-out' is not allowed as an alternative, this can distort (bias) the welfare measure for non-marginal changes (Kontoleon & Yabe, 2003; Birol *et al.* 2006a), because respondents are forced to choose an alternative which they might not necessarily desire (Banzhaf, Johnson & Mathews, 2001; Dhar & Simonson, 2001; Bateman *et al.* 2002).

The inclusion of a status quo or 'opt-out' alternative is not without problems. It is included largely to eliminate bias caused by forcing respondents to make choices that they otherwise would not have made, but it can create another bias whereby respondents continually select the status quo or 'opt-out' alternative. Possible reasons why this could happen include respondent boredom and respondent fatigue (Adamowicz *et al.* 1998; Scarpa, Willis, Acutt & Ferrini, 2004). Another issue to consider when deciding whether to include a status quo or 'opt-out' alternative is whether or not the current scenario or non-participation are relevant or feasible alternatives (Alpizar *et al.* 2001; Terawaki, Kuriyama & Yoshida, 2003).

<u>Number of choice sets per respondent</u>

There are no definitive rules that specify the number of choice sets that may be presented to each respondent. Task complexity must be taken into account (Bateman *et al.* 2002). When choices are complex, respondents may answer by applying a simplified decision rule (DeShazo & Fermo, 2002) such as 'yea' saying or 'nay' saying with respect to one attribute, for example, the most environmentally friendly alternative. This problem is also referred to as 'compliance bias' as respondents try and 'comply' by overstating their WTP values (Boxall *et al.* 1996). They do not want to appear as if they are voting against the environment. Another factor to consider, apart from task complexity, is the potential learning and fatigue effects that the CE can cause. This general problem is known as 'respondent fatigue'.

d) The experimental choice design

<u>Introduction</u>

One of the most important parts of carrying out a CE study is to identify an appropriate experimental design. Experimental design creates choice sets in the most efficient way possible. It combines attribute levels into alternatives, and alternatives into choice sets (Alpizar *et al.* 2001). The practice of experimental design is a complex process (Huber & Zwerina, 1996; Hensher *et al.* 2005). The accuracy of the results obtained from a CE study are dependent on the properties of the experimental design that was used to elicit respondents' preferences for the good being valued. Ideally, experimental designs should be generated from first principles, but for practical reasons most choice modellers rely on computer software to generate workable statistical designs (Hensher *et al.* 2005).

This section outlines the steps taken to develop an experimental design using computer software, namely SPSS[14].

The point of departure in developing a statistical design in SPSS, or any other statistical software, is deciding whether a full factorial design or a fractional factorial design is desired. The former refers to a design that incorporates all possible combinations of attribute levels that make up the different alternatives (Carlsson & Martinsson, 2003; Hensher *et al.* 2005). The size of the full factorial design is determined by multiplying the levels of the attributes together. For example, if a design has three attributes with two levels each and one attribute with four levels, the full factorial design consists of (2x2x2x4 = 32) 32 alternatives (Louviere *et al.* 2000; Hensher *et al.* 2005). In contrast, a fractional factorial design only uses a subset of all possible combinations that make up the full factorial design (Louviere *et al.* 2000).

A full factorial design allows for the estimation of all main and interaction effects, whereas the fractional factorial design does not. A main effect refers to an isolated attribute effect on the probability of choice and an interaction effect is a choice caused by interactions between two or more variables (Huber & Zwerina, 1996; Kuhfeld, Tobias & Garratt, 2004).

Although all effects can be estimated using a full factorial design, it is considered cumbersome and impractical within a CE setting. In most cases, the fractional factorial design is adopted (Kuhfeld *et al.* 2004). The change from a full factorial to a fractional factorial design can be costly as it leads to a loss of statistical information. Moreover, certain effects may become indistinguishable from each other (Louviere *et al.* 2000; Kuhfeld *et al.* 2004; Hensher *et al.* 2005).

Even though certain interaction effects are ambiguous, the use of the fractional factorial design involves making assumptions about some of these interactions. It is assumed that two-way or higher order interactions are insignificant (Louviere *et al.* 2000; Hensher *et al.* 2005). The acceptability of this assumption is supported by evidence from several other studies (Louviere *et al.* 2000). It has been found that 'main effects' account for 70 to 90 percent of explained variances, two-way

[14] Hensher *et al.* (2005) suggested that "to describe exactly how the expert generates experimental designs would require an entire book".

interactions account for 5 to 15 percent, and higher-order interactions usually account for the remaining variance.

Generating experimental choice designs using SPSS

The 'Orthogonal Design' data option is used to develop an experimental design in SPSS. The following steps are taken. First, the attributes to be included in the design are named. The analyst can choose to provide the attributes with their actual names or generic ones (Hensher *et al.* 2005). Second, once the attributes have been named, their respective levels must be assigned (the actual level names, level codes, or both can be used). Two types of coding formats are frequently applied. For an attribute with three levels, 0, 1 and 2 or -1, 0 and 1[15] can be used. Third, the analyst must decide on the number of treatment combinations required for the specific design. If SPSS is not informed about the required number of treatment combinations (alternatives in the choice sets), it will generate the smallest design available (Hensher *et al.* 2005). In most cases, this will produce a 'main effects only' design. Once these steps are completed, SPSS generates an orthogonal design[16].

After the experimental design has been generated in SPSS, it is copied to Microsoft Excel. The required number of randomised choice set profiles is generated in Excel (using the Random Number Generator). If the analyst wishes to have 32 different questionnaires containing four choice sets each with two alternatives per set, the following information will be provided to run the Random Number Generator in Excel:

- Number of variables = 4 choice sets x 2 choices per set = 8
- Number of random variables = number of profiles generated in SPSS = 32
- Distribution = Uniform
- Parameters = 0.5 and 32.5

The relevant treatment combinations or alternatives contained in the SPSS orthogonal design are assigned to each choice set and the codes replaced by the actual attribute names and their associated levels.

4.4.4.3 Additional questions

a) Debriefing and follow-up questions

It is widely recommended that follow-up questions be included in the questionnaire. These questions are used to check several different aspects: (1) the presence of biased and illegitimate responses, (2) the respondent's comprehension and acceptance of the

[15]-1, 0 and 1 are referred to as orthogonal codes (Hensher *et al.* 2005).

[16]In an orthogonal design, the columns of the design show zero correlation. In other words, all attributes are statistically independent of one another (Hensher *et al.* 2005).

CE, and (3) the motives that drive the respondent's decision making (Louviere *et al.* 2000; Bateman *et al.* 2002). The inclusion of these questions allows for reliability and validity assessments.

To test for reliability, the respondent should be asked whether or not they found it difficult to make the necessary choices. If respondents found it hard to make trade-offs, this could indicate that the level of task complexity was too high for the respondent. The consequences are threefold: first, the respondent could be induced to supply less reliable answers; second, the respondent could adopt a simplified decision strategy; third, the respondent could find the completion of the choice task too time-consuming. Conversely, it may be more problematic if the respondent finds the choice task too easy. A respondent who finds it too easy to complete the choice task may adopt potentially non-compensatory decision making strategies (Watson, Phimister & Ryan, 2004).

Another relevant validity question is over the level of importance respondents attach to the different attributes when making their choices. This question can help identify whether the respondent has followed a non-compensatory decision making strategy. An important assumption when using the CE approach for non-market valuation is that individuals apply compensatory decision making strategies (Watson *et al.* 2004). It is assumed that individuals consider all attributes within the choice set when making their choices. If respondents answer that they took all the attributes into consideration when making choices, the compensatory decision making assumption has not been violated (Watson *et al.* 2004). Answers that state that choices were made with one attribute in mind does not automatically prove non-compensatory decision making strategies, but reveal the potential for these strategies to have been employed. Another explanation for the focusing on one attribute when making choices could be that certain attribute ranges have been set too narrow and resulting in the respondents not being induced to make trade-offs (Watson *et al.* 2004).

An alternative technique for detecting and correcting hypothetical bias with respect to the choice scenarios is called certainty calibration (Samnaliev *et al.* 2003). According to this technique, on completion of the choice task, respondents are asked to rate their certainty of choice by selecting a number on a scale ranging from 1 to 10, where 1 represents a low level of certainty and 10 represents a high level of certainty.

b) Socio-demographic questions

Socio-demographic questions relate to personal characteristics of the respondents. These questions are placed towards the end of the questionnaire due to their personal nature. Possible questions that could be included in this section relate to age, gender, race, household income, household size, and number of children. The answers to these questions can be useful to test for differences in WTP between certain sub-sample groups, for example, differences in WTP across income groups.

4.4.5 DATA COLLECTION

Once the sampling frame and sample size have been determined, the response selection and collection mechanisms must be established. The selection method is guided by the requirement that the sample respondents represent the sample population. The collection mechanism is largely a function of the type of respondent, the level of simplicity in identifying potential respondents, the length and complexity level of the questionnaire and the type of survey instrument implemented (Louviere *et al.* 2000). The main three survey collection modes employed are (1) mail surveys, (2) telephone interviews, and (3) face-to-face interviews. Two relatively recent additions to these modes are the Internet survey and the mixed mode survey (Dillman, Smythe & Christian, 2009).

A cost-effective method of collection is the mail survey, whereby respondents are recruited via the telephone. After this telephonic recruitment, the surveys are mailed to the respondents. These can be supported by sending reminders as well as providing incentives for timeous completion and return. The mail survey, or the 'drop-off and pick-up' option, is preferred when respondents are required to make realistic monetary trade-offs, as it allows them the freedom to spend more time thinking about their choices (Nam Do & Bennett, 2007). The mail survey method is inexpensive, but is subject to disadvantages, such as low response rates and it can be time-consuming (Bateman *et al.* 2002).

Depending on budgetary constraints, other more rigorous survey techniques are available. Personal interviewers might be required in order to conduct surveys that are more complex in nature. CE surveys can be complex, especially the selection of alternatives contained in the choice sets. Personal interviews, which allow for enhanced thoroughness in explanation, enable the respondent to have assistance in terms of understanding potentially complex matters within the CE setting (Nam Do & Bennett, 2007). These interviews can be conducted at the respondent's home, or alternatively, the respondent can be intercepted in order to fill in the questionnaire (Bateman *et al.* 2002). Face-to-face contact with the respondent allows the interviewer the best opportunity to encourage him/her to give accurate answers. Face-to-face interviews are helpful in the execution of missing data approaches (Mitchell & Carson, 1989). The ability to compensate for omitted data is important for the extrapolation of part-worth estimations from the sample to the population (Mitchell & Carson, 1989). There are also disadvantages to using this survey method. These include the potential for interviewer bias, and expense.

Mixed mode survey methods can also be used. One such method is a computerised assisted interview (Bateman *et al.* 2002). In this case, self-completion surveys are sent to the respondent on a CD or via email. The respondent mails the response back as a hard copy. Alternatively, personal interviews conducted via computer and responses are typed in real time. These computerised interview techniques have the advantage of flexibility as well as increased data quality (Louviere *et al.* 2000). In the context of developing countries, personal interviews are frequently used, as respondents frequently have little education and limited understanding of the aims of the CE study and many respondents do not have access to a computer or the Internet (Champ, 2003).

4.4.6 DATA ANALYSIS AND CHOICE MODEL ESTIMATION

Once the data is collected, it needs to be recorded in a format suitable for statistical analysis and this record checked for accuracy (Amemiya, 1985; Greene, 2000; Louviere *et al.* 2000). In the survey instrument, each respondent indicates his/her preferred alternative for each choice set provided (Bennett & Blamey, 2001). This data element must be combined with the information pertaining to the selected alternative's attribute levels and that pertaining to the attribute levels of the alternative/s not selected (Bennett & Blamey, 2001). For example, a three alternative choice set produces three lines of data, with each line showing an alternative and its attribute levels. In cases where the alternatives included in the choice sets are labelled, alternative specific constants (ASCs)[17] must also be incorporated in the rows of data. These constants reveal any variation not captured by the attributes. For a three alternative choice set, additional attributes (ASCs) must be created for two of the three alternatives (Bennett & Blamey, 2001). In cases where a status quo alternative is included in the choice sets, a status quo ASC must be incorporated in the rows of data. This constant may reveal the presence of status quo bias (in other words, there is a preference among respondents for the status quo alternative). The ASCs may also be interacted with the respondents' socio-economic characteristics in order to investigate respondent heterogeneity (Bennett & Blamey, 2001). These interactions are necessary because the socio-economic characteristics are invariant across the alternatives and drop out during the statistical model estimation process (Hessian singularities arise during the estimation process).

After a summary has been presented of the data collected, the choice models should be estimated. There are many versions – the CL model, the heteroskedastic extreme value (HEV) model and the RPL model.

4.4.6.1 Conditional Logit

The CL model has the following form (Louviere *et al.* 2000):

[17] It has been argued that although ASCs improve discrete choice model fit, they have no behavioural interpretation (Adamowicz *et al.* 1998).

$$P(i \mid A) = \frac{1}{\sum_{\mathrm{j=1}}^{\mathrm{j}} \exp - (\mathrm{V_i} - \mathrm{V_j})} \tag{4.5}$$

where:

P_i is the probability of an individual choosing the i^{th} alternative over the j^{th} in the set of choices A,

V_i is the representative utility from the i^{th} alternative, and

V_j is the representative utility from the j^{th} alternative.

This model is restrictive in terms of its underlying assumptions. According to Louviere *et al.* (2000), the model assumes:

- that scale parameters have constant variance (typically equal to 1 (Ben-Akiva & Lerman, 1985)),
- that random components do not exhibit serial correlation (IIA assumption),
- that utility parameters are set, and
- that there is no heterogeneity between individual preferences.

If the first of these assumptions is relaxed, the scale parameter (λ) will not have constant variance, and will become an additional multiple of each of the alternatives in the model and will therefore influence choice. The CL model can then be adapted to allow for variance of the scale parameter (λ):

$$P_{iq} = \frac{\exp(V_{iq} / \lambda_i)}{\sum_{j=1}^{j} \exp(V_{jq} / \lambda_j)} \tag{4.6}$$

If the IIA assumption is violated, the observed and unobserved components of utility could be dependent on one another and the error term exhibits serial correlation leading to biased estimates (Nam Do & Bennett, 2007). A more flexible model that relaxes the IIA assumption is the HEV model. This model, initially developed and applied by Bhat (1995), allows the variance of the error term to differ across alternatives within a choice set. It models the probability that an individual (q) will choose the ith alternative in a choice set (A), but relaxes the assumption of independence among the random components. Substituting z in place of ($\varepsilon_i / \lambda_i$), the HEV specification of the choice is:

$$P_i = \int_{z=-\infty}^{z=+\infty} \prod_{j \in C, j \neq 1} F\left[\frac{V_i - V_j + \lambda_i z}{\lambda_j}\right] f(z) dz \tag{4.7}$$

4.4.6.2 Random parameters logit

A problem with both the CL and HEV models is that they assume that the coefficients of variables that enter the model are the same for all consumers, i.e. that there is homogeneity in preferences across respondents (MacDonald, Barnes, Bennett, Morrison & Young, 2005). This implies that consumers that exhibit the same socioeconomic characteristics, for example, level of income, will value the good in question in an equal manner (MacDonald *et al.* 2005). However, preferences are largely heterogeneous in nature. A model that relaxes the assumption of homogeneity is the RPL model.

The RPL model is a generalisation of the standard MNL logit model[18]. The advantages of this model are that (1) the alternatives are not independent because the model does not rely on the IIA assumption, and (2) the existence of unobserved heterogeneity can be investigated (Ben-Akiva, McFadden, Garling, Gopinath, Walker, Bolduc, Borsh-Supan, Delquie, Larichev, Morikawa, Polydoropoulou & Rao, 1999; Hensher & Greene, 2002; Carlsson *et al.* 2003). Early studies applying the RPL model in order to account for preference heterogeneity include Gopinath (1995), Bhat (1997), Revelt and Train (1998), and McFadden and Train (2000). More recent applications of the RPL model have indicated that it is superior to the CL model in terms of fit and overall welfare estimation (Carlsson *et al.* 2003; MacDonald *et al.* 2005; Kragt & Bennett, 2008).

A generalised version of the RPL choice model is (Louviere *et al.* 2000):

$$P(j \mid \mu_i) = \frac{\exp(\alpha_{ji} + \theta_j \mathbf{z}_i + \delta_j \mathbf{f}_{ji} + \beta_{ji} \mathbf{x}_{ji})}{\sum_{j=1}^{J} \exp(\alpha_{ji} + \theta_j \mathbf{z}_i + \delta_j \mathbf{f}_{ji} + \beta_{ji} \mathbf{x}_{ji})} \tag{4.8}$$

where:

α_{ji} is a fixed or random alternative specific constant (ASC) with j = 1,....,J alternatives and i = 1,....,I individuals; and $\alpha_j = 0$,

δ_j is a vector of non-random parameters,

β_{ji} is a parameter vector that is randomly distributed across individuals; μ_i is a component of the β_{ji} vector,

$\mathbf{z}_i$ is a vector of individual-specific characteristics, for example, income,

$\mathbf{f}_{ji}$ is a vector of individual-specific and alternative-specific attributes,

$\mathbf{x}_{ji}$ is a vector of individual-specific and alternative-specific attributes, and

μ_i is the individual-specific random disturbance of unobserved heterogeneity.

[18] Increases in estimation capabilities through advancements in computational power have led to the RPL method becoming the most popular method of choice during the previous two decades.

The RPL can take on a number of different functional forms and incorporate a number of assumptions. The most popular assumptions are normal, triangular, uniform and log-normal distributions (Bhat, 2000; Bhat, 2001). The log-normal distribution is applied if the response parameter needs to be a specific sign (Louviere *et al.* 2000; Carlsson *et al.* 2003). Where dummy variables are used, a uniform distribution with a (0,1) bound is appropriate. It can be difficult to determine which variables to distribute and which distributions to choose. Some applications only randomise the cost variable (Layton, 2000) whereas others choose to randomise all non-price variables and leave cost as non-random (Anderson, 2003). The latter choice is favoured for two reasons: firstly, the distribution of the marginal WTP for an attribute is simply the distribution of that attribute's parameter estimate, and secondly, it allows the cost variable to be restricted to be non-positive for all individuals (Carlsson *et al.* 2003).

4.4.7 WELFARE CALCULATIONS

Once the appropriate model has been estimated (CL, HEV or RPL), the WTP for each attribute can be calculated. These estimates are also known as implicit prices.

4.4.7.1 Implicit price estimates

Implicit prices are point estimates of the value of a unit change in an attribute. They are calculated by determining the marginal rates of substitution between the attributes. This is done by using the coefficient for cost as the "numeraire" (Hanemann, 1984). The ratios of the attribute in question to the cost coefficient can be interpreted as the average marginal WTP for a change in each of the attribute values (Hanemann, 1984). If $X = X_1,\ldots, X_a$ attributes, then implicit prices can be derived using Equation 4.9 below:

$$IP = -\left[\frac{\beta_a}{\alpha}\right] \qquad (4.9)$$

where:

IP is the implicit price,

β_a is the parameter estimate of the specific attribute X_a (Hanley, Wright & Alvarez-Farizo, 2006), and

α is the parameter estimate of the price variable.

In order for these welfare estimates to have relevance, the parameter estimates for each attribute need to be statistically significant (Hensher *et al.* 2005). It is important to provide estimates of the precision of welfare measures, i.e. standard errors and confidence intervals (Eggert & Olsson, 2004). Confidence intervals for an implicit price (a ratio parameter) can be formed by applying the delta method[19], which is based on a truncated Taylor series expansion (Cameron & Trivedi, 2005). Let $\hat{IP} = -\left[\frac{\hat{\beta}_a}{\hat{\alpha}}\right]$ be an estimate of implicit prices, where the mean parameters for the estimates, respectively, are provided by $E(\hat{\beta}_a) = \beta$ and $E(\hat{\alpha}) = \alpha$. Also, let the estimated variance-covariance matrix of the estimators ($\hat{\beta}_a, \hat{\alpha}$) be given by:

$$\begin{bmatrix} V_{11} & V_{12} \\ V_{21} & V_{22} \end{bmatrix}$$

where V_{11} and V_{22} show, respectively, the variance of $\hat{\beta}_a$ and $\hat{\alpha}$, and $V_{12} = V_{21}$ denotes the covariance between $\hat{\beta}_a$ and $\hat{\alpha}$. The variance of $\hat{IP}$ is estimated, using the delta method, by:

$$\hat{\sigma}^2 = \frac{1}{\hat{\alpha}^2}\left(V_{11} - 2\hat{IP}V_{12} + \hat{IP}^2 V_{22}\right) \tag{4.10}$$

It can be assumed, that for a large sample size, $\hat{IP}$ has a Gaussian distribution with mean θ and variance σ^2 from which a (1 – α) percent delta method-based confidence interval may be calculated as $\hat{IP} \pm z_{\alpha/2}\hat{\sigma}$, where $z_{\alpha/2}$ is the (1 – α/2) percent quintile of the standard distribution (for example, for a 95 percent confidence interval α = 0.05 and $z_{\alpha/2}$ = 1.96) and $\hat{\sigma}$ is the square root of the expression in Equation 4.10 (Cameron & Trivedi, 2005; Greene, 2007).

4.4.7.2 Compensating surplus estimates

Implicit prices provide estimates of WTP for improvements in attributes, but they do not provide estimates of WTP for a combination of attributes representing an improved management scenario (Birol *et al.* 2006a). In order to estimate the respondent's WTP for an improved management scenario, the compensating surplus (CS) needs to be calculated. The CS associated with an improvement from a specified constant base (V_C) to a change alternative (V_N) is given as:

$$CS = - (1/\alpha)(V_C - V_N) \tag{4.11}$$

[19] The delta method can be applied in the LIMDEP NLOGIT Version 4.0 software by invoking the Wald command (Greene, 2007). Other options for forming confidence intervals include the Krinsky and Robb (1986) method and bootstrapping (Greene, 2007).

where:
α	is the marginal utility of income,
V_C	is the utility derived from the constant base, and
V_N	is the utility derived from the change alternative.

Once implicit prices and CS estimates have been calculated and interpreted, their value must be determined by conducting validity and reliability tests.

4.4.8 VALIDITY AND RELIABILITY TESTING

Validity relates to how well a concept is defined by a measure, for example, marginal WTP, whereas reliability is concerned with the measures overall consistency (Desvousges, Johnson, Dunford, Boyle, Hudson & Wilson, 1993; Hair, Black, Babin & Anderson, 2010).

4.4.8.1 Validity

The validity of a measurement is the extent to which it accurately assesses the theoretical construct being investigated, by overcoming potential biases and the hypothetical nature of the study (Carson & Mitchell, 1993; EFTEC, 2002). In a CE context, the theoretical construct is the maximum amount of money that a consumer would pay for a combination of attributes that make up a composite good if an appropriate market existed for the good in question. This monetary amount, known as the WTP, is determined by providing the respondent with various scenarios from which a preferred alternative must be selected. More specifically, validity can be viewed as the extent to which a survey instrument overcomes bias and the hypothetical confines of the study in order to arrive at the closest approximation of the respondents' actual WTP values (Bateman *et al.* 2002). The approaches to assessing validity must make use of indirect methods. These include the implementation of content validity and construct validity tests.

a) Content validity

Content validity, also known as face validity, assesses the extent to which the content of the survey instrument is consistent with the definition of the theoretical construct (Hair *et al.* 2010). It is achieved if the survey instrument is such that the respondent feels motivated to answer it in a serious and thoughtful manner (Bateman *et al.* 2002). This occurs when the instrument is set out in a clear and understandable manner and does not suffer from biased questions or descriptions. The concept of content validity encompasses the entire CE study. It tests all the components that make up a CE application in order to persuade respondents to make informed and valid choices and reveal valid preferences. These components range from determining the sample frame and method of administering the survey instrument to checking the descriptions of the environmental quality scenarios (Bateman *et al.* 2002). The three main areas of focus when undertaking content validity testing are (1) basic design and implementation issues, (2) the good in question and its attributes, and (3) the payment description and its vehicle.

b) Construct validity

Construct validity is achieved if the measurement of interest, namely the implicit prices, are similar to implicit prices derived from other similar studies or are consistent with expectations (Bateman *et al.* 2002). If construct validity exists, it implies that the implicit prices derived from the study sample can with confidence be used to represent the actual implicit prices that exist in the population (Hair *et al.* 2010). The two types of construct validity are convergent validity and expectations-based validity.

<u>Convergent validity</u>

The convergent validity assessments compare results obtained from the CE study to (1) results obtained from other similar studies, (2) results obtained from other methods, for example, a CV study, and (3) results obtained from creating experimental simulated markets (Carson & Mitchell, 1993). Tests for convergence are often applied in environmental evaluation by comparing the study's implicit price estimates with estimates from another valuation technique, for example CV study estimates (Hanley *et al.* 1998a). It should be noted, however, that no method is entirely accurate. If one study produces a measure which is very similar to another, this does not automatically imply that these measures are valid, as both could be invalid (Bateman *et al.* 2002).

<u>Expectations-based validity</u>

Expectations-based validity is achieved if the measurements in question, the implicit price estimates, conform to theoretically sensible *a priori* expectations (Bateman *et al.* 2002). In other words, the implicit price estimates are consistent with economic theory. It is debatable to what extent economic theory can provide clear expectations regarding CE outcomes (Hanemann, 1996). Generally speaking, economic theory can be used to indicate the directionality of an effect, if it occurs, but it cannot be used to determine whether or not that effect will actually occur.

4.4.8.2 Reliability

An implicit price can be considered reliable if there is a high degree of consistency between responses from the individuals used to calculate the measure at two points in time (Hair *et al.* 2010). The objective of reliability testing is to ensure that choices made by respondents are not too varied over different time periods. Types of reliability testing methods include the test-retest method, the parallel testing method and the alternative form method. The test-retest method involves determining implicit price estimates for the same individuals at two different points in time. Classic test-retest experiments, however, have found WTP measurements to exhibit a variable degree of reliability (see Loomis, 1989; Teisl, Boyle, McCollum & Reiling, 1995). There could be valid reasons though for explaining differences in an individual's answers over time, for example, a change in a person's financial situation, or a change in their expenditure patterns (Bateman *et al.* 2002). The parallel testing method involves comparing the implicit price distributions from two independent, yet equivalent samples from the same population, but interviewed at different points in time. The alternative form method divides the sample into two parts and one part is re-estimated using a slightly different measurement method.

4.5 A CRITICAL ASSESSMENT OF THE CM METHOD

The CM method has, over the past two decades, evolved into a practical means of analysing peoples' preferences for environmental goods and services (Bennett & Blamey, 2001). This Chapter has shown that a number of useful measures can be calculated from statistically robust estimates of choice models, namely the implicit prices of the attributes that make up a composite good and the CSs associated with varying the levels of the attributes that comprise the composite good.

The merits and demerits of the CM method are considered here by comparing it to an alternative stated preference method, namely the CVM. One of the most important shortcomings of the CVM is that it is incapable of "generating multiple value estimates from a single application" (Bennett & Blamey, 2001). This shortcoming is especially relevant when dealing with the valuation of the recreational and environmental attributes of an estuary (a composite good). The application of the CVM in this case would require the execution of separate CV studies for each recreational and environmental attribute.

Unlike the CVM, the CM approach allows for the decomposition of the values of an environmental resource's constituent parts in a single application. In a discrete choice CV study, the respondent makes a binary choice, but a CM study requires the respondent to make several choices and trade-offs between different resource use alternatives (Hanley *et al.* 2001). An extensive data set that contains a large amount of detail in terms of consumer preferences (Bennett & Blamey, 2001) is thereby created. This has advantages in terms of the amount of information available for resource use decision making, and can provide a wealth of information to policy makers.

The CVM has also been criticised for not providing respondents with the necessary 'frame' in which to consider preferences for non-marketed goods (Bennett & Blamey, 2001). Unlike the CV study, CM studies do not focus on a specific scenario, as this could make the respondent believe that this case was of specific importance. The CM method is superior to the CVM in this case, as it allows more than one specified scenario within the 'frame' of reference. A 'disguise' is offered in terms of different scenarios. All scenarios or alternatives are included in the 'frame' and receive equal weighting in the mind of the respondent. This 'frame' provides a broader context in which to value the environmental good and its characteristics (Bennett & Blamey, 2001). In CV studies, respondents are asked to explicitly and directly state their WTP for a specific bundle of goods (Hanemann, 1994). The CM method, by way of contrast, indirectly infers WTP, and by so doing, reduces the problems of protest bids and 'yea' saying (Bateman *et al.* 2002).

Another problem with CV applications is that, in many cases, they are unable to show the impact on WTP estimates of a change in the scope of the good in question (Carson & Mitchell, 1993; Bennett & Blamey, 2001; Carson, Flores & Meade, 2001). For this reason, Arrow *et al.* (1993) recommended that all CV studies carry out scope tests in order to determine whether there is 'embedding'. This adds to the cost of carrying out a CV study. The risk of 'embedding' in CM studies is greatly reduced, as internal tests of scope are automatically run when model estimation occurs. In addition, if the choice sets presented to the respondent are complete and well designed, the respondent will not mistake the "scale of the resource with something that it could be embedded in" (Birol *et al.* 2006b).

Both CV and CM studies can be subject to strategic biases, but there are certain factors that serve to decrease this bias in CM applications. Firstly, strategic bias in CM studies can be minimized as the prices of the good in question are already specified (Birol *et al.* 2006b). This makes it more difficult to construct a strategy of behaviour in a CM study in respect of the pricing mechanism. Secondly, the CM method hides the purpose of the study by providing the respondent with different attribute characteristics, as well as different price levels. This 'disguise' retards the development of any strategic behaviour on the part of the respondent.

Although it is widely acknowledged that the CM method is superior to the CVM (Adamowicz, Louviere & Williams, 1994; Adamowicz, 1995; Adamowicz *et al.* 1998; Louviere *et al.* 2000; Adamowicz & Boxall, 2001; Bennett & Blamey, 2001; Hensher *et al.* 2005) it also has a number of weaknesses.

The CM method requires that respondents carry out a number of choice tasks (Hanley *et al.* 2001). The degree of complexity of a choice task depends on the number of alternatives per choice set, the number of attributes that make up or describe each alternative, the levels of the different attributes, and the number of repetitions made (Bennett & Blamey, 2001). This task complexity, coupled with the cognitive burden on the respondent, can lead to 'respondent fatigue', i.e. the respondent simplifying their required choices by using simple decision strategies or heuristics, rather than genuinely weighing up the alternatives before choosing (Swait & Adamowicz, 2001).

Although the CM method has an advantage over the CVM in terms of 'framing', the 'frame' can easily be incorrectly specified in the CM application. A 'framing' statement should be included that reminds respondents of their other financial commitments and budgetary constraints (Bennett & Blamey, 2001). The use of "cheap talk" can mitigate this problem (Cummings & Taylor, 1999).

A study conducted by Carson, Hanemann, Kopp, Krosnick, Mitchell, Presser, Ruud and Smith (1997) revealed that a CM study that includes more than two alternatives in each choice set adds a degree of freedom in terms of strategic behaviour. Certain management alternatives might be identified as having a low probability of being implemented and thus would not be chosen by the respondent. This could occur through the use of improper labels.

Due to the fact that the CM study is more complex in terms of its structure and focus, the contingencies it contains must also be more complex. The respondents understanding of the CM application is contingent on the questionnaire including clear descriptions of the alternative scenarios, as well as the purpose and meaning of the study.

The level of technical complexity of a CM application far exceeds that of a CV application. This difference is most noticeable in the design stage, as the CM application requires an experimental design on which to base the development of the choice sets. Many of the technical complexities of this technique still need to be explored.

The CM method is more costly than the CVM in the development of the experimental design. The latter needs to be tested through the use of focus groups and pilot surveys, which is costly and time-consuming.

Despite these weaknesses, the CM method remains a highly appropriate technique by which to value the recreational services provided by an estuary. The most compelling reason for choosing this technique over the CVM is its ability of "generating multiple value estimates from a single application" (Bennett & Blamey, 2001).

4.6 CONCLUSION

Chapter four has shown that the CE method has the potential to generate the information required for the effective management of the identified recreational challenges facing South African estuary management. When the challenges are related to the recreational attributes of an estuary, each attribute can be defined with levels that represent both the challenge and a potential improvement. The inclusion of a cost attribute allows for monetary trade-offs between the identified recreational challenges for each estuary.

Chapters five and six apply the various stages of the CE method to the selected estuaries.

CHAPTER FIVE: THE DESIGN AND ADMINISTRATION OF THE CHOICE EXPERIMENTS

5.1 INTRODUCTION

It is very important to design and administer the CE correctly (See Chapter four). For the selected case studies (estuaries) Chapter five reports the design of the sample, the design of the CE survey instruments, the testing of them by means of a pilot survey, the administration of the improved questionnaires, and the capturing of the collected data. Existing literature and expert consultations were used to determine relevant policy scenarios for the valuation of the sustainability of the recreational services provided by these estuaries (Hasler *et al.* 2005). Chapter six will report the methods by which the relevant welfare measures were calculated.

5.2 RECREATIONAL CONCERNS ELICITED FROM FOCUS GROUP DISCUSSIONS

The focus group discussions are a fundamentally important stage of a CE analysis. They inform the analyst which management challenges need to be addressed. The findings of this stage were reported in Chapter two.

5.3 SAMPLE DESIGN

The sample design of this study entailed three distinct steps, namely selecting the target population, specifying the sample frame, and calculating the sample size. The calculation of the sample size was based on a non-probability quota sampling technique. These steps are described below.

5.3.1 THE TARGET POPULATION

The populations of interest with respect to all the estuaries were those with a recreational demand for their services. For the Sundays and Kromme River estuaries this population included all users and potential users (current non-users) of the recreational services provided by each estuary. These populations included all individuals who, at the time of the survey, made use of the estuaries for recreational purposes, as well as those individuals who had high potential to make use of the estuaries for recreational purposes in the future. It was not feasible to survey the entire target population for each estuary. The populations of interest were unrepresentative of society at large. Many stakeholders in the estuary did not reveal or declare a recreational demand.

The populations of interest with respect to the Nahoon and Gonubie River estuaries were rate payers who were deemed current or potential users (current non-users) of the recreational services provided by each estuary.

5.3.2 THE SAMPLE FRAME

A sample frame for each estuary cannot be compiled, as this population does not reveal itself until it visits the estuary. The steps taken in generating knowledge about the sample frames for each estuary are discussed below.

5.3.2.1 The Sundays River Estuary

A sample frame for the Sundays River Estuary should be a list of all the users and potential users of the recreational services provided by the estuary. The only list that existed was one for the holders of boat licenses. The use of this list was rejected for two reasons: firstly, boat license holders constitute a fraction of all the current users of the Sundays River Estuary; and secondly, a boat license is issued for several estuaries located in close proximity to each other. For example, a boat license issued for the Sundays River Estuary may also be used for the Swartkops River Estuary and vice versa. Fishing and bait collecting permits cannot be used as a source of information as they are anonymously issued by the Post Office, and allow fishers and bait collectors to carry out their activities within a large coastal area. There is no official list of recreational fishers and bait collectors for the Sundays River Estuary. Other recreational activities also provided by the estuary are mentioned in Table 5.2 below. These activities are not subject to government regulation, and the users who carry out these activities, most often are not organized through club structures (such as walkers and those who enjoy picnicking).

a) The Sundays River Estuary recreational status and user groups

In identifying the recreational status of the users of the Sundays River Estuary knowledge of the sample population was derived from Forbes (1998) and, more recently, Cowley *et al.* (2009). These studies surveyed various aspects of recreational activity on the estuary with special reference to fishery resource utilization. The Forbes (1998) study related to activities on the estuary for the period December 1995 to April 1996, while the Cowley *et al.* (2009) study entailed a survey of the fishery resource utilization and recreational activities on the estuary for the period September 2007 to August 2008. Table 5.1 compares these two studies and Table 5.2 details the observed activities recorded during the Cowley *et al.* (2009) survey.

Table 5.1: The recreational status of the Sundays River Estuary users

Recreational Status	Forbes (1998)	Cowley *et al*. (2009)
Resident	24.7	18.6
Visitor	75.3	81.4

Source: Forbes (1998) and Cowley et al. (2009)

Table 5.2: Observed activities for the Sundays River Estuary

Activity	Percentage[1]
Recreational Shore Fishing	32.4
Recreational Boat Fishing	18.7
Boating	11.2
Recreational Bait Collecting	8.9
Recreational Fishing Boats Moving in Estuary	5.5
Subsistence Fishing	2.8
Water Skiing	2.5
Paddling	1.7
Subsistence Bait Collecting	1.4
Jet Skiing	0.5
Launching/Retrieving Boats	Not Specified
Walking	Not Specified
Running	Not Specified
Washing Clothes	Not Specified
Research	Not Specified
Walking the Dog	Not Specified
Swimming	Not Specified
Picnicking and Relaxing	Not Specified
Fishing in the Surf	Not Specified
Boat and Jetty Maintenance	Not Specified

Source: Cowley et al. (2009)

Notes: The total percentage of the unspecified observed activities equals 14.4 percent.

For ease of interpretation, all recreational fishing-related activities were grouped together (shore fishing, boat fishing, bait collecting, and fishing boats moving to and from fishing spots). All subsistence fishing-related activities were excluded, namely fishing and bait collecting. The recreational boating user group was defined as one that is involved with general boating activity, i.e. motorised boating activity unrelated to fishing. Other recreational user groups included those involved with skiing, paddling (rowing, canoeing and kayaking activities unrelated to fishing), jet skiing, walking, running, walking the dog, swimming, and picnicking and relaxing. Table 5.3 shows these proportions for the Sundays River Estuary (Forbes (1998) study and Cowley *et al.* (2009) study).

Table 5.3: Composition of the user population for the Sundays River Estuary

Recreational Use	Percentage	
	Forbes (1998) Study	**Cowley *et al.* (2009) Study**
Recreational Fishing	33.9	74
Boating	17.4	13
Water Skiing	18.9	3
Paddling	4.9	2
Jet Skiing	1.3	0.5
Walking	1.75	1.5
Running	1.75	1.5
Walking the Dog	1.75	1.5
Swimming	16.6	1.5
Picnicking and Relaxing	1.75	1.5

Source: Forbes (1998) and Cowley et al. (2009)

Notes: In order to calculate the percentages for the unspecified observed activities, for example, walking, and running, the cumulative percentages were divided by the number of activities.

5.3.2.2 The Kromme River Estuary

The Kromme River Estuary provided similar difficulties with regards to the specification of a sample frame. The use of a list that captures boat license holders could not be used from which to draw a representative sample, as this list did not capture all the users and potential future users of the recreational services provided by the estuary in question. The boat license list also included individuals who never made use of the Kromme River Estuary (only other estuaries in the area). Fishing and bait collecting permits could not be used as a source of information for this estuary, given their anonymity. The other main recreational activities provided by this estuary are not regulated.

b) The Kromme River Estuary recreational status and user groups

Less information could be gained about the composition of the Kromme River Estuary user population (see Tables 5.4 and 5.5).

Table 5.4: The recreational status of the Kromme River Estuary users

Recreational Status	Percentage
Resident	18.9
Visitor	81.1

Source: Forbes (1998)

Table 5.5: Observed activities for the Kromme River Estuary

Recreational Use	Percentage
Recreational Fishing	22
Boating	17.9
Water Skiing	18.5
Paddling/Canoeing	6.3
Jet Skiing	1.2
Windsurfing	9.2
Swimming	24.3
Other	0.6

Source: Forbes (1998)

Forbes (1998) found swimming to be the most popular recreational pursuit, but not the most popular first choice for an activity. This choice was recreational fishing (34 percent), followed by water skiing (22.6 percent), swimming (30.2 percent) and boating (9.4 percent). The boating user group was defined as watercraft usage for pleasure or leisure cruising, unrelated to recreational fishing (Forbes, 1998). Other recreational user groups included those involved with skiing, paddling (rowing, canoeing and kayaking activities unrelated to fishing), jet skiing, and windsurfing.

5.3.2.3 The Nahoon River Estuary

From the onset it was recognized that the population of user-rate-payers and that there were other non-rate-payer-beneficiaries excluded, who, it could be argued, should have been included. The user population also includes an undetermined transient component. The target population selected for this CE was all individuals who **use** the Nahoon River Estuary with a focus on recreational usage. The term "use" was broadly defined to include active use, for example regular swimming, boating, fishing, skiing and camping, but also includes those who may simply go there to take recreational walks or to visit the estuary to sit and enjoy the estuary view on a relatively regular basis. To this group of active users were added all those who lived along the estuary. From those living on the estuary it was also difficult to accurately determine qualifying respondents. Much debate at the focus group level went into whether all residents living at the waters' edge would be recreational users, how many rows back from the waters' edge would one be able to assume relevance to our population and those who simply had a majestic view of the estuary from high up on the cliff edges.

The following club members and residents were adjudged to make up the sample population:

(a) The East London Surf Life Saving Club has 119 members, of which approximately 70 percent are juniors. The majority of the seniors are also members of the Border Canoe Club as they own both canoes and surf skis.
(b) The Border Canoe Club has 250 paid-up members of which the chairman stated that approximately 150 were active members. Many members were members for the benefit of being able to house their canoes at the clubhouse right next to the river but their active use of the estuary was sporadic. The active members used the estuary at least twice a week.
(c) About 500 homes along the Nahoon River Estuary, from Abbottsford to the river mouth.
(d) Those issued with boat and fishing licenses. The number of boats / fishing licenses issued for the year July 2009 to July 2010 totalled 308. Interestingly, the usage (or those simply not renewing their licenses) showed a substantive decrease. From July 2009 to December 2009 issues totalled 228 and from January 2010 to July 2010 they totalled 80. The decline in boating activity did not appear to be matched by a decline in fishing activity.
(e) Walkers and bird watchers. The number of people who walk along the estuary banks or watch birds along the banks were estimated by early morning and evening observation. The results from a three week period of observation showed a rather limited use of the estuary by such users during the week including Sunday (from 2 to 16), but on a Saturday morning this figure jumped to over 50.

It was deduced that the sample frame for the Nahoon River Estuary included at least the following user-ratepayers (see Table 5.6).

Table 5.6: The Nahoon River Estuary User-Ratepayer Groups

Sample Population Group	**Approximate Active User Size**
The East London Surf Lifesaving Club	30
The Border Canoe Club	150
The East London Surfing Club	70
Homes along the Nahoon River Estuary	500
Annual Average Boat/fishing Licenses Issued	26
Bird watching, Walkers, Nature Seekers	50
Total	**826**

5.3.2.4 The Gonubie River Estuary

The specification of a sample frame for the Gonubie River Estuary required a list that captured all the users and potential users of the recreational services provided by the estuary, but no such list exists. Boat licenses issued are for groups of estuaries not one. Fishing and bait collecting permits could not be used as a source of information as they are anonymously issued by the Post Office, and allow fishers and bait collectors to carry out their activities within a large coastal area. There is no official list of recreational fishers and bait collectors for the Gonubie River Estuary. Typical recreational activities are listed in Table 5.7. These activities are not subject to government regulation, and the users who carry out these activities are not necessarily organized through club structures (such as walkers and those who enjoy picnicking). As is the case for most estuaries, there is a lack of user and potential user information for the Gonubie River Estuary.

Table 5.7: Observed activities for the Gonubie River Estuary

Activity
Recreational shore fishing
Recreational boat fishing
Boating
Recreational bait collecting
Recreational fishing boats moving in estuary
Subsistence fishing
Skiing
Canoeing
Subsistence bait collecting
Jet skiing
Launching/retrieving boats
Walking
Running
Washing clothes
Research
Walking the dog
Swimming
Picnicking and relaxing
Fishing in the surf
Boat and jetty maintenance

5.3.3 DETERMINATION OF SAMPLE SIZE

In an ideal setting (a labelled experiment), with a known population and sample frame, and known market proportions, the appropriate sample size can be determined with the simple random sample equation. Sample size can be estimated using Microsoft Excel (see Table 5.8) and the information about the sample populations and frames.

Table 5.8: Sample size estimation for the Four Estuaries

Alternative in Choice Set (Unlabelled)	Reported Choice Proportion (p)	Allowable Deviation (a)	$1 - p$ (q)	1-α/2	$\Phi^{-1}(1 - \alpha/2)$ (Z)	Z^2	Minimum Number of Choices per Questionnaire (r)	Sample Size for One Choice Set Alternative (N)	N/r
A	0.5	0.09	0.5	0.955	1.69	2.87	4	354	88
B	0.5	0.09	0.5	0.955	1.69	2.87	4	354	88

Applied to this particular CE setting – each respondent (decision maker) was shown four choice sets, and asked to select within this set between two unlabelled alternatives (denoted by A and B in Table 5.8 above). Assuming that the reported choice proportion (p) for each alternative in a given choice set was 50 percent, the allowable deviation (a) was set at 9 percent and applying the inverse cumulative normal distribution function, $\Phi^{-1}(1 - \alpha/2)$, denoted by Z at (1-α/2) (Hensher *et al*. 2005), Equation 4.4 from Chapter four may be used to estimate the sample size. Using the simple random sample formula, the minimum sample size required for each estuary is 176 (= 88 + 88) respondents (decision makers).

These sample size calculations presume knowledge of the better sample population than was the case at the four estuaries. As an alternative, a '*rule of thumb*' approach can be used to calculate the minimum sample size required to estimate a model of choice using unlabelled experiments and design attributes only. Under this rule, a sample of 50 respondents each exposed to 16 choice sets is deemed acceptable (Bennett & Adamowicz, 2001). This translates into a sample of 200 respondents if they are offered 4 choice sets each.

Combining this non-probabilistic sampling technique together with population proportion strata as indicated through analyses of the population of users, sample size and strata were derived as outlined in Tables 5.9 to 5.12.

Table 5.9: Strata sample sizes for the Sundays River Estuary

Stratum 1	Sample Size		Stratum 2	Sample Size	
	Forbes (1998) Study	Cowley *et al.* (2009) Study		Forbes (1998) Study	Cowley *et al.* (2009) Study
Resident	38	38	Recreational Fishing	68	148
Visitor	162	162	Boating	35	27
			Water Skiing	38	6
			Paddling	10	3
			Jet Skiing	2	1
			Walking	3	3
			Running	3	3
			Walking the Dog	3	3
			Swimming	35	3
			Picnicking and Relaxing	3	3

Notes: Calculations based on percentages from Forbes (1998) and Cowley et al. (2009)

The strata sample sizes calculated for the Kromme, Nahoon and Gonubie River estuaries using the overall population proportions from Table 5.4 to Table 5.6 are displayed, respectively, in Table 5.10, 5.11 and 5.12.

Table 5.10: Strata sample sizes for the Kromme River Estuary

Stratum 1	Sample Size	Stratum 2	Sample Size
Resident	38	Recreational Fishing	44
Visitor	162	Boating	36
		Water Skiing	38
		Paddling/Canoeing	13
		Jet Skiing	2
		Windsurfing	17
		Swimming	49
		Other	1

Source: Calculations based on percentages from Forbes (1998)

Table 5.11: Strata sample sizes for the Nahoon River Estuary

Stratum 1	Sample Size	Stratum 2	Sample Size
Estuary recreation user	67	Surf lifesaving club	7
Bank estuary user	133	Canoe club	36
		Surfing club	17
		House owners	121
		Fishing and boat license purchasers	7
		Walkers/Bird watchers	12

Table 5.12: Strata sample sizes for the Gonubie River Estuary

Stratum 1	Sample Size
In estuary recreation user	67
Bank estuary user	133
Total	

The weakness of non-probability sampling is inability to measure the sampling error, or make definitive statements about the results of applying such a method (Kinnear & Taylor, 1991).

5.3.3.1 Sampling with 'knowledge' of the sample population

As it was impossible to identify a sample frame, the closest to this objective was knowledge of the sample population and use of this knowledge to sample select. This form of non-list sampling can be used when the target population refers to visitors to a beach, or in this case, an estuary (Bateman *et al.* 2002; Dillman *et al*. 2009). Timeliness is very important when attempting to sample the recreational users of an estuary, as they ideally need to be sampled when they are actually engaged in carrying out the recreational activities. This requires on-site sampling, and is known as an intercept survey (Bateman *et al.* 2002). In the case of the Sundays and Kromme River estuaries, intercept surveys were a suitable technique for sample selection (Dillman *et al*. 2009). This type of survey method was also used in other estuary service valuation studies, such as the one that valued the recreation and resources of the Peconic Estuary System, United States of America (Opaluch *et al*. 1999). One of the many weaknesses of intercept surveys is that the nature of the visitors differs at different times of the year. During these surveys, every n^{th} recreational user is approached, but the sampling period was over the peak summer season.

The representativeness of intercept surveys can also be undermined by the greater readiness of some respondents to be interviewed, but this problem may also be present when a sample frame has been identified.

The knowledge of the user population was applied by alerting the interviewers to approach the estimated proportion of each population type in executing their intercept strategy. The process followed for respondent selection was as follows: The researcher and 3-6 fieldworkers identified sites believed to ensure respondents from each of the relevant strata above would be covered. In all cases some of the respondents were advised before the administration of the survey that they may be surveyed and clubs were approached and the purpose of the survey explained.

5.4 DESIGNING THE SURVEY INSTRUMENT

5.4.1 QUESTIONNAIRE DEVELOPMENT

Most of the questionnaire development for the estuaries surveys took place during the course of 2010. Copies of the Sundays, Nahoon, Kromme and Gonubie River estuaries surveys are provided in Appendices B, C, D and E, respectively. The process of questionnaire development for both estuaries included expert interviews, and the implementation of focus groups and pilot studies. One of the key issues when designing a survey instrument is to keep the format and language simple and consistent across all sections. A useful resource to aid the drafting of a questionnaire is Dillman *et al*.'s (2009) publication (Hensher *et al*. 2005). This book was consulted whilst drafting this study's questionnaires. Different word choices were pretested in order to evaluate the ease with which the respondents understood the various wording combinations. This pretesting is essential in a context where there might be cultural and language differences between researchers and the study participants (Mangham, Hanson & McPake, 2009). The questionnaire was also presented to the respondents in the pilot study to determine if there was any 'respondent fatigue', i.e. if the questionnaire was too long. The aim of the pilot study was to develop a concise, clear and consistently written questionnaire. Specific details with regards to the development of the questionnaires are discussed separately for each estuary.

5.4.1.1 Sundays River Estuary Questionnaire

The example of the development of the Sundays River Estuary questionnaire is described below. It began with a meeting with two scientists from the Zoology department in the Faculty of Science at Nelson Mandela Metropolitan University, namely Prof. Tris Wooldridge and Prof. Janine Adams. These interviews helped clarify the research area, and the concerns facing the various interest groups making use of the estuary for recreational purposes. An informal telephonic interview was then conducted with Prof. Paul Cowley from the Zoology department in the Faculty of Science, Rhodes University, Grahamstown. He provided detailed information on the population of users of the Sundays River Estuary and also information regarding recreational fishing activities.

Informal interviews followed with the Chairman of the Sundays River Joint River Forum, as well as members of the Sundays River Ratepayers Association. They were asked to list their concerns with regards to the recreational use of the estuary, and rank them in order of importance. This information, together with that provided by the experts, led to the development of a pilot questionnaire. A pilot study was then conducted in order to 'fine tune' the questionnaire. During the pilot study a significant problem was identified – a lack of understanding of the way to answer the CE part of the questionnaire. The impression some respondents gained was that only one choice had to be made out of all four choice sets given. In order to correct this potential problem, prior to the main survey, an example choice set with a hypothetical choice already made, was included in the questionnaire.

5.4.1.2 From pilot study phase to final questionnaire design

The development of the questionnaire began with meetings of the focus groups and various email correspondences thereafter on the main concerns facing the users of the estuary. In consultation with various member organizations, these concerns were placed in order of importance. This information informed the development of a pilot questionnaire. In order to refine the wording and layout pilot studies were conducted. Typical problems experienced by the members of the focus group included (1) not understanding the area covered by the term 'estuary', and (2) not including a specific question relating to the issue of bait collection. Following the pilot study phase the design steps proposed by Hasler *et al.* (2005) were followed. These steps include (1) the collecting of introductory information from the respondent through the use of an introductory section, (2) the setting out of the CE with relevant descriptions of the attributes and levels, and (3) the provision of follow-up questions, which allow for reliability and validity checks. Socio-demographic information from the respondent was also collected. A broad overview of the questionnaire is provided below.

5.4.2 INTRODUCTORY QUESTIONS

It is important to ensure that all respondents have access to the same information before attempting to make choices for a CE. The amount of detail provided to the respondent, however, must not be too extensive as this can lead to respondent boredom. It must be enough to provide the respondent with a clear idea of the study's main objective, and increase the respondents understanding of the constructed choice scenarios presented in the next section of the questionnaire. In this section questions were asked regarding the respondent's attitude to the estuarine environment, the recreational problems facing the estuary, the importance of flora and fauna in the area, and the roles of government in protecting estuaries in a sustainable manner. One of government's main concerns when dealing with the recreational use of estuaries is whether these estuaries are being used in a sustainable manner. When establishing what policy initiatives need to be put in place, it is important for government and other stakeholders to be aware of the attitudes of estuary users.

5.4.3 THE CE PART OF THE QUESTIONNAIRE

5.4.3.1 Selecting attributes and levels

The first step in the development of a discrete CE is the identification of the attributes of interest and the specification of levels for each attribute chosen (Ryan, Bate, Eastmond & Ludbrook, 2001; Hensher *et al.* 2005; Yacob & Shuib, 2009). The choices of attributes and levels are heavily influenced by what members of the focus group perceive to be feasible, relevant and realistic. These perceptions may include options that are illegal or contrary to government policy, where the latter are poorly enforced or implemented, for example, the keeping of undersized fish, dumping of unsanitised municipal waste into estuaries and the limitation of public access to an estuary by excluding access through privately held property[20]. The inclusion of an illegal choice is permissible if it is relevant and realistic because the Law is improperly enforced, i.e. not actually serving to constrain choice.

The four attributes defined included three qualitative attributes relating to the effects of different management options in relation to the quality of estuarine services and the estuarine environment, and one quantitative attribute which specified the cost/price of the option. The qualitative attributes were used because respondents relate more confidently to these. Qualitative attributes are considered less cognitively demanding (Hasler *et al.* 2005). The different attributes and their levels were described in a 'neutral' manner. Choices are made according to the respondent's tastes and preferences and therefore any descriptions within the CE should not include phrases and/or words that were leading in nature.

The inclusion of a monetary attribute was necessary in order to facilitate the derivation of monetary values that respondents could attach to the qualitative effects of different management options. The payment vehicle selected for both estuaries was an annual environmental levy. This was found to be the most understandable and

[20] The comments of a Reference Group member are gratefully acknowledged in this connection. One of the members argued that it did not make sense to present an illegal option to respondents. The ICMA advocates equitable coastal access (including to estuaries), so it is illegal to limit rights of access to coastal resources. Similarly, the Law and policy protect the Coastal Resources from degradation, for example through spills of sewage into estuaries and the taking undersized fish.

uncontroversial option out of those discussed in the focus groups. The specific attributes and levels for each estuary are discussed below.

An example of the attributes selected and presented in the choice options is that for the Sundays River Estuary CE, shown in Table 5.13 below.

Table 5.13: The Sundays River Estuary attributes and their levels

Indicator/attribute	**Levels**	**Description of levels**
Physical size of fish caught	Mostly small fish now	Catch and retain whatever fish species you want 'today'
	None now but bigger and more fish next year	Keep no undersize fish now but more and bigger fish next year
Congestion	Hear and see few boats	The recreational user sees and hears a few boats
	Hear and see many boats	The recreational user sees and hears many boats
More public access	Yes	Establish a path access along the banks of the estuary
	No	Do not establish a path access along the banks of the estuary

Each of the three attributes presented in Table 5.13 assumed two different levels. The written description of the monetary attribute, or cost variable, was:

"It is assumed that the cost of providing these recreational use alternatives is ***partly*** *covered by the Sundays River Estuary's fishing and boat license holders. SANPARKS will cover the* ***majority*** *of the costs. We ask you to imagine that all fishing and boat license holders will contribute equally by means of a fixed annual sum added to the existing license structure. This annual sum will then be directed back to the Sundays River Estuary. This annual sum can take four different values, namely R0 (current situation), R45, R90 and R120".*

This cost variable was expressed by four different Rand values in the CE. The designer considered it to be "credible, relevant, acceptable and coercive" payment vehicle (Bateman *et al.* 2002).

5.4.3.2 Construction of the choice sets

a) The number of alternatives

As mentioned in Chapter three, the alternatives which respondents are asked to choose between in the CE each represented different policy proposals concerning future estuarine resource management. The number of alternatives presented to each respondent in the context of environmental valuation is ideally not more than two to three per choice set (Adamowicz & Boxall, 2001). For the purposes of this study, two alternatives were adopted for each estuary. This number was considered appropriate as more than two alternatives can become demanding for the respondent in terms of cognitive burden. During focus group discussions, the users of both estuaries revealed a preference for fewer alternatives per choice set. The alternatives presented to the respondent in each choice set were left as unlabelled, so as not to distract the respondent's attention away from the attribute levels to the labels (Blamey, Bennett, Louviere, Morrison & Rolfe, 2000).

b) The inclusion of a status quo or 'opt-out' option

A large number of valuation studies advocate the inclusion of a status quo or 'opt-out' alternative. Literature suggests that if one is not included, the respondent is forced to pick a scenario that is not necessarily favoured. The inclusion of a status quo or 'opt-out' option, however, is not always recommended (Qin, 2008). It can create new biases (Scarpa *et al.* 2004). It also provides an 'easy way out' for respondents if they want to avoid the choice task (Dhar & Simonson, 2001; Kontoleon & Yabe, 2003). It might also be impossible to include a status quo alternative if the current or base scenario is not a relevant or feasible option (Adamowicz & Boxall, 2001).

For the purposes of this study, a status quo alternative was not included for any of the estuaries except for one, the Gonubie River Estuary. The reason for this was two-fold: firstly, it was difficult to define a status quo option as some of the current recreational uses pertaining to both estuaries can be defined as illegal activities (for the Sundays River Estuary, bag and size limits are not adhered to; for the Kromme River Estuary, jet skis and wet bikes are often ridden in prohibited areas). Secondly, it was not thought necessary to include a status quo alternative if the study is assumed to guide policy-making (Hasler *et al.* 2005). In the case of the Gonubie River Estuary, a status quo was identified offered as a choice – mainly to explore what the consequences would be of incorporating this feature into the design.

c) Number of choice sets per respondent

The number of choice sets that each respondent must face is considered to be inversely proportional to the complexity of the task at hand (Bateman *et al.* 2002). There are three qualitative attributes with two levels each, and one cost variable with four levels. This number represents a fairly low task complexity, but the effects of task complexity were not investigated in this study. Most studies recommend a maximum of six choice sets be presented to a respondent (Hasler *et al.* 2005; Bateman *et al.* 2002), in order to make the choice task manageable and not cognitively burdensome.

5.4.3.3 Experimental design

Each estuary had 4 attributes. Three of the attributes had two levels each, and one had four levels. A full factorial design (2x2x2x4 = 32) was generated using SPSS, yielding 32 different treatment combinations or alternatives. These alternatives were randomly allocated to 32 different questionnaires containing four choice sets each. Each choice set had two alternatives.

5.4.3.4 The budget constraint and the inclusion of "cheap talk"

Even though the effects of "cheap talk" within a CE context are inconclusive, it was decided to include a short "cheap talk" section in the design of each questionnaire. In comparison to other international studies conducted, the length of the "cheap talk" section included in the questionnaires was significantly shorter – only a couple of lines. It was felt that the inclusion of an extensive "cheap talk" section was inappropriate, since it was expected that the negative impacts of increasing the length of the questionnaire would by far exceed the potential benefits arising from the inclusion of a lengthy "cheap talk" section. Due to its brevity, it may be questioned whether the "cheap talk" section included in these questionnaires actually qualifies as "cheap talk".

In both the questionnaires, information on the CE payment was specified so that the respondents were aware of the payment vehicle, as well as the need to consider the constraints on the households' budget. The assumptions with respect to the payment were (1) that the costs of implementing the policy alternatives would be covered by each estuary's recreational users', and (2) that all users would contribute equally to the implementation of the scenarios by means of a fixed annual sum per household. This sum was to be paid once a year via an environmental levy. The "cheap talk" section was phrased as follows:

"It is important to remember that this recreational use management project is only one of many such projects in South Africa. Also, be aware that spending more money on any alternative would mean that you would have less money to spend on all other goods and services, i.e. you face a budget constraint.
Please note that the choices are hypothetical, but plausible (based on advice from scientists). It is important to treat each of your four choices as if they were real, and independent from each other."

5.4.4 ADDITIONAL QUESTIONS

As discussed in Chapter four, a section of follow-up questions should be included after the choice task. The follow-up questions for both the estuaries were very similar. In the questionnaires, four questions were asked immediately after the choice task regarding respondents' experience of the choice exercise and how they made their choices.

The first of these questions (Question 4.1) asked whether the respondents found it easy or difficult to make the choices in the choice sets (Question 3). The aim of this question was to elicit feedback on the reliability of their choices.

If respondents indicated that the choice task was difficult, i.e. answered 'Yes' to Question 4.1, they were subsequently asked in Question 4.2, what had made the choice tasks difficult for them. The categories included in this question were:

- I could not relate to the questions,
- I think there was too much information to consider,
- I did not understand the questions,
- I think the alternatives were too expensive,
- It was difficult to choose as several factors were important,
- I do not believe Estuary users should pay to ensure a healthy Estuary,
- Other reason (please specify), and lastly
- Don't know.

The answers respondents provided to this question were not intended for data modelling inclusion. One of the statements included as an option, namely "It was difficult to choose as several factors were important" served to establish the validity of respondent choices, in the sense that it provided opportunity to reveal the application of a compensatory decision-making strategy.

Question 4.3 asked the respondents which of the four attributes they put greatest weight on when choosing between the different alternatives. There was also an opportunity for them to state whether it had varied from choice to choice. This question aimed to help identify if the respondent had followed a non-compensatory decision strategy, by focusing on the levels of one attribute only when making choices. If respondents' answered that they took all the attributes into consideration when making choices, the compensatory decision making assumption was most likely not violated (Watson *et al.* 2004).

Question 4.4 was a policy-orientated question. It asked the respondent whether they would increase their level of estuary usage if certain recreational estuarine attribute improvements were made. This question was included as a quasi-validity test.

5.4.5 SOCIO-ECONOMIC QUESTIONS

Six questions relating to the respondent's socio-economic status were asked in both questionnaires. These questions asked about the respondent's gender, age, place of residence, occupation, household income and educational attainment.

5.5 ADMINISTERING THE SURVEY INSTRUMENTS

5.5.1 INTRODUCTION

Once the design of the survey instrument for each estuary was completed, it was administered. The steps followed in the administration of the main survey instruments are described below.

5.5.2 SELECTION OF SURVEY TECHNIQUE

The choice of a survey collection mode is vitally important in primary data generation using stated preference techniques (Mitchell & Carson, 1989; Champ, 2003; Alberini & Khan, 2006). The National Oceanic and Atmospheric Association (NOAA) inquiry recommended that personal interviews be the preferred mode of collection (Portney, 1994). Web-based survey methods, however, have recently received attention as an acceptable form of data collection (Windle & Rolfe, 2009). The use of a web-based survey method for this study was considered inappropriate, however, since it was expected that some of the targeted population would not have access to the Internet. The most commonly used approach when valuing recreational sites is the face-to-face interview (Lee & Han, 2002). This personal interview method was adopted for this study. Although costly, it affords the interviewer the best opportunity to encourage the respondents to cooperate with the survey. The interviewer is also given an opportunity to explain complex information and valuation scenarios to the respondent – which is very important in the CE setting (Mitchell and Carson, 1989).

In order to prevent respondent selection bias, interviewers participated in training sessions held approximately one week prior to data collection. All the interviewers had previous household interviewing experience. The training sessions were conducted by the chief researcher, as well as estuarine use experts from each estuary. The interviewers were provided with various study materials to familiarize themselves with prior to the training sessions (Natural Resource Damage Assessment, Inc. (NRDA), 1994). Each training session began with a brief overview of the study. A demonstration interview followed whereby interviewers were shown the correct way to administer the questionnaires. After the demonstration, the interviewers formed groups of two and conducted the interviews; one being the interviewer and one playing the part of the respondent. During this training the interviewers were also informed about the undesirability of selecting respondents based on their own personal perceptions and preferences. On conclusion of the training sessions, interviewers were provided with small gifts which they were to give to the respondents to thank them for their participation. It was hoped that this would ease the interviewer's burden of approaching unknown/unfamiliar respondents.

5.5.3 DATA COLLECTION

During the process of data collection, all interviewers reported to the chief researcher. The chief researcher managed the data collection process and dealt with any logistical issues that arose. The administration of the questionnaires for each estuary was administered on-site by a team of trained interviewers. Interviewers followed the intercept sample method whereby they approached every n^{th} potential respondent and asked them if they would be willing to spend approximately 15 minutes filling in the questionnaire. A face-to-face interview technique was used and the non-response rate was zero. At the Sundays River Estuary the survey was administered to 176 users during August, 2010. At the Kromme River Estuary the survey was administered to 244 users during December, 2010. At the Nahoon River Estuary the survey was administered to 216 users during December, 2010. At the Gonubie River Estuary the survey was administered to 204 users during March, 2011.

Once data collection was complete, a field edit was carried out for each estuary whereby questionnaires were validated by the chief researcher in the presence of the respective interviewers (NRDA, 1994). Once complete, the questionnaires from each estuary were handed over to a qualified data processor for capturing into MS Excel. Finally, as recommended in the relevant literature, the data was checked for inconsistencies (Hensher *et al*. 2005).

5.6 CONCLUSION

The main demand challenges facing recreation users at each of the estuaries selected for further study were identified through focus groups selected because of their strong interest in the recreational use of the estuaries. The sample design for each estuary was guided by a *rule of thumb* approach. Once the process of sample design was complete, the survey instrument was developed along the lines recommended by authoritative texts. The various survey instruments took many months to design and was reviewed after the administration of a pilot study. The parts making it up included (1) introductory questions to 'warm up' the respondent, (2) the CE section where the respondent was required to make choices, (3) the follow-up section where respondents answered questions relating to why they had made certain choices, and (4) socio-economic questions. In the administration care was taken to elicit carefully considered responses and accurately capture the responses. The accuracy of the spread sheet record of the responses was checked prior to the model estimation phase of the CE analysis (see Chapter six).

CHAPTER SIX: RESPONSE ANALYSIS, CHOICE MODELS ESTIMATED AND PRICE AND WELFARE CALCULATIONS

6.1 INTRODUCTION

Prior to model estimation an important step is to check the data for multicollinearity between the attributes that are going to be used to explain choice. Following this step, one can estimate appropriate maximum likelihood models, and from these estimates one may calculate implicit prices for the recreational attributes of interest and deduce welfare implications of selected choice modifications. An important final step is to assess the validity of the modelling outcomes. Chapter six reports these stages of the application of the CE method.

6.2 CHECKING THE ATTRIBUTE DATA FOR MULTICOLLINEARITY

High correlations among the design attributes indicate a potential problem of multicollinearity in the model. Multicollinearity is a problem because correlations between attributes can be introduced into a model through a loss of design orthogonality. The level of orthogonal loss is reflected in the degree of correlation between the attributes, that is, multicollinearity (Hensher *et al.* 2005). Unfortunately, if the presence of multicollinearity is detected there is very little the researcher can do to reduce the problem at this stage. Having determined through the focus group stage that an attribute is important, it is not credible to suddenly drop one of the affected attributes (Hensher *et al.* 2005).

A number of methods are available to the researcher to test for the existence of multicollinearity. Two methods to test for the presence of multicollinearity are considered in this section. The first test entails the use of the method of auxiliary regressions (Amemiya, 1985; Hensher *et al.* 2005). Three steps must be carried out to administer this test. Firstly, each attribute must be regressed on the remaining attributes in the design. Secondly, the R^2 of each auxiliary regression must be calculated as well as the R_i for each regression. The R_i is calculated as follows:

$$R_i = \frac{\left[R^2_{x1x2x3\ldots xk}/(k-2)\right]}{\left[\left(1-R^2_{x1x2x3\ldots xk}\right)/(n-k+1)\right]} \qquad (6.1)$$

where:

$R^2_{x1x2x3\ldots xk}$ is the coefficient of determination of the regression of attribute x_i on the remaining attributes,

k	is the number of explanatory variables in the model, including the constant and,
n	is the sample size, i.e. the number of observations (Hensher *et al.* 2005).

Thirdly, each R_i must be compared to a critical F-statistic with $(k - 2)$ degrees of freedom in the numerator and $(n - k + 1)$ degrees of freedom in the denominator. If the critical F-statistic is exceeded by a R_i for an auxiliary regression, the test does not reject the hypothesis that the attribute x_i is correlated with the remaining attributes and the presence of multicollinearity in model estimation (Hensher *et al.* 2005).

The results of this test for the Sundays River Estuary design are shown in Table 6.1.

Table 6.1: Test for multicollinearity by the method of auxiliary regressions – Sundays River Estuary

Dependent Variable in Auxiliary Regression	Regressors	Auxiliary Regression R^2	R_i	F-statistic*
Size of Fish	Congestion, Public access, Cost	0.00123	0.86	3.00
Congestion	Size of fish, Public access, Cost	0.00105	0.74	
Public Access	Size of fish, Congestion, Cost	0.00029	0.20	
Cost	Size of fish, Congestion, Public access	0.00185	1.30	

**Critical value of F-statistic at 5 percent level of significance with two (4 – 2) and 1395 (1400 – 4 + 1) degrees of freedom. The F-statistic is equal to 3.00 for each test, as the degrees of freedom for each auxiliary regression does not change (Hensher et al. 2005)*

As can be seen from Table 6.1 above, none of the R_i values exceed the critical F-statistic (3.00). It was concluded that multicollinearity was not a problem in this particular case.

The second test entails using Klein's rule (Klein, 1962) and employing the auxiliary regression's $R^{2'}$s estimated in the method above. The coefficients of determination, i.e. R^2, for the estimated auxiliary regressions above must be compared to the R^2 of the regression of the dependent variable (choice) on the attributes of the model as used in the auxiliary regression models (Hensher *et al.* 2005). If it is found that the R^2 of any of the auxiliary regression models exceeds the R^2 of the regression of choice on the design attributes of the model, multicollinearity cannot be excluded (Hensher *et al.* 2005). The results of this test are shown in Table 6.2.

Table 6.2: Multicollinearity test using Klein's rule – Sundays River Estuary

Dependent Variable in Auxiliary Regression	Regressors	Auxiliary Regression R^2	R^2 of Regression of Dependent Variable on Attributes
Size of Fish	Congestion, Public access, Cost	0.00123	0.0148
Congestion	Size of fish, Public access, Cost	0.00105	
Public Access	Size of fish, Congestion, Cost	0.00029	
Cost	Size of fish, Congestion, Public access	0.00185	

Table 6.2 shows that none of the auxiliary regressions' R^2s exceed the R^2 of the regression of the dependent variable (choice) on the attributes of the model. This test confirms the findings of the method of auxiliary regressions carried out above – multicollinearity was not a concern in this CE.

In a similar fashion to the Sundays River Estuary analysis, the data was checked for possible correlations among attributes using the same two tests. The results of the method of auxiliary regressions test for the Kromme River Estuary design are shown in Table 6.3.

Table 6.3: Test for multicollinearity by the method of auxiliary regressions – Kromme River Estuary

Dependent Variable in Auxiliary Regression	Regressors	Auxiliary Regression R^2	R_i	F-statistic*
Navigability	Congestion, Jet Skiing, Cost	0.0022	2.1535	3.00
Congestion	Navigability, Jet Skiing, Cost	0.0022	2.1691	
Jet Skiing	Navigability, Congestion, Cost	0.0018	1.8262	
Cost	Navigability, Congestion, Jet Skiing	0.0016	1.6474	

**Critical value of F-statistic at 5 percent level of significance with two (4 – 2) and 1949 (1952 – 4 + 1) degrees of freedom. The F-statistic is equal to 3.00 for each test, as the degrees of freedom for each auxiliary regression does not change (Hensher et al. 2005)*

As can be seen from Table 6.3, none of the R_i values exceed the critical F-statistic (3.00). It was concluded that multicollinearity was not a problem in this case.

The results of Klein's test are shown in Table 6.4.

Table 6.4: Multicollinearity test using Klein's rule – Kromme River Estuary

Dependent Variable in Auxiliary Regression	**Regressors**	**Auxiliary Regression R^2**	**R^2 of Regression of Dependent Variable on Attributes**
Navigability	Congestion, Jet skiing, Cost	0.0022	0.0591
Congestion	Navigability, Jet skiing, Cost	0.0022	
Jet skiing	Navigability, Congestion, Cost	0.0018	
Cost	Navigability, Congestion, Jet skiing	0.0016	

Table 6.4 shows that none of the auxiliary regressions' R^2s exceed the R^2 of the regression of the dependent variable (choice) on the attributes of the model. This test confirms the findings of the method of auxiliary regressions carried out above – multicollinearity was not a concern in this CE.

The same relevant results for the Nahoon and Gonubie River estuaries are shown in Tables 6.5 to 6.8.

Table 6.5: Test for multicollinearity by the method of auxiliary regressions – Nahoon River Estuary

Dependent variable in auxiliary regression	Regressors	Auxiliary regression R^2	R_i	F-statistic*
Water Safety	Interest in Facilities, Public Safety, Cost	0.00295	2.49	3.00
Interest in Facilities	Water Safety, Public Safety, Cost	0.00566	4.78	
Public Safety	Water Safety, Interest in Facilities, Cost	0.00937	7.94	
Cost	Water Safety, Interest in Facilities, Public Safety	0.00557	4.70	

**Critical value of F-statistic at 5 percent level of significance with two (4 – 2) and 1677 (1680 – 4 + 1) degrees of freedom. The F-statistic remains equal to 3.00 for each test, as the degrees of freedom for each auxiliary regression does not change (Hensher et al. 2005)*

Three of the four R_i values exceed the associated critical F-statistic, i.e. 3.00. This implies that multicollinearity cannot be excluded in this case. The results of the Klein test are shown in Table 6.6 below.

Table 6.6: Multicollinearity test using Klein's rule – Nahoon River Estuary

Dependent variable in auxiliary regression	Regressors	Auxiliary regression R^2	R^2 of regression of dependent variable on attributes
Water Safety	Interest in Facilities, Public Safety, Cost	0.00295	0.05010
Interest in Facilities	Water Safety, Public Safety, Cost	0.00566	
Public Safety	Water Safety, Interest in Facilities, Cost	0.00937	
Cost	Water Safety, Interest in Facilities, Public Safety	0.00557	

Table 6.6 shows that none of the auxiliary regressions' R^2s exceed the R^2 of the regression of the dependent variable, i.e. choice, on the attributes of the model, which implies the absence of multicollinearity. It follows that the tests for the presence of multicollinearity were inconclusive for the Nahoon River estuary case.

Table 6.7: Test for multicollinearity by the method of auxiliary regressions – Gonubie River Estuary

Dependent variable in auxiliary regression	Regressors	Auxiliary regression R^2	R_i	F-statistic*
Water Safety	Naturalness, Security, Cost	0.66410	2417	3.00
Naturalness	Water Safety, Security, Cost	0.68223	2625	
Security	Water Safety, Naturalness, Cost	0.67305	2517	
Cost	Water Safety, Naturalness, Security	0.61260	1933	

**Critical value of F-statistic at 5 percent level of significance with two (4 – 2) and 2445 (2448 – 4 + 1) degrees of freedom. The F-statistic remains equal to 3.00 for each test, as the degrees of freedom for each auxiliary regression does not change (Hensher et al. 2005)*

All of the R_i values exceed the associated critical F-statistic, i.e. 3.00, implying multicollinearity could be a problem in this case. This finding is confirmed applying Klein's rule (Klein, 1962). The results of this test are shown in Table 6.8 below.

Table 6.8: Multicollinearity test using Klein's rule – Gonubie River Estuary

Dependent variable in auxiliary regression	Regressors	Auxiliary regression R^2	R^2 of regression of dependent variable on attributes
Water Safety	Naturalness, Security, Cost	0.66410	0.16222
Naturalness	Water Safety, Security, Cost	0.68223	
Security	Water Safety, Naturalness, Cost	0.67305	
Cost	Water Safety, Naturalness, Security	0.61260	

All of the auxiliary regressions' R^2s exceed the R^2 of the regression of the dependent variable, i.e. choice, on the attributes of the model.

6.3 SOCIO-ECONOMIC CHARACTERISTICS, ATTITUDES AND HABITS

6.3.1 THE SUNDAYS RIVER ESTUARY

6.3.1.1 Socio-economic characteristics

This section describes the data collected from the responses from the socio-economic section of the questionnaires. The only other socio-economic information available was that gathered in the Forbes (1998), and more recently, the Cowley *et al.* (2009) studies. The Forbes (1998) study captured data on the recreational users of the estuary, while the Cowley *et al.* (2009) study captured data on both recreational and subsistence users of the estuary. Comparisons with the Cowley *et al*. (2009) study are possible for the following socio-economic characteristics: residential location, age, gender and education. The Forbes (1998) study allows comparisons for residential location only. Selected, socio-economic results of the Sundays River Estuary survey (Lee, 2011) are summarized as follows:

- The majority (91 percent) of visitors came from areas less than 50 km away from the estuary.
- The majority (55 percent) of recreational users surveyed were over the age of 35.
- The majority (84 percent) of recreational users surveyed are male.
- The average annual income for the sample was R184 000.
- Of the respondents sampled, 35 percent had a matric qualification with university exemption.
- All occupational categories are well represented in the sample of respondents, with the exception of plant and machinery operators/assemblers (2 percent), agricultural workers (1 percent), and elementary occupations (1 percent).

a) Residential Location

Not unlike the sample of respondents interviewed as part of the Forbes (1998) and Cowley *et al*. (2009) studies, most of the visitors surveyed came from areas less than 50 km away from the estuary. Of these respondents, most came from Port Elizabeth (59 percent). Permanent residents of the Sundays River Estuary, living in Colchester and Cannonville, accounted for approximately 21 percent of the sample. The information pertaining to respondents' zones of origin is displayed in Table 6.9.

Table 6.9: Percentage of respondents by place of residence – Sundays River Estuary

Place	**Percentage of Respondents**
Port Elizabeth	59
Swartkops	1
Uitenhage	6
Despatch	4
Colchester	19
Cannonville	2
Grahamstown	1
Port Alfred	1
East London	2
Jeffreys Bay	1
Humansdorp	1
Knysna	4
Kleinemond	1
Johannesburg	1
Total	**100**

A comparison of the residential location of the respondents in the Lee (2011) study to that of the Forbes (1998) and Cowley *et al.* (2009) studies is provided in Table 6.10.

Table 6.10: Comparison of residential location – Sundays River Estuary

Distance	**Percentage of Respondents**		
	Lee (2011) Study	**Forbes (1998) Study**	**Cowley *et al.* (2009) Study**
<50 km from Estuary	91	84.9	91.2
<5 km from Estuary (Local Residents)	21	24.7	18.6
Between 5 and 50 km	70	60.2	72.5
Between 50 and 200 km	5	3.5	3.4
Between 200 and 400 km	6	8	0.8
>400 km from Estuary	1	3.6	3.5
Foreign Visitors	0	0	1.2
Total	**100**	**100**	**100**

A survey conducted by Forbes and Wooldridge (1999) showed similar trends in terms of the provincial and city/town distribution of recreational users (Afri-Coast Engineers, 2004): 94.5 percent of the recreational users visiting the Sundays River Estuary were from the Eastern Cape, and only 3.6 percent were from Gauteng. Of the recreational users that visited the Sundays River Estuary, 56.6 percent came from Port

Elizabeth, 8.4 percent from Uitenhage, and 19.9 percent from Colchester and Cannonville.

b) Age

The majority of recreational users sampled were over the age of 35. The minimum age sampled was 18 years. The percentage of respondents per age category is shown in Table 6.11.

Table 6.11: Percentage of respondents per age category – Sundays River Estuary

Age Category	Percentage of Respondents
18-20	9
21-25	11
26-30	14
31-35	11
36-40	17
41-45	14
46-50	11
51-55	8
56-60	3
61 Years and Older	2
Total	**100**

A comparison of the age of the respondents of this study to that of the Cowley *et al.* (2009) study is provided in Table 6.12.

Table 6.12: Comparison of age profile – Sundays River Estuary

Age Category (Years)	**Percentage of Respondents**	
	Lee (2011) Study	**Cowley *et al.* (2009) Study**
<10	0	2.3
11-20	9	13.7
21-30	25	19.2
31-40	28	20.1
41-50	25	21.4
51-60	11	14.5
60+	2	8.7
Total	**100**	**100**

c) Gender

The vast majority of respondents were male (84 percent). Table 6.13 shows the gender of sampled respondents.

Table 6.13: Percentage of respondents by gender – Sundays River Estuary

Gender	Percentage of Respondents
Male	84
Female	16
Total	**100**

A comparison of the gender of the respondents of this study to that of the Cowley *et al.* (2009) study is provided in Table 6.14.

Table 6.14: Comparison of gender profile – Sundays River Estuary

	Percentage of Respondents	
Gender	Lee (2011) Study	Cowley *et al.* (2009) Study
Male	84	91.8
Female	16	8.2
Total	**100**	**100**

d) Income

The percentage of respondents per income category is presented in Table 6.15. If respondents ticked the "Refuse to Answer" category, an income value was allocated to them based on their stated occupation. The income values for the occupational categories were obtained from the Labour Force Survey (LFS) of September 2007 (Statistics South Africa (STATSSA), 2007). In order to calculate average income, respondents were allocated random income values within their specified income categories. These income values were generated using a random number generator programme in the statistical package Stata Version 11.0. These values were then summed, divided by the total number of respondents, and adjusted for inflation. The average annual income for this sample was R184 000. A small number of very high incomes per annum captured in the upper end of the income distribution skewed the average upwards – the majority of respondents earned less than R150 000 per annum.

Table 6.15: Percentage of respondents per income category – Sundays River Estuary

Income Category	Percentage of Respondents
less than R50000	22
R50 000-R99 999	18
R100 000-R149 999	21
R150 000-R199 999	15
R200 000-R249 999	5
R250 000-R299 999	2
R300 000-R349 999	3
R350 000-R399 999	3
R400 000-R449 999	2
R450 000-R499 999	1
R500 000-R749 999	3
R750 000-R999 999	3
R1 000 000 or more	1
Total	**100**

e) Education

Most of the respondents sampled had a matric qualification with university exemption. In addition to a matric, 57 percent had attained at least one tertiary qualification – 27 percent held a Technikon diploma, 21 percent held a University degree and 9 percent held a post-graduate degree. The percentage of respondents per education category is shown in Table 6.16.

Table 6.16: Percentage of respondents per education category – Sundays River Estuary

Education Category	Percentage of Respondents
Secondary School Education	8
Matriculation	35
Technikon Diploma	27
University Degree	21
University Post-graduate Degree	9
Total	**100**

A comparison of the educational attainment of the respondents of this study to that of the Cowley *et al.* (2009) study is provided in Table 6.17. This study interviewed a more highly educated sample.

Table 6.17: Comparison of education profile – Sundays River Estuary

Education Category	Percentage of Respondents	
	Lee (2011) Study	**Cowley *et al*. (2009) Study**
No Education	0	0.23
Primary School Education	0	8.2
Secondary School Education	8	33.7
Matriculation	35	27.5
Technikon Diploma	27	21.8
University Degree	30	8
Total	**100**	**100**

f) Occupation

For the purposes of the study, occupational categories were specified in accordance with the Labour Force Survey of South Africa (LFS), currently known as the Quarterly Employment Survey (QES) – see Table 6.18 (STATSSA, 2001). All occupational categories are well represented in the sample of respondents, with the exception of plant and machinery operators/assemblers (2 percent), agricultural workers (1 percent), and elementary occupations (1 percent). Three respondents were grouped into the unspecified category because they refused to divulge their occupation.

Table 6.18: Percentage of respondents per occupation – Sundays River Estuary

Occupation	Percentage of Respondents
Legislators, Managers & Senior Officials	14
Professionals	12
Technicians & Associate Professionals	9
Clerks	5
Service Workers & Market/Sales Workers	15
Skilled Agricultural and Fishery Worker	1
Craft & Related Trade Workers	15
Plant & Machinery Operators/Assemblers	2
Elementary Occupations	1
Self Employed	14
Student	10
Unspecified	2
Total	**100**

6.3.1.2 Attitudes towards the environment

The respondents were asked certain questions in order to elicit information about their attitudes towards various aspects affecting the estuarine environment. The first question was whether or not the protection of the estuarine environment was considered to be one of government's most important responsibilities. The majority of respondents agreed with this statement. Respondents were split, however, when it came to the issue of boat congestion. About 32 percent of them felt that congestion on the river was a threat to the quality of the services provided by the estuary, whereas approximately 38 percent felt that it was not.

The vast majority of respondents (almost 70 percent) believed that recreational over-fishing was a threat to the quality of the recreational services provided by the estuary. Approximately 60 percent of respondents believed that public access to the estuary was sufficient. However, when asked specifically about access to the jetties, 40 percent of them indicated that these should be easily and freely accessible to the recreational user. Most of these jetties are currently treated as private property. The majority of respondents (63 percent) agreed with the statement that the estuary should provide a sustainable habitat for animal and plant life.

6.3.1.3 Recreational use habits

a) Number of visits

Respondents were asked the number of times they visited the Sundays River Estuary in the past year. Table 6.19 indicates that the majority of the respondents (non-residents) had visited the estuary more than once in the past year.

Table 6.19: Number of visits by respondents – Sundays River Estuary

Number of Visits	Percentage of Respondents
Never Visited	1
Visited Once	13
Visited Two to Ten Times	35
Visited Eleven to Twenty Times	10
Visited More than Twenty Times	21
I live in Sundays River	20
Total	**100**

b) Recreational activities

Respondents were asked what the main recreational activity was that they participated in during their visits to the Sundays River Estuary. This information is summarized in Table 6.20 below. Fishing was the most popular recreational activity at this estuary – 41 percent of respondents engaged in shore fishing and also 41 percent engaged in boat fishing.

Table 6.20: Main recreational activities for the Sundays River Estuary

Recreational Activities	**Percentage of Respondents**
Shore Fishing	41
Boat Fishing	41
Speed Boating	11
Water Skiing	1
Paddling	2
Jet Skiing	1
Swimming	1
Bird Watching	1
Other	2
Total	**100**

If the respondent had indicated that they had participated in either boat or shore fishing, they were subsequently asked if they knew what the legal regulations were with respect to the size and bag limits of fish kept. Of the anglers, 70 percent knew the legal requirements.

A comparison of the recreational activities of the respondents of this study to that of the Cowley *et al.* (2009) study is provided in Table 6.21.

Table 6.21: Comparison of recreational activities profile – Sundays River Estuary

Recreational Activities	**Percentage of Respondents**		
	Lee (2011) Study	**Forbes (1998) Study**	**Cowley *et al.* (2009) Study**
Shore Fishing	41	33.9 (Shore and Boat)	32.4
Boat Fishing	41	-	18.7
Speed Boating	11	17.4	11.2
Water Skiing	1	18.9	2.5
Paddling	2	4.9	1.7
Jet Skiing	1	1.3	0.5
Swimming	1	16.6	Undefined
Bird Watching	1	1.75	Undefined

Source: Forbes (1998) and Cowley et al. (2009)

The Sundays River Estuary status quo assessment report, prepared by Afri-Coast Engineers (2004), showed that 96 percent of estuary users were interested in recreational activity. Of all the recreational activities available, recreational fishing was the most popular (28.8 percent), followed by swimming (21.8 percent), leisure cruising (17.8 percent) and water skiing (14.8 percent).

6.3.2 THE KROMME RIVER ESTUARY

6.3.2.1 Socio-economic characteristics

This section describes the data collected from the responses from the last section of the questionnaires. The only other socio-economic information available was that gathered in the Forbes (1998) and, more recently, the Sale (2007) studies. Both the Forbes (1998) and Sale (2007) studies captured data on the recreational users of the Kromme River Estuary. Comparison with the Forbes (1998) data are possible for residential location and number of days visited, whilst the Sale (2007) study provided information about the average recreational user's education and income per annum. Selected, socio-economic results of the Kromme River Estuary survey (Lee, 2011) are summarized as follows:

- The majority (59 percent) of visitors came from areas more than 50 km away from the estuary.
- The majority (64 percent) of recreational users surveyed were over the age of 35.
- The majority (65 percent) of recreational users surveyed are male.
- The average annual income for the sample was R447 000.
- Of the respondents sampled, 29 percent had a matric qualification with university exemption.
- All occupational categories are well represented in the sample of respondents, with the exception of plant and machinery operators/assemblers (0 percent), agricultural workers (0.41 percent), and elementary occupations (0 percent).

a) Residential Location

Unlike the sample of respondents interviewed as part of the Sundays River Estuary CE, most of the visitors to the Kromme River Estuary surveyed came from areas more than 50 km away from the estuary. Of these respondents, most came from Port Elizabeth (28.69 percent). Permanent residents of the Kromme River Estuary, living in St Francis Bay, Santareme, Sea Vista and Kromme River, accounted for approximately 26.6 percent of the sample. The percentages of respondents' by place of origin are compared with Forbes (1998) in Table 6.22 and provided in detail in Table 6.23.

Table 6.22: Comparison of residential location – Kromme River Estuary

Distance	Percentage of Respondents	
	Lee (2011) Study	**Forbes (1998) Study**
<50 km from Estuary	40.2	22.6
<5 km from Estuary (Local Residents)	26.6	18.9
Between 5 and 50 km	13.6	5.6
Between 50 and 200 km	32.4	20.8
Between 200 and 400 km	0.41	3.8
>400 km from Estuary	26.1	45.2
Foreign Visitors	0.8	5.7

Table 6.23: Percentage of respondents by place of residence – Kromme River Estuary

Place	Percentage of Respondents
St Francis Bay	22.95
Cape St Francis	5.74
Port St Francis	0.82
Santareme	0.82
Sea Vista	0.41
Kromme River	2.46
Jeffreys Bay	2.87
Humansdorp	3.28
Ashton Bay	0.82
Port Elizabeth	28.69
Cape Town	4.10
Johannesburg	8.61
Pretoria	4.51
Durban	1.23
Stellenbosch	0.41
East London	2.46
Bloemfontein	1.23
Grahamstown	0.82
George	1.64
Rustenburg	0.41
Richards bay	0.41
Mossel Bay	0.41

Place	Percentage of Respondents
Benoni	0.41
Soweto	0.41
Patensie	0.41
Uitenhage	0.82
Pietersburg	0.82
Uniondale	0.41
Volksrust	0.41
Tygerberg	0.41
United Kingdom	0.41
United States of America	0.41
Total	**100**

The Forbes (1998) study captured a similar composition of residents/visitors with respect to their places of origin. The Forbes (1998) study captured a higher proportion of long-distance travellers, i.e. those travelling from cities or towns more than 400 km away from the estuary. The Lee (2011) study reflects a growth in the recreational use of the estuary of visitors from cities or towns less than 200 km away.

b) Age

The majority (approximately 64 percent) of recreational users sampled were over the age of 35. The percentage of respondents per age category is shown in Table 6.24 below.

Table 6.24: Percentage of respondents per age category – Kromme River Estuary

Age Category	Percentage of Respondents
18-20	6.15
21-25	18.03
26-30	7.38
31-35	4.51
36-40	6.15
41-45	11.07
46-50	16.39
51-55	12.30
56-60	6.56
61 Years and Older	11.48
Total	**100**

c) Gender

The vast majority of respondents were male (65.57 percent). Table 6.25 shows the gender of sampled respondents.

Table 6.25: Percentage of respondents by gender – Kromme River Estuary

Gender	Percentage of Respondents
Male	65.57
Female	34.43
Total	**100**

d) Income

The percentage of respondents per income category is presented in Table 6.26. As for the Sundays River Estuary, if a respondent ticked the "Refuse to Answer" category, an income value was allocated to them according to their stated occupation. Average income for this sample, calculated in the same manner as for the Sundays River Estuary, was R447 000. About 10 percent of the sample (34 respondents) earned incomes exceeding R1 million per annum. These respondents were made up of managers, professionals and associate professionals. There were a few respondents earning incomes below R25 000 per annum and consisted mainly of students. A high representation of upper-income earners skewed the average upwards. The Sale (2007) study found an average income of approximately R257 000 per annum[21] (adjusted for inflation). This is similar to the middle-income earners' (the median respondent) income of R222 000 in the Lee (2011) study.

Table 6.26: Percentage of respondents per income category – Kromme River Estuary

Income Category	Percentage of Respondents
less than R50000	20.90
R50 000-R99 999	4.51
R100 000-R149 999	24.18
R150 000-R199 999	15.16
R200 000-R249 999	3.28
R250 000-R299 999	1.64
R300 000-R349 999	2.05
R350 000-R399 999	2.05
R400 000-R449 999	3.69
R450 000-R499 999	4.10
R500 000-R749 999	3.28
R750 000-R999 999	5.33
R1 000 000 or more	9.84
Total	**100**

[21] The CPI was 81.4 and 111.7 in 2004 and 2010 respectively (South African Reserve Bank (SARB), 2011). This implies that the income figure of R187 000 must be inflated by 37.22 percent.

e) Education

Most of the respondents sampled had a matric qualification with university exemption. In addition to a matric, 68.85 percent had attained at least one tertiary qualification – 15.98 percent held a Technikon diploma, 35.25 percent held a University degree and 17.62 percent held a post-graduate degree. The percentage of respondents per education category is shown in Table 6.27.

Table 6.27: Percentage of respondents per education category – Kromme River Estuary

Education Category	**Percentage of Respondents**
Secondary School Education	2.05
Matriculation	29.10
Technikon Diploma	15.98
University Degree	35.25
University Post-graduate Degree	17.62
Total	**100**

In the Sale (2007) study, the average number of years of education was 13 years (a matriculation qualification with an additional year of study, for example, a Technikon Diploma). The Lee (2011) study indicated an average level of completed education as being slightly more than a Technikon Diploma (13.8 years). The median respondent, however, had no less than 15 years of completed education.

f) Occupation

Not unlike the Sundays River Estuary CE, occupational categories were specified in accordance with the Labour Force Survey of South Africa (LFS), currently known as the Quarterly Employment Survey (QES) – see Table 6.28 below (STATSSA, 2001). All occupational categories are well represented in the sample of respondents, with the exception of plant and machinery operators/assemblers (0 percent), agricultural workers (0.41 percent), and elementary occupations (0 percent). Of the respondents, 18.85 percent were grouped into the “other” category because they represented students and occupational unknowns.

Table 6.28: Percentage of respondents per occupation – Kromme River Estuary

Occupation	Percentage of Respondents
Legislators, Managers & Senior Officials	20.08
Professionals	28.28
Technicians & Associate Professionals	23.77
Clerks	2.46
Service Workers & Market/Sales Workers	2.87
Skilled Agricultural and Fishery Worker	0.41
Craft & Related Trade Workers	3.28
Plant & Machinery Operators/Assemblers	0
Elementary Occupations	0
Unspecified	18.85
Total	**100**

6.3.2.2 Attitudes towards the environment

As was the case for the Sundays River Estuary CE, the respondents were asked certain questions in order to elicit information about their attitudes towards various aspects affecting the estuarine environment. The first question was whether or not the protection of the estuarine environment was considered to be one of government's most important responsibilities. Almost all of the respondents (97.13 percent) agreed with this statement. The majority of respondents (68.45 percent) felt that boat congestion constituted a serious threat to the quality of the recreational services provided by the estuary.

The vast majority of respondents (85 percent) believed that reduced navigability was a threat to the quality of the recreational services provided by the estuary. Approximately 61 percent of respondents believed that the use of jet skis and wet bikes were a threat to the quality of the recreational services provided by the estuary. The vast majority of respondents (97.13 percent) agreed with the statement that the estuary should provide a sustainable habitat for animal and plant life. Approximately 77 percent of respondents felt that uncontrolled, commercial and illegal bait harvesting was a threat to the overall quality of recreational services provided by the estuary.

6.3.2.3 Recreational use habits

a) *Number of visits*

Respondents were asked the number of times they visited the Kromme River Estuary in the past year. Table 6.29 below indicates that the majority of the respondents (non-residents) had visited the estuary more than once in the past year.

Table 6.29: Number of visits by respondents – Kromme River Estuary

Number of Visits	Percentage of Respondents
Never Visited	3.28
Visited Once	7.79
Visited Two to Ten Times	32.79
Visited Eleven to Twenty Times	5.74
Visited More than Twenty Times	15.16
I live in Close Proximity to the Kromme River Estuary*	35.25
Total	**100**

**This percentage exceeds the local resident percentage of 26.6 percent, but some individuals erroneously ticked this category as they lived in areas close to the estuary, but do not consider themselves a resident of St Francis Bay or on the Kromme River.*

b) Recreational activities

Respondents were asked what their main recreational activities were that they participated in during their visits to the Kromme River Estuary. This information is summarized in Table 6.30. Recreational shore fishing was the most popular recreational activity at this estuary – 38.52 percent of the respondents engaged in shore fishing. Respondents also enjoyed recreational boat fishing (18.04 percent), swimming (15.57 percent), and speed/power boating (13.11 percent).

Table 6.30: Main recreational activities for the Kromme River Estuary

Recreational Activities	Percentage of Respondents
Shore Fishing	38.52
Boat Fishing	18.04
Power/Speed Boating	13.11
Water Skiing	6.15
Paddling	5.74
Jet Skiing	1.23
Swimming	15.57
Bird Watching	0.82
Other	0.82
Total	**100**

A comparison of the four most popular recreational activities of the respondents in this study to those of the Forbes (1998) study is provided in Table 6.31.

Table 6.31: Comparison of most popular recreational activities – Kromme River Estuary

Recreational Activities	Percentage of Respondents	
	Lee (2011) Study	**Forbes (1998) Study**
Shore Fishing	38.52	-
Angling	-	34.0
Boat Fishing	18.04	-
Water Skiing/Speed Boating	13.11	22.6
Swimming	15.57	30.2
Recreational Boating	-	9.4

The Sale (2007) study indicated that, of those estuary users sampled, 92 percent participated in recreational activities.

6.3.3 THE NAHOON RIVER ESTUARY

6.3.3.1 Socio-economic characteristics

This section describes the data collected from the responses from the last section of the questionnaires.

a) Residential location

Most of the surveyed recreational users of the Nahoon River Estuary come from surrounding areas. Of these respondents, most reside in the East London area (51.4 percent). The information pertaining to respondents' residential location is displayed in Table 6.32.

Table 6.32: Percentage of respondents by place of residence – Nahoon River Estuary

Place	**Percentage of Respondents**
East London	51.43
Nahoon	26.67
Gonubie	18.57
Unspecified	3.33
Total	**100**

b) Age

The majority of recreational users sampled were over the age of 30, i.e. approximately 75 percent. The percentage of respondents per age category is shown in Table 6.33.

Table 6.33: Percentage of respondents per age category – Nahoon River Estuary

Age Category	Percentage of Respondents
Under 20 years	2.38
20-29	21.90
30-39	28.10
40-49	22.86
50-59	14.76
60 years and older	9.05
Unspecified	0.95
Total	**100**

c) Gender

The majority of respondents are male (53.33 percent). Table 6.34 shows the gender of sampled respondents.

Table 6.34: Percentage of respondents by gender – Nahoon River Estuary

Gender	Percentage of respondents
Male	53.33
Female	46.67
Total	**100**

d) Income

The percentage of respondents per income category is presented in Table 6.35 below. The average income for the sample of respondents was calculated as R373 000 per annum. This is compared to a median income of R249 000. The average was skewed upwards through a higher representation of upper-income earners, i.e. approximately 8 percent earned in excess of R750 000 per annum.

Table 6.35: Percentage of respondents per income category – Nahoon River Estuary

Income Category	Percentage of Respondents
less than R50000	10.48
R50 000-R99 999	10.95
R100 000-R149 999	12.38
R150 000-R199 999	8.10
R200 000-R249 999	6.19
R250 000-R299 999	5.71
R300 000-R349 999	6.19
R350 000-R399 999	7.14
R400 000-R449 999	5.24
R450 000-R499 999	4.76
R500 000-R749 999	4.76
R750 000-R999 999	4.29
R1 000 000 or more	2.38
Refuse to Answer	11.43
Total	**100**

e) Education

Most of the respondents sampled had a matric qualification with university exemption. In addition to a matric, 73.34 percent had attained at least one tertiary qualification. More specifically, 28.1 percent hold a Technikon diploma, 24.76 percent hold a University degree and 20.48 percent hold a post-graduate degree. The percentage of respondents per education category is shown in Table 6.36.

Table 6.36: Percentage of respondents per education category – Nahoon River Estuary

Education Category	Percentage of respondents
Primary School Education	0.95
Secondary School Education	1.90
Matriculation	23.81
Technikon Diploma	28.10
University Degree	24.76
University Post-graduate Degree	20.48
Total	**100**

f) Occupation

For this estuary, occupational categories were specified as in Table 6.37[22]. A large percentage of workers are employed in traditional 'White Collar' occupations (47.14 percent).

Table 6.37: Percentage of respondents per occupation – Nahoon River Estuary

Occupation	Percentage of Respondents
Self Employed: Professional	3.81
Self Employed: Entrepreneur	7.62
Employed: Blue Collar	10.48
Employed: White Collar	47.14
Employed: Management	11.90
Unemployed	10.48
Unspecified	8.57
Total	**100**

6.3.3.2 Attitudes towards the environment

The respondents were asked certain questions in order to elicit information regarding their attitudes towards various aspects affecting the estuarine environment. The first question dealt with whether or not the protection of the estuarine environment is considered to be one of government's most important responsibilities. Most respondents (89.5 percent) agreed with this statement. The majority of respondents (56.66 percent) felt that the level of public access to the Nahoon River Estuary was sufficient for general recreational enjoyment.

The majority of respondents (63.33 percent) believe that the water in the estuary is not safe for swimming, boating or fishing and thus poses a threat to the quality of the recreational services provided. In addition to this, approximately 92.38 percent of respondents agreed that a water quality advisory should be set up in order to inform recreational users on specific water safety issues. Approximately 97.14 percent of respondents believe that the estuary should be safe, i.e. crime free for recreational users. A general consensus among recreational users of the Nahoon River Estuary is that the condition of the estuary has worsened (72.38 percent). Of these users, 23.33 percent state that they would make use of another estuary if there was one in the immediate area.

[22] Two independent researchers valued the recreational attributes of four Eastern Cape estuaries. The one researcher valued the recreational attributes at the Sundays and Kromme River estuaries, whilst the other valued the recreational attributes at the Nahoon and Gonubie River estuaries. Due to the independence of the research carried out, the questionnaires used differed with respect to certain question formats. The researcher who conducted the studies at the Sundays and Kromme River estuaries used the Statistics South Africa Standard International Classification (SIC) for occupational categories whilst the other researcher did not.

6.3.3.3 Recreational use habits

a) Number of Visits

Respondents were asked the number of times they visited the Nahoon River Estuary in the past year. Table 6.38 below indicates that the majority of the respondents had visited the estuary more than once in the past year.

Table 6.38: Number of visits by respondents – Nahoon River Estuary

Number of Visits	Percentage of respondents
Never Visited	1.90
Visited Once	15.24
Visited two to ten times	23.81
Visited eleven to twenty times	9.52
Visited more than twenty times	39.05
I live on the banks of the Nahoon River	10.48
Total	**100**

b) Recreational activities

Respondents were asked what their main recreational activities were that they partook in during their visits to the Nahoon River Estuary. This information is summarized in Table 6.39. The largest percentage of respondents indicated paddling as their first choice of recreational activity (27.14 percent). Their second choice was recreational shore fishing (18.10 percent), followed by swimming (15.24 percent), and recreational boat fishing (6.67 percent).

Table 6.39: Main recreational activities for the Nahoon River Estuary

Recreational activities	Percentage of respondents
Shore Fishing	18.10
Boat Fishing	6.67
Power/speed Boating	2.38
Water skiing	3.33
Paddling	27.14
Jet skiing	0.48
Swimming	15.71
Bird Watching	5.71
Camping	3.33
Other	17.14*
Total	**100**

**This category includes sightseeing activities, as well as walking along the beach.*

6.3.4 THE GONUBIE RIVER ESTUARY

6.3.4.1 Socio-economic characteristics

This section describes the data collected from the responses from the last section of the questionnaire.

a) Residential Location

Most of the surveyed recreational users of the Gonubie River Estuary come from the Gonubie and East London area (59.8 percent). The information pertaining to respondents' residential locations is displayed in Table 6.40.

Table 6.40: Percentage of respondents by place of residence – Gonubie River Estuary

Place of origin	Percentage of Respondents
Gonubie	24.51
East London	35.29
Visitor	38.24
Unspecified	1.96
Total	**100**

b) Age

The majority of recreational users sampled were over the age of 30. The percentage of respondents per age category is shown in Table 6.41.

Table 6.41: Percentage of respondents per age category – Gonubie River Estuary

Age Category	Percentage of Respondents
Less than 20 years	5.88
20-29	22.06
30-39	29.90
40-49	25.98
50-59	11.76
60-69	2.45
70 years and older	1.96
Total	**100**

c) Gender

The majority of respondents are male (54.4 percent). Table 6.42 below shows the gender of sampled respondents.

Table 6.42: Percentage of respondents by gender – Gonubie River Estuary

Gender	Percentage of respondents
Male	54.41
Female	45.59
Total	**100**

d) Income

The percentage of respondents per income category is presented in Table 6.43. The average income for the sample of respondents was calculated as R459 000 per annum. This is compared to a median income of R250 000. The mean has, however, been skewed upwards through a high representation of upper-income earners, i.e. approximately 16 percent of respondents earn more than R700 000 per annum.

Table 6.43: Percentage of respondents per income category – Gonubie River Estuary

Income Category	Percentage of Respondents
less than R50000	21.57
R50 000-R199 999	19.61
R200 000-R399 999	22.55
R400 000-R699 999	16.18
R700 000-R999 999	9.80
R1 000 000 or more	5.39
Refuse to answer	4.90
Total	**100**

e) Education

Most of the respondents sampled had a matric qualification with university exemption. In addition to a matric, 70.1 percent had attained at least one tertiary qualification. The percentage of respondents per education category is shown in Table 6.44.

Table 6.44: Percentage of respondents per education category – Gonubie River Estuary

Education Category	Percentage of Respondents
Primary School Education	1.96
Matriculation	27.94
Technikon Diploma	26.47
University Degree	26.47
University Post-graduate Degree	17.16
Total	**100**

f) Occupation

For the purposes of this estuary, occupational categories were specified as in Table 6.45. There is a large representation of 'white collar' workers (25 percent), as well as self-employed entrepreneurs (21 percent).

Table 6.45: Percentage of respondents per occupation – Gonubie River Estuary

Occupation	**Percentage of Respondents**
Self Employed: Professional	12.25
Self Employed: Entrepreneur	20.59
Employed: Blue Collar	11.76
Employed: White Collar	25.00
Employed: Management	15.69
Unemployed	14.71
Total	**100**

6.3.4.2 Attitudes towards the environment

The respondents were asked certain questions in order to elicit information regarding their attitudes towards various aspects affecting the estuarine environment. The first question dealt with whether or not the protection of the estuarine environment is considered to be one of government's most important responsibilities. Almost all of the respondents (93.13 percent) agreed with this statement. The majority of respondents (83.33 percent) felt that public access to the estuary was sufficient for general recreational enjoyment. Respondents were also asked whether the water quality of the estuary was adequate for swimming, boating and fishing. The majority of respondents (64.21 percent) believe that water quality is adequate for recreational purposes. Approximately 93 percent of respondents believe that the estuary should be a crime free environment for recreational users. Though the water quality is deemed adequate for certain recreational activities, 92.65 percent of respondents feel that a water quality advisory should be set up to keep recreational users informed with regards to any changes in water quality of the estuary. A general consensus among recreational users of the Gonubie River Estuary is that the condition of the estuary has not changed (71.57 percent). In order for certain improvements to be made to the recreational services provided by the Gonubie River Estuary, the majority of respondents feel that these improvements should be funded through a voluntary payment system (69.12 percent).

6.3.4.3 Recreational use habits

a) Number of Visits

Respondents were asked the number of times they visited the Gonubie River Estuary in the past year. Table 6.46 indicates that the majority of the respondents had visited the estuary more than once in the past year.

Table 6.46: Number of visits by respondents – Gonubie River Estuary

Number of Visits	**Percentage of respondents**
Never Visited	0
Visited Once	15.20
Visited two to ten times	41.18
Visited eleven to twenty times	15.69
Visited more than twenty times	11.27
I live on the banks of the Gonubie River	16.67
Total	**100**

b) Recreational activities

Respondents were asked what their main recreational activities were that they partook in during their visits to the Gonubie River Estuary. This information is summarized in Table 6.47. Most respondents indicated swimming as their first choice of recreational activity (38.73 percent). Their second choice was recreational shore fishing (35.78 percent), followed by paddling (8.82 percent), and recreational boat fishing (5.39 percent).

Table 6.47: Main recreational activities for the Gonubie River Estuary

Recreational activities	**Percentage of respondents**
Shore Fishing	35.78
Boat Fishing	5.39
Paddling	8.82
Jet skiing	0.98
Swimming	38.73
Bird Watching	3.92
Other	6.37*
Total	**100**

**This category includes sightseeing activities, as well as walking along the beach.*

6.4 MODEL ESTIMATION AND CALCULATION OF IMPLICIT PRICE AND WELFARE

6.4.1 THE SUNDAYS RIVER ESTUARY

6.4.1.1 Model estimation

Three different choice model specifications were estimated as part of the Sundays River Estuary CE: a CL model, a HEV model and a RPL model. The LIMDEP NLOGIT Version 4.0 programme was used in all the estimations. All models estimated showed the importance of choice set attributes in explaining respondents' choices across the two different options: option A and option B. Two utility functions (V_{1-2}) were derived from the models[23]. Each function represented the utility generated by one of the two options. For the two option choice set with four attributes, the utility functions can be expressed as follows:

Option A: $V_A = \beta_1 \text{Physsizeoffish} + \beta_2 \text{Congestion} + \beta_3 \text{Publicaccess} + \beta_4 \text{Cost}$

Option B: $V_B = \beta_1 \text{Physsizeoffish} + \beta_2 \text{Congestion} + \beta_3 \text{Publicaccess} + \beta_4 \text{Cost}$

For these two utility functions, utility is determined by the levels of the four attributes in the choice sets. The model provides an estimate of the effect of a change in any of these attributes on the probability that one of these options will be chosen.

The first model shown in Table 6.48 is the estimate of a standard CL model.

[23] ASCs were not included in the models for two reasons: the alternatives were unlabelled and a *status quo* alternative was not included in the choice sets.

Table 6.48: Estimation results of the CE[24] – Sundays River Estuary

Variables	CL		HEV		RPL	
	Coeff.	**Std err.**	**Coeff.**	**Std err.**	**Coeff.**	**Std err.**
Physical Size of Fish	1.59225259**	.14157877	1.79113653**	.23779355	1.95816676**	.53555192
Congestion	-.34136177**	.13044418	-.40008933*	.15818898	-.39402824*	.15836246
Public Access	.34253510**	.12461801	.39809588**	.15093428	.38157738**	.14429206
Cost[1]	-.01033063**	.00144555	-.01192456**	.00214754	-.01126248**	.00194773
	Standard deviation of random parameters					
Physical Size of Fish					1.18863441	.97650395
Congestion					.28761409	.69802099
Public Access					.18711344	1.08321161
No. of Respondents	175		175		175	
No. of Choice Sets	700		700		700	
Pseudo R^2	.22091		.2394251		.2386784	

**indicates that parameter is statistically significant at the 5 percent level*
*** indicates significance at the 1 percent level*
1. Cost was specified as a non-random parameter in the RPL.

All the coefficients[25] in these models have the correct signs[26], *a priori*, and are significantly different from zero at the 99 percent confidence level.

The probability that an alternative would be chosen was reduced:

- The lower the physical size of the fish stock;
- The higher the amount of boat congestion;
- The lower the amount of public access available; and
- The higher the environmental quality levy.

The significant coefficients of the CL model can be interpreted by estimating their odds ratios. This is done by calculating the antilog[27] of the various coefficients. Odds

[24] The number of iterations taken to fit a model is an important aspect of interpreting LIMDEP NLOGIT Version 4.0 output (Hensher *et al.* 2005). It is argued that if more than 25 iterations have occurred in estimating a CL model the researcher should question the final model produced (Hensher *et al.* 2005). In this case, the number of iterations taken for the conditional, HEV and RPL, respectively were 6, 11 and 18.

[25] A variable coefficient estimated by a discrete choice model reveals the relationship between the decision-makers' choice and the variable of interest. A positive (negative) coefficient shows that decision-makers prefer a quantitative increase (decrease) or a qualitative improvement (deterioration) of the attribute.

[26] The sign of a coefficient is used to test whether the relationship between variables correspond to *a priori* expectations (based on micro-economic theory).

interpretation indicates how an increase (decrease) in an attribute's level would result in a change in the probability of choosing an option which includes this increase (decrease). The 'Physical size of the fish' coefficient can be interpreted as follows – an increase in the physical size of the fish stock will result in an increase in the probability of a respondent choosing this option by 39.12 percent. An increase in boat congestion will result in a decrease in the probability of a respondent choosing this option by 2.19 percent. An increase in public access will result in an increase in the probability of a respondent choosing this option by 2.20 percent.

The explanatory power of the model is measured by the Pseudo R^2. At 22 percent this is a good fit for CE-type studies – Louviere *et al.* (2000) suggest that anything between 0.2 and 0.4 can be considered very good.

An alternative approach to the Pseudo R^2 for determining how well a choice model explains the data is to generate a contingency table in LIMDEP NLOGIT Version 4.0 (Hensher *et al.* 2005). This table predicts choice results for the sample based on the model generated and compares these to the actual choices made. Table 6.49 shows the contingency table results for the CL model estimated.

Table 6.49: Contingency table – CL model – Sundays River Estuary

	X1	**X2**	**Total**
X1	241	132	373
X2	115	212	327
Total	356	344	700

In Table 6.49, the rows show the number of choices made by the respondents surveyed for each alternative. The columns represent the number of times an alternative was predicted to be selected – this prediction is based on the specified choice model (Hensher *et al*. 2005).

From Table 6.49, one is able to derive a measure of the aggregate proportion of correct predictions. This is achieved by summing across the number of correct predictions and dividing by the total number of choices made (Hensher *et al*. 2005). The number of correct predictions is represented by the diagonal elements of the table (the number of times the choice model incorrectly predicted which alternative the respondent would select is represented by the off-diagonal elements). In this case, the model correctly predicted the alternative chosen 453 times (241 + 212) out of the total of 700 choices made. The overall proportion of correct predictions of actual choice is 453/700 = 0.647 (or 64.7 percent).

[27] Finding the antilog entails calculating the value of 10 to the power of the coefficient's value.

As mentioned in Chapter four, the CL model was developed for use in market research, transportation and environmental valuation literature (Brownstone, 2001). Even though it is widely used in these areas, there is potential for bias in the estimates. The first potential for bias comes from the assumption that the utility weights for the recreational attributes are the same across all respondents. The second is the IIA assumption. This property implies that the random components of utility are independent across alternatives and are identically distributed (Louviere *et al.* 2000). If the IIA assumption does not hold, utility parameter estimates could be biased. Finally, CL estimates assume that errors in each respondent's series of answers are uncorrelated.

In order to overcome some of the abovementioned potential sources of bias, a HEV logit may be estimated. The HEV model relaxes the assumption of identically distributed random components, and allows for variance across all alternatives (Louviere *et al.* 2000). Like the CL model, the results of this model indicate that all the coefficients have the correct *a priori* signs. However, only three of the four coefficients are significantly different from zero at the 99 percent confidence level, namely the physical size of the fish stock, public access and cost. The congestion coefficient is significantly different from zero at the 95 percent confidence level.

The odds interpretation of significant coefficients may also be applied to the HEV model results. An increase in the physical size of the fish stock will result in an increase in the probability of a respondent choosing this option of 61.82 percent. An increase in boat congestion will result in a decrease in the probability of a respondent choosing this option of 2.51 percent. An increase in public access will result in an increase in the probability of a respondent choosing this option of 2.50 percent.

The McFadden Pseudo R^2 of the HEV model is 23.9 percent. As with the CL model, a contingency table was generated to compare predicted choice to the actual choices made (see Table 6.50).

Table 6.50: Contingency table – HEV model – Sundays River Estuary

	X1	**X2**	**Total**
X1	248	125	373
X2	120	207	327
Total	368	332	700

In this case, the model correctly predicted the alternative chosen 455 times (248 + 207) out of the total of 700 choices made; an overall proportion of correct predictions of 455/700 = 0.65 (or 65.0 percent).

As explained in Chapter four, the RPL approach addresses all three potential sources of bias. Table 6.28 reports the RPL[28]. In the RPL models, recreational attribute parameters are treated as random variables except for the cost variable. In the case of the random variables (physical size of the fish stock, congestion and public access), each coefficient includes a systematic and a random component. The model estimates a mean and a standard deviation for each distribution. Treating the recreational attributes as random parameters allows the researcher to test for the degree of heterogeneity in preferences across respondents by examining the significance of the standard deviation (Hensher *et al.* 2005).

In this case, a normal distribution[29] was selected for all the random parameters. The cost variable was specified as fixed, and not randomly distributed, because in this case, the distribution of the marginal WTP for an attribute is simply the distribution of that attribute's coefficient.

Comparing the results from the RPL, HEV and CL models reveals that the magnitudes, signs and statistical significance of the coefficients are very similar. Allowing preferences for recreational attributes to vary across respondents, shows that there is very little unexplained heterogeneity in respondent preferences. All of the standard deviation coefficients are statistically insignificant, indicating statistically similar preferences for these attributes across respondents. The random variables specified in the RPL confirm preference to increase the physical size of fish stocks, for less boat congestion, and for increased public access.

As with the CL and HEV models, a contingency table was estimated for the RPL model estimates. This table is shown below (Table 6.51).

Table 6.51: Contingency table – RPL model – Sundays River Estuary

	X1	**X2**	**X3**
X1	241	132	373
X2	114	213	327
Total	355	345	700

In this case, the model correctly predicted the alternative chosen 454 times (241 + 213) out of the total of 700 choices made. The overall proportion of correct predictions of actual choice is 455/700 = 0.648 (or 64.8 percent).

That preferences for the physical size of fish stocks, boat congestion and public access do not vary much across respondents is not surprising, because most of the

[28] This model was estimated with simulated maximum likelihood using Halton draws with 500 replications. Compared to standard pseudo random draws, this method (which uses low dispersion sequences) requires fewer draws to obtain robust, accurate results.
[29] Other options include a uniform distribution, a triangular distribution, and a lognormal distribution (Hensher *et al*. 2005).

recreational users at the Sundays River Estuary are fishers and prefer to fish from boats.

6.4.1.2 Implicit price and welfare calculation

a) Implicit price estimates

Implicit prices are calculated by determining the marginal rates of substitution between the attributes, using the coefficient for cost as the "numeraire" (Hanemann, 1984). The ratios of the attribute in question to the cost coefficient can be interpreted as the marginal WTP for a change in each of the attribute values (Hanemann, 1984). More specifically, the marginal WTP value represents a change from one attribute level to another. In the case of the Sundays River Estuary, these marginal WTP values represent: a change from catching small fish now to catching bigger and more fish next year, a change from seeing and hearing few boats to seeing and hearing many boats, and a change from limited recreational appeal to an improvement in the recreational appeal of estuary banks. Table 6.52 reports the implicit prices, or marginal WTP (MWTP), for each of the Sundays River Estuary's recreational attributes estimated using the delta method (Wald procedure[30]) in LIMDEP NLOGIT Version 4.0 (Greene, 2007). For comparisons, estimates were calculated using all three models.

Table 6.52: Marginal WTP (MWTP) for attributes (Rands) and 95 percent confidence intervals (CI)* – Sundays River Estuary

Attributes	**CL**	**HEV****	**RPL**
	MWTP	**MWTP**	**MWTP**
Physical Size of Fish Stock	154.13 (108.71-199.55)	150.21	173.87 (95.10-252.70)
Congestion	-33.04 (-59.64 - -6.44)	-33.55	-34.99 (-62.31 - -7.67)
Public Access	33.16 (7.74-58.58)	33.38	33.88 (8.28-59.48)

** Confidence intervals in parentheses.*

*** Confidence intervals not calculated for HEV due to the presence of fixed parameters.*

The differences in WTP among the three models are small, with the exception of the RPL estimate for 'Physical size of fish stock'. Rounded to the nearest rand the respective marginal WTP value for the RPL model is R174. This is compared to the marginal WTP values of R154 and R150 for the CL and HEV models, respectively. Despite the difference in this attribute's estimates, 'Congestion' and 'Public access' show similar WTP values across models. Confidence intervals for the CL and RPL

[30] This procedure automates the process of estimating standard errors for non-linear functions, such as marginal rates of substitution (Suh, 2001).

models are overlapping for all attributes however the CL model shows a narrower range. Given these results, the standard CL model estimates are used for calculating welfare measures and explaining sub-sample WTP differences.

b) WTP estimates: models grouped according to socio-demographic variables

The marginal WTP for the respective environmental attributes according to different socio-demographic groupings were calculated and tabulated in Table 6.53. The sample was grouped according to the following socio-demographic characteristics: age, education, gender, income, and type of respondent. A CL model was estimated for each sub-sample. Most of the sub-sample's calculated marginal WTP estimates are insignificant at the 5 percent level.

Table 6.53: Implicit prices according to different socio-demographic sub-samples – Sundays River Estuary

Grouped Models	Size of Fish	Congestion	Access
Age < 36	116.82 (0.000)	-66.00 (0.000)	26.91 (0.1139)
Age ≥ 36	211.89 (0.000)	1.54 (0.9291)	42.78 (0.0248)
≤ Matric	118.10 (0.000)	-62.00 (0.000)	23.36 (0.1783)
>Matric	206.89 (0.000)	-7.00 (0.730)	44.78 (0.0164)
Female	145.60 (0.000)	0.80 (0.9732)	59.20 (0.0133)
Male	167.89 (0.000)	-47.11 (0.0029)	28.33 (0.0575)
Income ≤ R150 000	152.11 (0.000)	-61.22 (0.000)	29.00 (0.0974)
Income > R150 000	187.82 (0.000)	2.82 (0.8916)	47.45 (0.0129)
Resident	177.14 (0.000)	-5.86 (0.7974)	37.14 (0.0757)
Visitor	159.56 (0.000)	-46.89 (0.0036)	34.33 (0.0264)

Note: p-values in brackets

The line plots (Figures 6.1) illustrate the variability of each attribute with respect to marginal WTP for all the sub-samples.

Figure 6.1 shows that the highest marginal WTP estimates, when it comes to improving the physical size of fish stocks, are those of males, over the age of 35, with tertiary education. These individuals are also higher income earners within the sample, earning more than R150 000 per annum. The resident sub-sample has a higher marginal WTP than the visitor sub-sample.

The majority of the marginal WTP estimates for boat congestion on the Sundays River Estuary are negative, implying that most of those sampled would pay in order to 'decrease' boat congestion on the Sundays River Estuary. The highest marginal WTP estimates for decreasing boat congestion are for males with, at most, a matriculation exemption, who earn low levels of income, i.e. less than R150 000 per annum. Visitors were willing to pay more for decreased boat congestion than residents. The various marginal WTP estimates for improving public access to the Sundays River Estuary show residents valued public access more than visitors. Older (over 35) females earning higher incomes (over R150 000), also placed a high value on increased public access.

In the models estimated from the socio-demographically grouped sub-samples, all 'physical size of fish' and 'cost' attributes are significant. Visitors, lower income, and male categories are significant at the 10 percent level across all sub-samples.

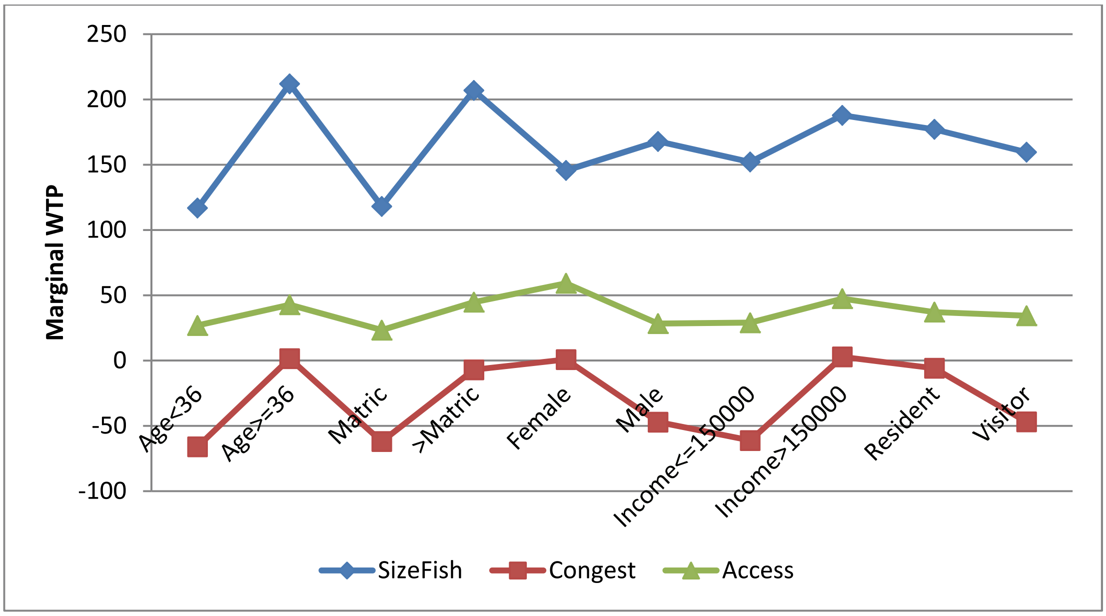

Figure 6.1: Variability of marginal WTP (Rands) of attributes for all sub-samples – Sundays River Estuary

c) CS estimates

<u>Attribute specific CS estimates</u>

The CS associated with an improvement in the physical size of fish stock in the Sundays River Estuary (from a specified constant base (V_C) to a change alternative (V_N)) is estimated below. The constant base and the change alternative are defined as follows:

Constant base: Catch and keep small fish now, congestion, same public access.
Change alternative: Keep no undersize fish now but more and bigger fish next year, congestion, same public access.

The CS is calculated as follows:

$$CS = -\ (1/\alpha)\ (V_C - V_N) \qquad (6.2)$$

where:
α is the marginal utility of income
V_C is the utility of the constant base
V_N is the utility of the change alternative

For the change to an increased physical size of fish stocks (V_N):

CS = 96.8x(– 1.59) = -R153.90

The negative sign shows that in order to maintain utility at level V_C, given an improvement in the physical size of fish stocks in the Sundays River Estuary, income must be reduced by R154 (to the nearest Rand). Another way of stating this is that the WTP per household for an improvement in the physical size of fish stocks was R154.

The CS associated with a decrease in the level of boat congestion in the Sundays River Estuary, from a specified constant base (V_C) to a change alternative (V_N), is estimated below. The constant base and the change alternative are defined as follows:

Constant base: Catch and keep small fish now, congestion, same public access.
Change alternative: Catch and keep small fish now, no congestion, same public access.

The CS is calculated as follows:

CS = 96.8x(- 0.34) = -R32.90

The negative sign shows that to maintain utility at level V_C, given a reduction in the level of boat congestion in the estuary, income must be reduced by R33 (to the nearest Rand).

The CS associated with an improvement of public access at the Sundays River Estuary, i.e. from a specified constant base (V_C) to a change alternative (V_N), is estimated below. The constant base and the change alternative are defined as follows:

Constant base: Catch and keep small fish now, congestion, same public access.

Change alternative: Catch and keep small fish now, congestion, more public access.

The CS is calculated as follows:

CS = 96.8x(- 0.34) = -R32.90

The negative sign shows that to maintain utility at level V_C, given an improvement in public access at the Sundays River Estuary, income must be reduced by R33.

Overall CS

The CS associated with an improvement from a specified constant base (V_C) to a change alternative (V_N) can also be estimated. The constant base and the change alternative are defined as follows:

Constant base: Catch and keep small fish now, congestion, same public access.
Change alternative: Keep no undersize fish now but more and bigger fish next year, no congestion, more public access.

CS = 96.8x(– 2.28) = -R220.70

The negative sign shows that to maintain utility at level V_C, given an improvement in estuary recreational services, income must be reduced by R221.

6.4.2 THE KROMME RIVER ESTUARY

6.4.2.1 Model estimation

Like the Sundays River Estuary, three different choice model specifications were estimated as part of the Kromme River Estuary CE: a CL model, a HEV model and a RPL model. Once again, the LIMDEP NLOGIT Version 4.0 statistical programme was used to make all the estimations. The three models estimated showed the importance of choice set attributes in explaining respondents' choices across the two different options: option A and option B[31]. For the two-option choice set, with four attributes, the utility functions were expressed as follows:

Option A: $V_A = \beta_1$Navigability + β_2Congestion + β_3Jetskiing + β_4Cost
Option B: $V_B = \beta_1$Navigability + β_2Congestion + β_3Jetskiing + β_4Cost

In the same way as for the Sundays River Estuary CE, the levels of the four attributes in the choice sets determine utility. The model provides an estimate of the effect of a

[31] ASCs were not included in the models for two reasons: the alternatives were unlabelled and a *status quo* alternative was not included in the choice sets.

change in any of these attributes on the probability that one of these options will be chosen.

The first model shown in Table 6.54 is the estimate of a standard CL model.

Table 6.54: Estimation results of the CE – Kromme River Estuary

Variables	CL		HEV		RPL Model 1[2]		RPL Model 2[3]	
	Coefficient	Std Error	Coefficient	Std Error	Coefficient	Std Error	Coefficient	Std Error
Navigability	.672167**	.096057	.632440**	.09912	1.950906**	.722367	2.383288*	.965053
Congestion	-.467298**	.097580	-.424775**	.09849	-1.608222*	.693198	-1.984012*	.864568
Jet Skiing[1]	-.053177	.097113	-.044222	.08477	.122747	.182631	.1552595	.185983
Cost[1]	-.001539**	.000252	-.001405**	.00026	-.003332**	.000627	-.0034440**	.000616
	Standard Deviation of Random Parameters							
Navigability					3.356599*	1.556617	6.310501*	2.677684
Congestion					5.288879*	2.176638	9.526799*	3.695197
No. of Respondents	244		244		244		244	
No. of Choice Sets	976		976		976		976	
Pseudo R^2	.081		.085		.094		.091	

Notes: **indicates that parameter is statistically significant at the 5 percent level*

*** indicates significance at the 1 percent level*

1. *Jet skiing and Cost were specified as non-random parameters in both the RPL models.*
2. *The random parameters were normally distributed in Model 1.*
3. *The random parameters were uniformly distributed in Model 2.*

All the coefficients in these models have the correct signs, *a priori*, and three of the four coefficients are significantly different from zero at the 99 percent confidence level.

The probability that an alternative would be chosen was reduced:

- The lower the level of navigability;
- The higher the amount of boat congestion;
- The higher the amount of jet skiing activity; and
- The higher the environmental quality levy.

The significant coefficients of the CL model can be interpreted by estimating their odds ratios. An increase in the level of navigability will result in an increase in the probability of a respondent choosing this option by 4.7 percent. An increase in boat congestion will result in a decrease in the probability of a respondent choosing this option by 0.34 percent. Permitting the regulated use of jet skis and wet bikes will result in a decrease in the probability of a respondent choosing this option by 0.88 percent.

The Pseudo R^2 of this model is 8 percent. As was the case with the Sundays River CE, a contingency table was estimated for the CL model. This table is shown below (Table 6.55).

Table 6.55: Contingency table – CL model – Kromme River Estuary

	X1	**X2**	**Total**
X1	271	210	481
X2	223	272	495
Total	493	483	976

In this case, the model correctly predicted the alternative chosen 543 times (271 + 272) out of the total of 976 choices made. The overall proportion of correct predictions of actual choice is 543/976 = 0.556 (or 55.6 percent).

In order to address a potential source of bias (non-identical distributed random components and constant variances) a HEV model was estimated (see Table 6.54).

Like the CL model, the results of this model indicate that all the coefficients have the correct signs *a priori*. Three of the four coefficients are significantly different from zero at the 99 percent confidence level: the level of navigability, congestion and cost. The McFadden Pseudo R^2 is 8.6 percent. The contingency table results for the HEV model are shown in Table 6.56 below.

Table 6.56: Contingency table – HEV model – Kromme River Estuary

	X1	X2	Total
X1	265	216	481
X2	216	279	495
Total	481	495	976

For this model the alternative was correctly predicted 544 times (265 + 279) out of the total of 976 choices made. The overall proportion of correct predictions of actual choice is 544/976 = 0.557 (or 55.7 percent).

Table 6.54 reports the RPL results for two models. As explained for the Sundays River model estimation, the RPL addresses three potential sources of bias. Two of the recreational attributes were treated as random variables; ‘navigability’ and ‘congestion’. The ‘use of jet skis/wet bikes’ and ‘cost’ variables were specified as fixed[32]. In other words, preferences relating to the use of jet skis/wet bikes and the cost were assumed to be homogenous, whereas the two variables assumed to be random represent heterogeneous preferences. A normal distribution was initially selected for both the random parameters specified. The contingency table results for the RPL (Model 1) are shown in Table 6.57.

Table 6.57: Contingency table – RPL (Model 1) – Kromme River Estuary

	X1	X2	Total
X1	273	208	481
X2	219	276	495
Total	492	484	976

The first RPL model correctly predicted the alternative chosen 549 times (273 + 276) out of the total of 976 choices made. The overall proportion of correct predictions of actual choice is 549/976 = 0.563 (or 56.3 percent).

The results of the RPL model utilizing a uniform distribution for the random variables are presented in Table 6.54. A contingency table (Table 6.58) was also estimated for the second RPL model.

Table 6.58: Contingency table – RPL (Model 2) – Kromme River Estuary

	X1	X2	Total
X1	272	209	481
X2	218	277	495
Total	491	485	976

[32] The use of Jet Skis variable was not made a random variable because during an initial estimation where it was specified as a random parameter its standard deviation coefficient was statistically insignificant.

The second RPL model correctly predicted the alternative chosen 549 times (272 + 277) out of the total of 976 choices made. The overall proportion of correct predictions of actual choice is 549/976 = 0.563 (or 56.3 percent).

Table 6.54 also shows the standard deviations and standard errors for the random parameters of the RPL estimates. Allowing preferences for two recreational attributes (Navigability and Congestion) to vary across respondents shows that there is unexplained heterogeneity in respondent preferences. Both the standard deviation coefficients are statistically significant, indicating statistically dissimilar preferences for these attributes across respondents. In other words, the random variables specified in the RPL indicate that respondents are divided on their views regarding the need to increase estuary navigability, and reduce boat congestion.

The RPL models indicate the presence of unobserved heterogeneity. However, they fail to explain the sources of the heterogeneity (Adamowicz & Boxall, 2001). One way to detect and account for unobserved heterogeneity is to include interactions of various respondent-specific characteristics with choice specific attributes in the utility function. This enables the RPL model to elicit preference variation, whether it is from unconditional taste heterogeneity (random) or conditional heterogeneity (individual characteristics). This can improve model fit (Revelt & Train, 1998).

In a model given in Appendix F, a series of respondent-specific control variables were included in the RPL specification[33]. These variables were: resident type, respondent type, gender, age, where the respondent lives, occupation, income and education. The inclusion of these variables did not improve the estimates. In this case, complete reliance is placed on the fixed mean and standard deviation of the parameter estimates, with the latter representing all sources of preference heterogeneity around the mean (Hensher *et al.* 2005). Comparing the results from the RPL, HEV and CL models reveals that the magnitudes, signs and statistical significance of the coefficients are very similar. Given these similarities, it was considered prudent to use the standard CL model’s results when estimating welfare measures and explaining sub-sample WTP differences.

6.4.2.2 Implicit price and welfare calculation

a) Implicit prices

In the case of the Kromme River Estuary, the marginal WTP values represent: a change from the current level of navigability to a pre-settlement level, a change from seeing and hearing few boats to seeing and hearing many boats, and a change from no

[33] These were specified in LIMDEP NLOGIT Version 4.0 as “Heterogeneity around the mean” variables. During estimation, these variables were interacted with the two random variables selected, namely Navigability and Congestion.

jet ski or wet bike access to the potential use of jet skis and wet bikes on the estuary. Table 6.59 reports the implicit prices, or marginal WTP (MWTP), for each of the Kromme River Estuary's recreational attributes estimated using the delta method (Wald procedure[34]) in LIMDEP NLOGIT Version 4.0 (Greene, 2007). For comparisons, estimates were calculated using all four models.

Table 6.59: Marginal WTP (MWTP) for attributes (Rands)* and 95 percent confidence intervals (CI) – Kromme River Estuary**

Attributes	**CL**	**HEV*** **	**RPL Model 1**	**RPL Model 2**
	MWTP	**MWTP**	**MWTP**	**MWTP**
Navigability	436.75 (256.15 – 617.35)	449.93	585.50 (231.22 – 939.78)	692.01 (211.33 – 1172.69)
Congestion	-303.63 (-463.09 - -144.17)	-302.20	-482.65 (-841.51 - -123.79)	-576.08 (-1023.38 - -128.82)
Jet Skiing	-34.55 (-161.35 – 92.25)	-31.47	-36.84 (-68.90 – 142.58)	45.08 (-58.86 – 149.06)

**Please note that the estimated coefficient for the jet ski attribute was statistically insignificant for all four models estimated (see Table 6.38 above). Implicit prices were calculated to inform policy analysis.*
***Confidence intervals in parentheses.*
**** Confidence intervals not calculated for HEV due to the presence of fixed parameters.*

The differences in the WTP estimates among the four models are not particularly large, except for the WTP figures reported for the second RPL model estimated. Confidence intervals for the CL and both RPL models are overlapping for all attributes however the CL model shows a narrower range.

b) Models grouped according to socio-demographic variables

The marginal WTP estimates for the respective attributes were also calculated according to different socio-demographic characteristics and presented in Table 6.60. The sample was grouped according to age, education, gender, income, respondent type and resident type. A CL model was estimated for each sub-sample. Most of the sub-samples calculated marginal WTP estimates are significant at the 5 percent level, with the exception of those for the Jet skiing variable.

[34] See Footnote 25.

Table 6.60: Implicit prices according to different socio-demographic sub-samples – Kromme River Estuary

Grouped Models	Navigability	Congestion	Jet Skiing
Age < 36	373.00 (0.000)	-307.00 (0.000)	187.50 (0.0307)
Age ≥ 36	642.00 (0.000)	-447.00 (0.000)	-242.00 (0.0437)
≤ Matric	235.33 (0.000)	-146.00 (0.0217)	96.00 (0.1145)
>Matric	650.00 (0.000)	-513.00 (0.000)	-179.00 (0.1243)
Female	670.00 (0.000)	-710.00 (0.000)	-126.00 (0.4583)
Male	319.50 (0.000)	-186.00 (0.0014)	-13.50 (0.8197)
Income ≤ R150 000	295.50 (0.000)	-169.50 (0.0146)	-23.50 (0.7324)
Income > R150 000	750.00 (0.000)	-617.00 (0.000)	-61.00 (0.6559)
Permanent	240.33 (0.000)	-172.00 (0.0047)	87.33 (0.1400)
Other	649.00 (0.000)	-492.00 (0.000)	-184.00 (0.1175)
Homeowner	295.00 (0.000)	-203.00 (0.000)	-26.00 (0.6408)
Visitor	861.00 (0.000)	-695.00 (0.000)	-74.00 (0.7028)

Note: p-values in brackets

The line plots (Figure 6.2) illustrate the variability of each attribute with respect to the marginal WTP estimates for each of the socio-demographic sub-samples. The highest marginal WTP estimates for improved navigability are those of females, over the age of 35, earning more than R150 000 per annum, with tertiary education. The visitor sub-sample has a higher marginal WTP than the permanent resident or homeowner sub-sample.

The highest marginal WTP for a reduction in boat congestion on the Kromme River Estuary are for females, over the age of 35, earning more than R150 000 per annum, with tertiary education. Visitors were willing to pay more for reduced boat congestion than permanent residents or homeowners.

The majority of users' marginal WTP for the regulation of jet skis/wet bikes on the estuary estimates are negative, which indicate that these categories of respondents do not want the use of jet skis or wet bikes re-instated on the estuary. Those respondents younger than 36 years of age and with less than a matric education, who are permanent residents of the estuary, are willing to pay to have jet skis/wet bikes reinstated. The estimates for this attribute are, however, largely insignificant.

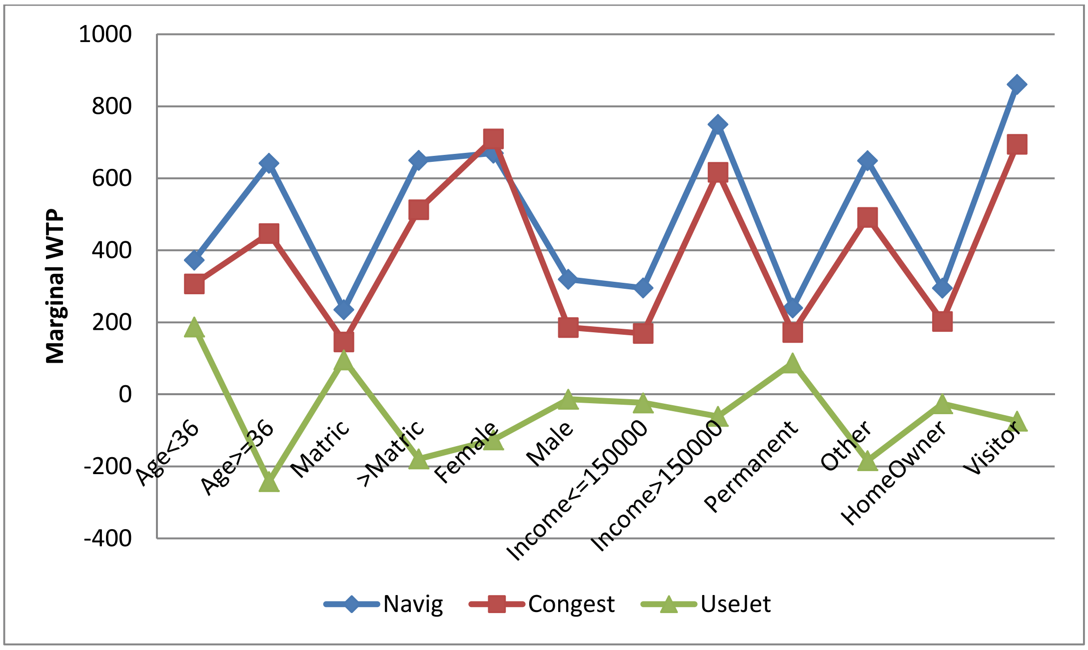

Figure 6.2: Variability of marginal WTP (Rands) of attributes for all sub-samples – Kromme River Estuary

c) CS estimates

Attribute specific CS estimates

The CS associated with an increase in the level of navigability in the Kromme River Estuary, from a specified constant base (V_C) to a change alternative (V_N), is estimated below. The constant base and the change alternative are defined as follows:

Constant base: Current navigability, congestion, jet skis/wet bikes banned.
Change alternative: Ideal navigability, congestion, jet skis/wet bikes banned.

For the change to ideal navigability, i.e. the change alternative (V_N):

CS = 649.8x(-0.67) = -R435.37

The negative sign shows that in order to maintain utility at level V_C, given an increase in the level of navigability on the Kromme River Estuary, income must be reduced by R435 (to the nearest Rand). Another way of stating this is that the WTP per household for the ideal level of navigability was R435.

The CS associated with a decrease in the level of boat congestion in the Kromme River Estuary, from a specified constant base (V_C) to a change alternative (V_N), is estimated below. The constant base and the change alternative are defined as follows:

Constant base: Current navigability, congestion, jet skis/wet bikes banned.
Change alternative: Current navigability, no congestion, jet skis/wet bikes banned.

For the change to no congestion (V_N):

CS = 649.8x(-0.57) = -R370.39

The negative sign shows that in order to maintain utility at level V_C, given a reduction in the level of boat congestion in the estuary, income must be reduced by R370.

The CS associated with the re-instatement of jet skis/wet bikes on the Kromme River Estuary, from a specified constant base (V_C) to a change alternative (V_N), is estimated below. The constant base and the change alternative are defined as follows:

Constant base: Current navigability, congestion, jet skis/wet bikes banned.
Change alternative: Current navigability, congestion, jet skis/wet bikes re-instated but regulated.

For the change to the re-instatement and regulation of jet skis/wet bikes on the estuary (V_N):

CS = 649.8x(-0.99) = -R643.30

The negative sign shows that in order to maintain utility at level V_C, given the re-instatement and regulation of jet skis/wet bikes on the Kromme River Estuary, income must be reduced by R643. The CS in this case is based on statistically insignificant coefficients.

<u>Overall CS</u>

The CS associated with an improvement from a specified constant base (V_C) to a change alternative (V_N) for a multiple change may also be estimated. The constant base and the change alternative are defined as follows:

Constant base: Current level of navigability, congestion, jet skis/wet bikes banned.
Change alternative: Ideal navigability, no congestion, jet skis/wet bikes re-instated but regulated.

For the change (V_N):

CS = 649.8x(-1.19) = -R773.26

The negative sign shows that to maintain utility at level V_C, given an improvement in estuary recreational services, income must be reduced by R773.

6.4.3 THE NAHOON ESTUARY

6.4.3.1 Model estimation

Three different choice model specifications were estimated as part of the Nahoon River Estuary CE, namely a CL model, an HEV model and an RPL model. Once again, LIMDEP NLOGIT 4.0 was used in all the estimations.

The first model shown in Table 6.61 is a standard CL model.

Table 6.61: Estimation results of the CE – Nahoon River Estuary

	CL		HEV		RPL	
Variables	**Coeff.**	**Std err.**	**Coeff.**	**Std err.**	**Coeff.**	**Std err.**
Water Safety	.41862687**	.06595099	.83577320**	.23218699	1.25772637**	.39284346
Interest in Facilities	.17442939**	.06351794	.41275988*	.16527328	.52282497*	.24433568
Public Safety[1]	.14338403**	.05246451	.27388383*	.12059663	..37413554**	.12236694
Cost[1]	-.00567247**	.00110876	-.01061374**	.00314805	-.01308230**	.00312018
	Standard deviation of random parameters					
Water Safety					2.32121764	.89617235
Interest in Facilities					2.57825248	1.0378591
No. of respondents	210		210		210	
No. of choice sets	840		840		840	
Pseudo R^2	.06218		.09005		.09164	

**indicates that parameter is statistically significant at the 5 percent level*
*** indicates significance at the 1 percent level*

1. *Cost and Public Safety were specified as non-random parameters in the RPL*

The results of the CL model indicate that all the coefficients have the correct *a priori* signs and all are significantly different from zero at the 99 percent confidence level.

The probability that an alternative would be chosen was reduced:

- The lower the quality of the water in the estuary;
- The lower the amount of interest in support facilities around the estuary;
- The lower the level of public safety; and
- The higher the environmental quality levy (cost).

The explanatory power of the model is fair, with a Pseudo R^2 of 6 percent.

A contingency table was estimated to determine the performance of the CL model. This is shown in Table 6.62 below.

Table 6.62: Contingency table – CL model – Nahoon River Estuary

	X1	**X2**	**Total**
X1	262	217	479
X2	160	201	361
Total	422	418	840

In this case, the model correctly predicted the alternative chosen 463, i.e. 262 + 201 = 463, times out of the total of 840 choices made. Thus, the overall proportion of correct predictions equals 463/840 = 0.551. Thus, for this data the model correctly predicted the actual choice outcome for 55.1 percent of the total number of cases.

In order to overcome some of the potential sources of bias, namely identically distributed random components and constant variances, a HEV logit was estimated (see Table 6.61 for results).

Not unlike the CL model, the results of this model indicate that all the coefficients have the correct *a priori* signs. However, only two of the four coefficients are significantly different from zero at the 99 percent confidence level, namely the 'level of water safety', and 'cost'. The explanatory power of the model is fair, with a McFadden Pseudo R^2 of 9 percent. The results of estimating a contingency table to determine model performance for the HEV is shown in Table 6.63 below.

Table 6.63: Contingency table – HEV model – Nahoon River Estuary

	X1	**X2**	**Total**
X1	293	186	479
X2	184	177	361
Total	477	363	840

In this case, the model correctly predicted the alternative chosen 470 (i.e. 293 + 177 = 470) times out of the total of 840 choices made. Thus, the overall proportion of correct predictions equals 470/840 = 0.559. Thus, for this data the model correctly predicted the actual choice outcome for 55.9 percent of the total number of cases.

Table 6.61 reports the RPL results that correspond to the CL and HEV logit models. Two of the recreational attributes were treated as random variables, namely 'water safety' and 'interest in facilities'. The 'public safety' and 'cost' variables were specified as fixed[35]. This implies that preferences relating to public safety and the cost

[35] The public safety variable was not made a random variable because during an initial estimation where it was specified as a random parameter its standard deviation coefficient was statistically insignificant.

are assumed to be homogenous, whereas the two variables treated at random represent heterogeneous preferences. A normal distribution was selected for both the random parameters specified.

The results of estimating a contingency table to determine model performance for the RPL is shown in Table 6.64 below.

Table 6.64: Contingency table – RPL model – Nahoon River Estuary

	X1	X2	Total
X1	269	210	479
X2	160	201	361
Total	429	411	840

In this case, the model correctly predicted the alternative chosen 470, i.e. 269 + 201 = 470, times out of the total of 840 choices made. Thus, the overall proportion of correct predictions equals 470/840 = 0.559. Thus, for this data the model correctly predicted the actual choice outcome for 55.9 percent of the total number of cases.

Table 6.61 above also gives the standard deviations and standard errors for the random parameters of the RPL estimates. Allowing preferences for two recreational attributes (‘water safety’ and ‘interest in ‘facilities’) to vary across respondents shows that there is some unexplained heterogeneity in respondent preferences. Both the standard deviation coefficients are highly statistically significant, indicating statistically dissimilar preferences for these attributes across respondents. In other words, the random variables specified in the RPL do not elicit general consensus regarding the need to improve water quality and support facilities for the estuary.

Comparing the results from the RPL, HEV and CL models reveals that the magnitudes, signs and statistical significance of the coefficients are very similar.

6.4.3.2 Implicit price and welfare calculation

a) Implicit prices

The implicit prices for the attributes of the Nahoon River Estuary CE are shown in Table 6.65 below.

Table 6.65: Marginal WTP (MWTP) for attributes (Rands) – Nahoon River Estuary

Attributes	**CL**	**HEV**	**RPL**
Water Safety	73.80	78.74	96.14
Interest in Facilities	30.75	38.89	39.96
Public Safety	25.28	25.81	28.60

The WTP estimates among the three models are all of the expected sign, and the differences between them are not particularly large, the exception being the 'water safety' WTP figure reported for the RPL model.

b) Models grouped according to socio-demographic variables

The marginal WTP estimates for the respective attributes are calculated according to different socio-demographic characteristics and presented in Table 6.66 below. The sample was grouped according to age, education, gender, and income. A CL model was estimated for each sub-sample.

Table 6.66: Implicit prices according to different socio-demographic sub-samples – Nahoon River Estuary

Grouped Models	Water Safety	Interest in Facilities	Public Safety	Cost
Age < 40	30.57 (0.014)	20.75 (0.081)	17.14 (0.091)	(0.000)
Age ≥ 40	175.81 (0.000)	63.17 (0.001)	47.37 (0.022)	(0.021)
≤ Matric	62.89 (0.000)	21.73 (0.220)	23.16 (0.093)	(0.001)
>Matric	78.74 (0.000)	34.75 (0.014)	26.05 (0.029)	(0.000)
Male	76.83 (0.000)	33.56 (0.039)	37.32 (0.004)	(0.000)
Female	71.32 (0.000)	27.17 (0.074)	12.52 (0.332)	(0.000)
Income < R200 000	37.34 (0.002)	37.61 (0.001)	-2.94 (0.778)	(0.000)
Income ≥ R200 000	115.01 (0.000)	20.18 (0.375)	59.84 (0.001)	(0.008)

Note: p-values in brackets

The line plots (Figures 6.3) illustrate the variability of each attribute with respect to the WTP estimates for each socio-demographic sub-sample.

The highest marginal WTP estimates for improved water safety are those representing males, over the age of 40, earning more than R200 000 per annum, with tertiary education. The highest marginal WTP estimates for an improvement in support facilities on the Nahoon River Estuary were for males, over the age of 40, earning less than R200000 per annum, with tertiary education. The highest marginal WTP estimates for improved public safety on the Nahoon River Estuary were for male respondents 40 years of age and older, with a tertiary qualification. Though insignificant, the negative marginal WTP for those respondents earning less than

R200 000 per annum is still presented. In terms of marginal WTP estimates, public safety is vitally important to high income earners, i.e. those earning more than R200 000 per annum.

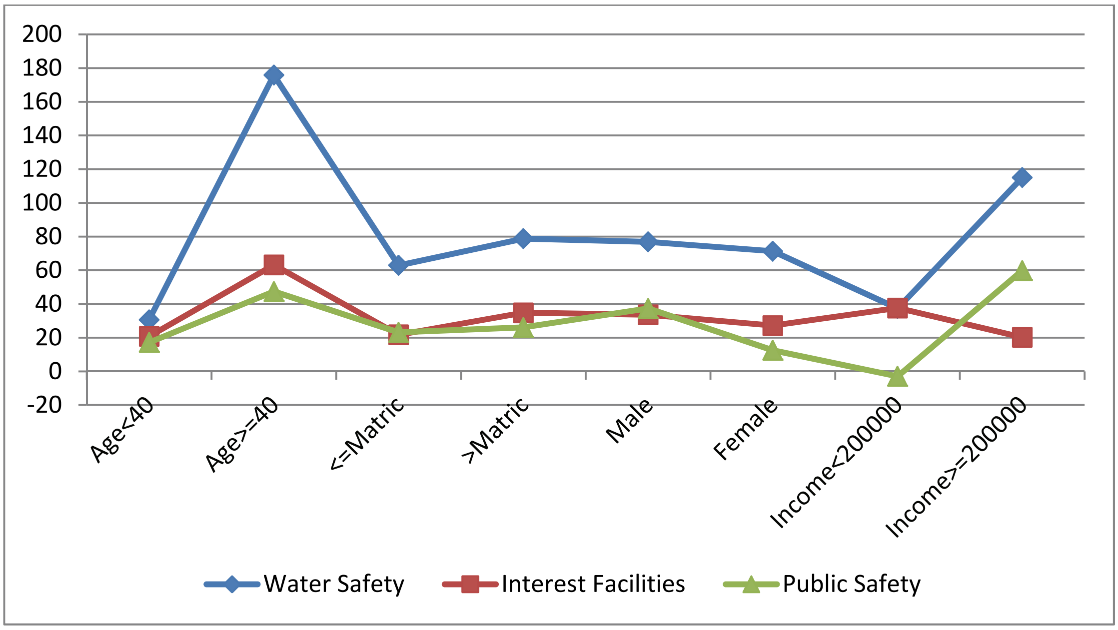

Figure 6.3: Variability of marginal WTP (Rands) of attributes for all sub-samples – Nahoon River Estuary

Respondents, representing all sub-samples, were willing to pay more for an improvement in water safety as opposed to further investments in support facilities and general public safety.

6.4.4 THE GONUBIE RIVER ESTUARY

6.4.4.1 Model estimation

Three different choice model specifications were estimated as part of the Gonubie River Estuary CE, namely a CL model, a HEV model and a RPL model. Once again, LIMDEP NLOGIT 4.0 was used in all the estimations.

The first model shown in Table 6.67 is a standard CL model.

Table 6.67: Estimation results of the CE – Gonubie River Estuary

Variables	CL		HEV		RPL	
	Coeff.	**Std err.**	**Coeff.**	**Std err.**	**Coeff.**	**Std err.**
Water Safety[1]	1.27391934**	.10678240	.47101715**	.03210353	2.54854256**	.25549970
Naturalness[1]	-.23570556*	.10301999	.07079639**	.02667848	.24162168	.18491603
Security	.59792047**	.09202242	.37900872**	.02597614	2.81513751*	1.14800531
Cost[1]	-.01745459**	.00169054	-.00252625**	.00049385	-.01968242**	.00293393
	Heterogeneity in mean, parameter: variable					
Security: Times					-.6384663**	.24075661
Security: Gender					1.04638677*	.47342696
Security: Res					-1.148256**	.39014461
Security: Income					.76462347**	.18118378
	Standard deviation of random parameters					
Security					4.50758198	.80612525
No. of respondents	204		204		204	
No. of choice sets	816		816		816	
Pseudo R^2	.16679		.26500		.27844	

**indicates that parameter is statistically significant at the 5 percent level*

*** indicates significance at the 1 percent level*

1. *Water Safety, Naturalness and Cost were specified as non-random parameters in the RPL*

The results of the CL model indicate that all the coefficients have the correct *a priori* signs and three of the four coefficients are significantly different from zero at the 99 percent confidence level.

The probability that an alternative would be chosen was reduced:

- The lower the level of water quality;
- The higher the level of bank development;
- The lower the level of security; and
- The higher the environmental quality levy.

The explanatory power of the model is good, with a Pseudo R^2 of 16.7 percent.
A contingency table was estimated to determine the performance of the CL model. This table is shown below.

Table 6.68: Contingency table – CL model – Gonubie River Estuary

	X1	**X2**	**X3**	**Total**
X1	181	97	57	335
X2	85	183	48	317
X3	70	61	33	164
Total	336	342	138	816

In this case, the model correctly predicted the alternative chosen 397 (i.e. 181 + 183 + 33 = 397) times out of the total of 816 choices made. Thus, the overall proportion of correct predictions equals 397/816 = 0.487. Thus, for this data the model correctly predicted the actual choice outcome for 48.7 percent of the total number of cases.

In order to overcome some of the potential sources of bias, namely identically distributed random components and constant variances, a HEV logit was estimated (see Table 6.67 for results).

The results of this model indicate that all the coefficients are significantly different from zero at the 99 percent confidence level however 'naturalness' no longer has the expected *a priori* sign. The explanatory power of the model is improved, with a McFadden Pseudo R^2 of 26.5 percent.

The results of estimating a contingency table to determine model performance for the HEV is shown in Table 6.69.

Table 6.69: Contingency table – HEV model – Gonubie River Estuary

	X1	**X2**	**X3**	**Total**
X1	198	66	71	335
X2	63	189	65	317
X3	71	56	37	164
Total	331	311	174	816

In this case, the model correctly predicted the alternative chosen 424 (i.e. 198 + 189 + 37 = 424) times out of the total of 816 choices made. Thus, the overall proportion of correct predictions equals 424/816 = 0.519. Thus, for this data the model correctly predicted the actual choice outcome for 51.9 percent of the total number of cases.

Table 6.67 reports the RPL results for a model that corresponds to the CL and HEV logit models. Only one of the recreational attributes was treated as a random variable, namely security. The other variables, namely water safety, naturalness and cost, were specified as non-random[36]. This implies that preferences relating to these three variables are assumed to be homogenous, whereas the variable treated as random represents heterogeneous preferences. A normal distribution was selected for the random parameter specified, namely 'security'.

The results of estimating a contingency table to determine model performance for the RPL is shown in Table 6.70 below.

[36] The other variables, namely Water Safety, Naturalness and Cost, were not made random because during an initial estimation where they were specified as random parameters, their standard deviation coefficients were statistically insignificant.

Table 6.70: Contingency table – RPL model – Gonubie River Estuary

	X1	X2	X3	Total
X1	194	77	64	335
X2	64	198	54	317
X3	65	57	42	164
Total	324	332	160	816

In this case, the model correctly predicted the alternative chosen 434 (i.e. 194 + 198 + 42 = 434) times out of the total of 816 choices made. Thus, the overall proportion of correct predictions equals 434/816 = 0.5319. Thus, for this data the model correctly predicted the actual choice outcome for 53.2 percent of the total number of cases.

Table 6.67 above also gives the standard deviation and standard error for the random parameter of the RPL estimates. Allowing preferences for the 'security' attribute to vary across respondents shows that there is some explained heterogeneity in respondent preferences. The standard deviation coefficient is highly statistically significant, indicating statistically dissimilar preferences for this attribute across respondents. The RPL model thus indicates the presence of heterogeneity. One way to detect and account for unobserved heterogeneity is to include interactions of various respondent-specific characteristics with choice specific attributes in the utility function. This enables the RPL model to elicit preference variation, whether it is from unconditional taste heterogeneity (random) or conditional heterogeneity (individual characteristics). This could thus improve model fit (Revelt & Train, 1998). A set of models were run whereby a series of respondent-specific control variables were included in the RPL specification[37]. These variables included: times visited, gender, resident type, age, occupation, education and income. The inclusion of some of these variables had an impact on the estimates – in other words, the "heterogeneity around the mean" parameters for four of the control variables were statistically significant. These variables include 'times visited', 'gender', 'respondent type' and 'income', and are reported in Table 6.67.

Comparing the three models estimated revealed that the results from the HEV and RPL models are very similar. Only one dissimilarity exists, namely the 'naturalness' coefficient is significant for the HEV model but insignificant for the RPL model. From a statistical point of view, this dissimilarity is not that important. One would simply use the results from the RPL model since this is the more sophisticated of the two models. However, when the results from these two models are compared to the standard CL model results, an important dissimilarity arises, namely the CL model estimates an expected negative relationship for the 'naturalness' coefficient, whereas the HEV and RPL models do not. This result may be due to a violation of the IIA

[37] These were specified in Nlogit as "Heterogeneity around the mean" variables. During estimation, these variables were interacted with the random variable selected, namely Security.

assumption. A test to detect this violation was attempted, but the results were inconclusive.

6.4.4.2 Implicit Price and welfare calculation

a) Implicit prices

The implicit prices for the attributes of the Gonubie River Estuary CE are shown in Table 6.71 below.

Table 6.71: Marginal WTP (MWTP) for attributes (Rands) – Gonubie River Estuary

Attributes	CL	HEV	RPL
Water Safety	72.99	186.45	129.48
Naturalness	-13.50	28.02	12.28
Security	34.26	150.03	143.03

The differences in the WTP estimates among the three models are quite large. These calculated implicit prices lend further credence to a suspected violation of the IIA assumption as far as the CL model is concerned. Moreover, the 'water safety' attribute for the CL model is less than half of the WTP value for the HEV model, and just over half that of the RPL model. In terms of the 'security' attribute, the WTP value for the CL model is approximately a fifth of the WTP for both the HEV and RPL models. Another inconsistency relates to the unexpected positive sign for the 'naturalness' coefficient with respect to the HEV and RPL models.

The marginal WTP estimates for the respective attributes are calculated according to different socio-demographic characteristics and presented in Table 6.72. The sample was grouped according to age, education, gender, and income. Even though the results of the CL model indicate a possible IIA violation, it was used to estimate WTP values for each sub-sample.

Table 6.72: Implicit prices according to different socio-demographic sub-samples – Gonubie River Estuary

Grouped Models	Water Safety	Naturalness	Security	Cost
Age < 40	68.28 (0.000)	-7.28 (0.246)	34.12 (0.000)	(0.000)
Age ≥ 40	97.63 (0.000)	-48.29 (0.003)	34.13 (0.017)	(0.000)
≤ Matric	51.08 (0.000)	-11.11 (0.224)	25.87 (0.001)	(0.000)
>Matric	84.47 (0.000)	-13.27 (0.078)	38.93 (0.000)	(0.000)
Male	69.75 (0.000)	-13.55 (0.030)	23.47 (0.000)	(0.000)
Female	82.63 (0.000)	-15.34 (0.225)	55.95 (0.000)	(0.000)
Income < R200 000	60.95 (0.000)	-22.40 (0.028)	34.80 (0.000)	(0.000)
Income ≥ R200 000	81.69 (0.000)	-7.98 (0.268)	35.31 (0.000)	(0.000)

Note: p-values in brackets

The line plots (Figures 6.4) illustrate the variability of each attribute with respect to the WTP estimates for each socio-demographic sub-sample. The highest marginal WTP estimates for improved water quality are those representing females, over the age of 40, earning more than R200 000 per annum, with some form of tertiary education.

The highest marginal WTP estimates for a reduction in bank developments on the Gonubie River are those for females, over the age of 40, earning less than R200 000 per annum, with tertiary education. The highest marginal WTP estimates for improved public security on and around the estuary are those for females of all ages and all incomes, with at least a tertiary education.

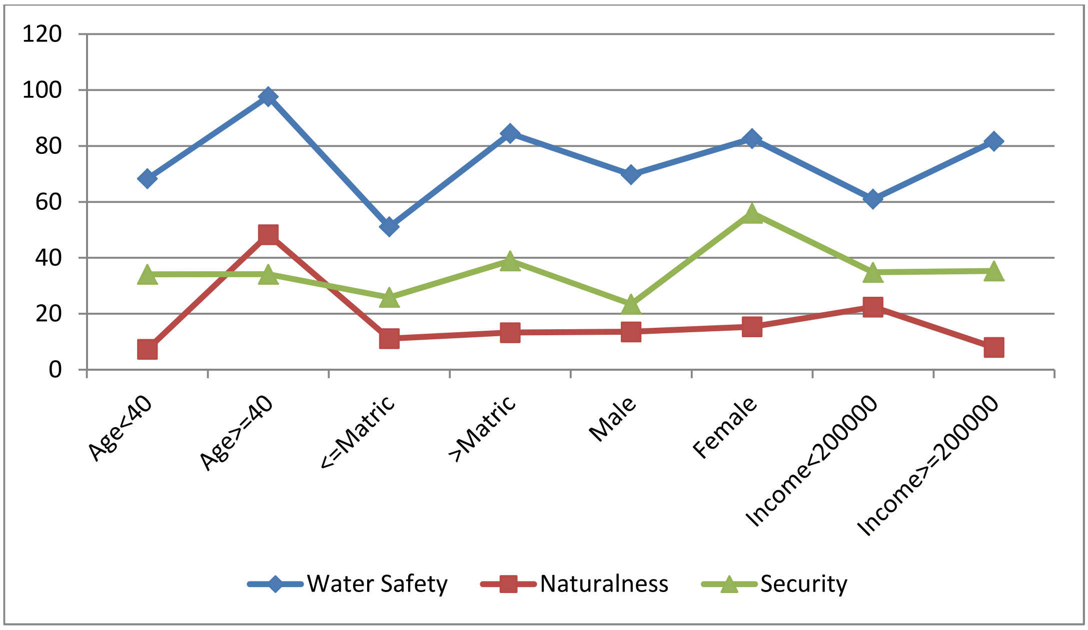

Figure 6.4: Variability of marginal WTP (Rands) of attributes for all sub-samples – Gonubie River Estuary

Similar to the Nahoon River Estuary, water safety is a priority relative to the other attributes at this estuary with the highest WTP estimates across all sub-samples.

6.5 VALIDITY AND RELIABILITY: THEORETICAL CONSIDERATIONS

As this study was the first CE study administered at the estuaries in question, the issue of reliability could not be tested. Moreover, as there were no comparable valuation studies available that value one or all of the attributes included in this study, convergent validity could not be tested. The latter is tested by comparing the WTP estimates from one study to those derived by a similar study at the same study site.

On the other hand, validity could be assessed. This was done for each estuary in terms of actual responses and the economic rationality of the responses, as well as an internal assessment of the theoretical adequacy of the way the questionnaires were constructed.

6.5.1 THE SUNDAYS RIVER ESTUARY

6.5.1.1 Follow-up questions on the issue of validity of response

A set of follow-up questions were asked after completion of the CE. In the case of the Sundays River Estuary, there were four follow-up questions on the respondents' experience of the CE exercise. The inclusion of these questions aimed to allow an assessment to be made of the extent to which the respondents' decision strategies conformed to the assumptions underlying the CE approach.

In the first follow-up question, Question 4.1, asked respondents whether they found it difficult or easy to complete the CE. Table 6.73 shows a percentage breakdown of the responses to this question.

Table 6.73: Respondents' view of choice complexity – Sundays River Estuary

Complexity Level	Percentage
Difficult	23
Easy	77

The majority of respondents found it easy to make the necessary choices, did not need to adopt a simplified decision rule to make their choice selections easier, felt the CE was not overly complicated and was not too time-consuming.

The next question (Question 4.2) was only answered by those respondents who indicated that the choice task was difficult (in other words, those who answered 'Yes' to Question 4.1). Table 6.74 shows the percentage breakdown of these answers.

Table 6.74: Reasons why the choice task was difficult – Sundays River Estuary

Reason	Percentage
Could not relate	12
Too much information	37
Did not understand	5
Options too expensive	5
Several factors important	29
Users should not pay	2
Other	5
Don't know	5

The responses to this question (Question 4.2) shed light on how different parts of the CE are understood. One of the assumptions underlying the use of the CE method is that individuals apply compensatory decision-making strategies, that "individuals are assumed to consider all attributes, and make trade-offs between all attributes within the choice sets provided in the design" (Watson *et al.* 2004). Encouragingly, out of the 'problem' respondents, 29 percent chose the "Several factors important" answer-option, indicating that they were aware of the need to adopt a compensatory decision-making strategy.

Question 4.3 asked the respondents to indicate which of the four attributes in each alternative they had put greatest weight on when choosing between the two alternatives. Two further answer categories were given as part of this question, namely "Varied between choices" and "Don't know". Table 6.75 shows the percentage breakdown of respondents' answers to this question.

Table 6.75: Respondents' attribute weights – Sundays River Estuary

Attribute	**Percentage**
Congestion	12
Physical size of fish stocks	49
Public access	11
Size of Environmental levy	15
Varied between choices	13
Don't know	1

The answers to this question serve to indicate which attributes were considered most important and thus potentially a likely focus of attention of non-compensatory decision-strategies. The physical size of fish stocks was considered most important in the case of the Sundays River Estuary. This result reveals that, if there were non-compensatory decision-strategies[38] adopted by respondents or lexicographic/dominant preferences, the most likely attribute linked to it was physical size of fish stocks.

Question 4.4 was a policy-orientated question, which asked the respondent whether they would increase their level of estuary usage if certain recreational estuarine attribute improvements were made. Table 6.76 below gives a percentage breakdown of the responses to this question.

Table 6.76: Potential future estuary use – Sundays River Estuary

Estuary Use	**Percentage**
Use the same	55
Use more often	45

6.5.1.2 Economic plausibility of response

The WTP estimates for the Sundays River Estuary were adjusted to pass the expectations-based validity test if they were consistent with the study's *a priori* expectations and conform to economic theory. All parameter estimates were significant and had the expected signs, as predicted by economic theory. An increase in the cost variable was associated with a decrease in overall welfare. The estimates calculated for each attribute are also considered plausible, given that WTP is for marginal changes (EFTEC, 2002). It was concluded that the results obtained in this study pass the 'reality check' for validity.

[38] The dominance of a "one attribute" answer-category is by no means definitive proof of non-compensatory decision-making.

An additional test was performed to check whether demand decreases in response to increasing prices (rational respondent behaviour). The relationship between the frequency of the chosen alternative and cost size is shown below (Figure 6.5).

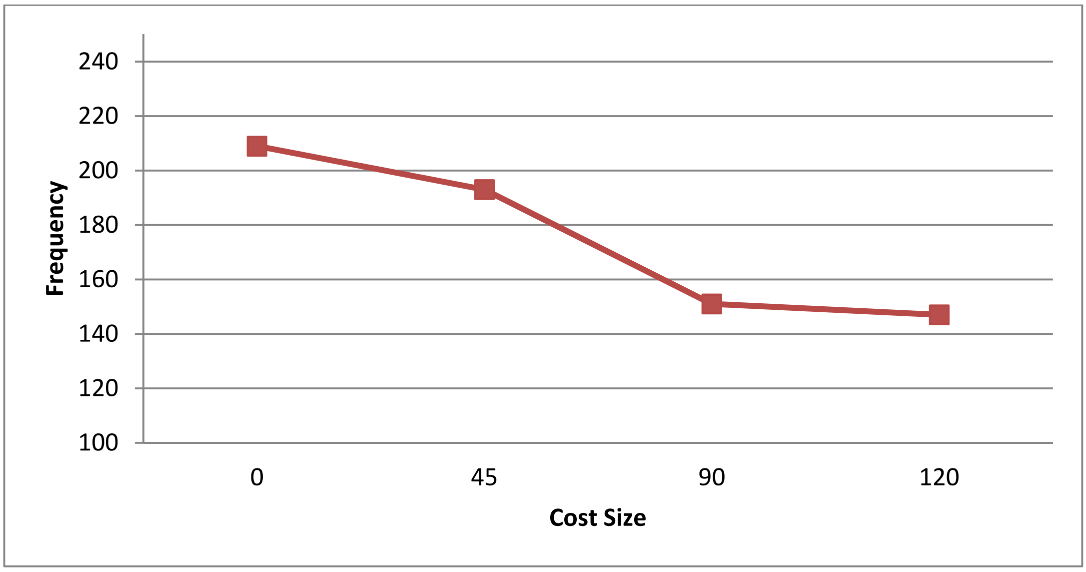

Figure 6.5: Relationship between cost size and frequency of chosen alternative – Sundays River Estuary

This figure shows that the number of chosen alternatives would drop as the cost associated with that alternative increases, which is consistent with a normal downward sloping demand curve for a normal good. For this reason the predictions of the model are consistent with economic theory and do not give rise to a query of validity on this account.

6.5.1.3 Internal assessment of construct and content validity

Content validity was assessed by analysing whether the questionnaire asked the appropriate questions in a clear and understandable manner, i.e. free from ambiguity. Construct validity was assessed in terms of the match between theoretical soundness of the questions in terms of the models being estimated and hypotheses tested, and the questionnaire administered. This assessment took the form of an overview internal assessment – see Table 6.77.

Table 6.77: A Summary of Content Validity Issues – Sundays River Estuary

CONTENT VALIDITY	
Scenario Design	**Assessment**
Are the attributes and their levels described in an understandable manner?	All attributes and levels were explained to respondents prior to the completion of the questionnaire
Does the information provided to the respondent adequately explain the environmental quality issue?	The respondents were fully aware of the environmental quality issues represented in the survey and had no problem making the necessary trade-offs
Is the payment vehicle considered relevant and realistic in order for the respondent to make plausible trade-offs?	The payment vehicle was the most realistic option proposed in the focus groups. The amounts were in line with current payment scenarios for recreational use
Is there a section of “cheap talk” in the questionnaire and does it highlight budget constraints and substitutes?	This section was included in the questionnaire and interviewers highlighted its importance prior to the completion of the choice section
Elicitation Issues	**Assessment**
Is the chosen non-market valuation technique appropriate?	The CE is most appropriate as it deals with multiple scenarios in one application, whereby each scenario can represent a different policy management option
Institutional Context	**Assessment**
Does the scenario presented to the respondent give them an expectation of payment in the future?	Yes. Respondents expect to pay for the provision of the good, but were concerned about effective administration of the payment.
Do respondents feel like their input has value in the decision making process?	Yes. Respondents were happy to give their views on the environmental issues investigated and eager to participate in the study
Sampling	**Assessment**
Was the target population and sampling frame correctly specified?	The population and thus a sample frame could not be identified. Non-list sampling was therefore used through the n^{th} intercept survey technique
Survey Format	**Assessment**
Was the survey mode of collection appropriate?	Yes. Personal interviews are widely regarded as the most appropriate surveying technique for stated preference methods (Arrow *et al.* 1993)
Was the administration of the survey been supervised and conducted in a professional manner?	Yes. Interviewers were trained and supervised during the survey. Quality checks were conducted on completed questionnaires.

Did the questionnaire design provide enough variable data for an in-depth explanation of WTP values?	Yes. WTP measures were derived for each attribute. Various socio-economic characteristics were interacted with the attributes in an attempt to reveal any sources of heterogeneity.

Source: Adapted from Oliver (2010)

The judgments reported in Table 6.77 are subjective. A number of questions contained in the CE questionnaire can be used to test content validity. A number of positive indicators of content validity (from the questionnaire responses) are as follows:

- Only 23 percent of the respondents found the valuation questions difficult. Of these, 2.86 percent could not relate to the questions and 1.14 percent did not understand the questions. It can thus be deduced that the questionnaire created a realistic hypothetical market (EFTEC, 2002).
- Income non-response is 27 percent of the sample. This is comparable to that found in other studies (EFTEC, 2002).
- Of the sampled respondents, 55 percent agreed that congestion is a problem (whereas 35 percent indicated that it is not a problem), 70 percent agreed that recreational over-fishing is a problem (whereas 18 percent indicated that it is not a problem), and 73 percent indicated that current levels of access are sufficient (whereas 18 percent indicated that it is not sufficient). This lends partial support for the design of the experiment, in that two of the three attributes were also considered important by respondents.

6.5.2 THE KROMME RIVER ESTUARY

6.5.2.1 Follow-up questions on the issue of validity of response

As with the Sundays River Estuary survey, four follow-up questions were asked regarding the respondent's experience of the choice exercise. The first question (Question 4.1) asked the respondents whether they found it difficult or easy to make the necessary choices. Table 6.78 shows the percentage breakdown of responses to this question.

Table 6.78: Respondents' view of choice complexity – Kromme River Estuary

Complexity Level	Percentage
Difficult	23
Easy	77

The majority of respondents found it easy to make the necessary choices, did not adopt simplified decision rules and did not find the completion of the choice task too time-consuming.

The next question (Question 4.2) was only answered by those respondents who indicated that the choice task was difficult (in other words, those who answered ‘Yes’ to Question 4.1). Table 6.79 below displays the percentage breakdown of answer-options chosen.

Table 6.79: Reasons why the choice task was difficult – Kromme River Estuary

Reason	Percentage
Could not relate	13
Too much information	27
Did not understand	7
Options too expensive	13
Several factors important	38
Users should not pay	1
Don’t know	1
Total	**100**

Out of the ‘problem’ respondents, 38 percent chose the “Several factors (were) important” category, indicating that they were aware of the need to adopt a compensatory decision-making strategy[39].

Question 4.3 asked the respondents to indicate which of the four attributes they had put greatest weight on when choosing between the two alternatives. Table 6.80 shows the percentage breakdown of respondents for each category.

Table 6.80: Respondents’ attribute weights – Kromme River Estuary

Attribute	Percentage
Navigability	18
Congestion	15
Jet Skis/Wet Bikes	39
Size of Levy	9
Varied between Choices	18
Don't know	1

The use of jet skis/wet bikes was considered most important in the case of the Kromme River Estuary.

Question 4.4 was a policy-orientated question. It asked the respondents whether they would increase their level of estuary usage if certain recreational estuarine attribute improvements were made. Table 6.81 provides a percentage breakdown of the responses to this question.

[39] See the discussion on compensatory decision-making in the Sundays River Estuary data analysis.

Table 6.81: Potential future estuary use – Kromme River Estuary

Estuary Use	Percentage
Use the same	68
Use more often	32

6.5.2.2 Economic plausibility of response

The WTP estimates for the Kromme River Estuary were consistent with the study's *a priori* expectations and conform to economic theory. The navigability, congestion and cost parameter estimates were significant at the 99 percent level. All the estimates had the expected signs, as predicted by economic theory. An increase in the cost variable is associated with a decrease in overall welfare. The estimates calculated for the significant attributes are also considered plausible, given that WTP is for marginal changes (EFTEC, 2002).

Moreover, the results were consistent with economic rationality. Figure 6.6 below graphs the number of chosen alternatives (y-axis) against a given cost (x-axis), ignoring other influences originating from the other three attributes in a choice set.

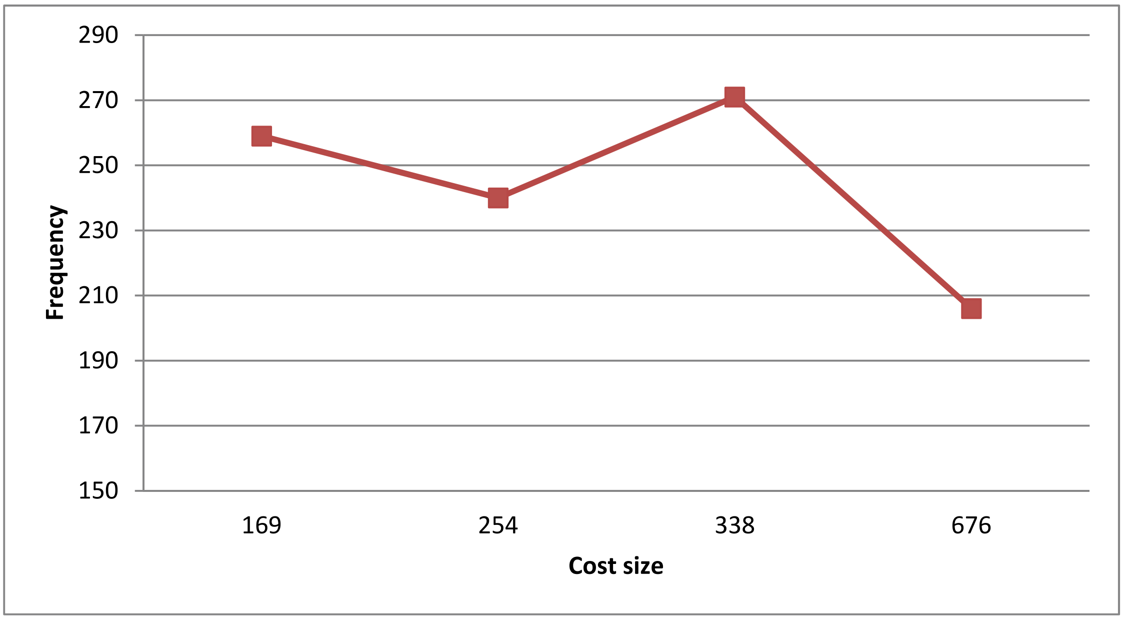

Figure 6.6: Relationship between cost size and frequency of chosen alternative – Kromme River Estuary

The relationship described in Figure 6.6 above is only partially consistent with a continuously downward-sloping demand curve, and in this sense is contrary to *a priori* expectations.

6.5.2.3 Internal assessment of construct and content validity

The assessment of content and construct validity took the form of an overview internal assessment, and is reported in Table 6.82 below.

Table 6.82: A Summary of Content Validity Issues – Kromme River Estuary

CONTENT VALIDITY	
Scenario Design	**Assessment**
Are the attributes and their levels described in an understandable manner?	All attributes and levels were explained to respondents prior to the completion of the questionnaire
Does the information provided to the respondent adequately explain the environmental quality issue?	The respondents were fully aware of the environmental quality issues represented in the survey and had no problem making the necessary trade-offs
Is the payment vehicle considered relevant and realistic in order for the respondent to make plausible trade-offs?	The payment vehicle was the most realistic option proposed in the focus groups and personal interviews. The amounts were in line with current payment scenarios for recreational use
Is there a section of "cheap talk" in the questionnaire and does it highlight budget constraints and substitutes?	This section was included in the questionnaire and interviewers highlighted its importance prior to the completion of the choice section
Elicitation Issues	**Assessment**
Is the chosen non-market valuation technique appropriate?	The CE is most appropriate as it deals with multiple scenarios in one application, whereby each scenario can represent a different policy management option
Institutional Context	**Assessment**
Does the scenario presented to the respondent give them an expectation of payment in the future?	Yes. Respondents expect to pay for the provision of the good, but were concerned about effective administration of the payment.
Do respondents feel like their input has value in the decision making process?	Yes. Respondents were happy to give their views on the environmental issues investigated and eager to participate in the study
Sampling	**Assessment**
Was the target population and sampling frame correctly specified?	The population and thus a sample frame could not be identified. Non-list sampling was therefore used through the n^{th} intercept survey technique

Survey Format	Assessment
Is the survey mode of collection appropriate?	Yes. Personal interviews are widely regarded as the most appropriate surveying technique for stated preference methods (Arrow *et al.* 1993)
Has the administration of the survey been supervised and conducted in a professional manner?	Yes. Interviewers were trained and supervised during the survey. Quality checks were conducted on completed questionnaires.
Does the questionnaire design provide enough variable data for an in-depth explanation of WTP values?	Yes. WTP measures were derived for each attribute. Various socio-economic characteristics were interacted with the attributes in an attempt to reveal any sources of heterogeneity.

Source: Adapted from Oliver (2010)

As was the case with the Sundays River Estuary CE, the judgments reported in Table 6.82 are essentially subjective. A number of positive indicators of content validity (from the questionnaire responses) are as follows:

- Only 23 percent of the respondents found the valuation questions difficult. Of these, 2.87 percent could not relate to the questions and 1.64 percent did not understand the questions. It can thus be deduced that the questionnaire created a realistic hypothetical market (EFTEC, 2002).
- Income non-response is 37 percent of the sample. This is comparable to that found in other studies (EFTEC, 2002).
- Of the sampled respondents, 68 percent agreed that congestion is a problem (whereas 23 percent indicated that it is not a problem), 85 percent agreed that the current level of navigability is a problem (whereas 6 percent indicated that it is not a problem), and 61 percent indicated that jet ski access is a problem (whereas 26 percent indicated that it is not a problem). This lends support for the design of the experiment, in that all the attributes were also considered important by respondents.

6.5.3 THE NAHOON RIVER ESTUARY

6.5.3.1 Follow-up questions on the issue of validity of response

In the case of the Nahoon River Estuary, four follow-up questions regarding the respondent's experience of the choice exercise were asked immediately after the choice task. These questions allowed for the assessment of the perceived complexity of the choice task. They also shed light on the degree of certainty by which the WTP bids and choices can be interpreted.

The first question in this section asked respondents' whether they found it difficult or easy to make the necessary choices (Question 4.1). Respondent answers to this question can indicate overall reliability of the choices made. Table 6.83 below shows the percentage breakdown of responses to this question.

Table 6.83: Respondents' view of choice complexity – Nahoon River Estuary

Complexity level	Percentage
Difficult	45
Easy	55

These responses indicate that choice complexity was a potential problem for respondents.

The next question (Question 4.2) was only answered by those respondents who indicated that the choice task was difficult (in other words, those who answered 'Yes' to Question 4.1). Table 6.84 below displays the percentage breakdown of answer-options chosen.

Table 6.84: Reasons why the choice task was difficult – Nahoon River Estuary

Reason	Percentage
Could not relate	9
Too much information	35
Did not understand	7
Options too expensive	4
Several factors important	24
Users should not pay	20
Don't know	1

This question investigates the issue of validity by considering percentages of respondents who chose the 'several factors (were) important' category. In total, 24 percent of respondents, who found the task difficult, chose this option. This implies that these particular respondents followed a compensatory decision-making strategy when faced with the choice task.

Question 4.3 asked respondents to indicate which of the four attributes they had put greatest weight on when choosing between alternatives in the choice task. Table 6.85 shows the percentage breakdown of respondents for each category.

Table 6.85: Respondents' attribute weights – Nahoon River Estuary

Attribute	Percent
Water Safety	70
Interest in Facilities	12
Public Safety	3
Size of Payment	3
Varied between choices	12

This question can be used to identify the attributes that were considered most important when making choices. These attributes could potentially have been the focus of non-compensatory decision-making. The level of water safety was clearly considered most important in the case of the Nahoon River Estuary.

Question 4.4 was a policy-orientated question, which asked the respondent whether they would increase their level of estuary usage if certain recreational estuarine attribute improvements were made. Table 6.86 provides a percentage breakdown of the responses to this question.

Table 6.86: Potential future estuary use – Nahoon River Estuary

Estuary use	Percent
Use the same	29
Use more often	71

6.5.3.2 Economic plausibility of response

The WTP estimates for the Nahoon River Estuary were consistent with the study's *a priori* expectations and conform to economic theory. All the parameter estimates were significant at the 99 percent level. All the estimates had the expected signs, as predicted by economic theory. An increase in the cost variable is associated with a decrease in overall welfare. The estimates calculated for the significant attributes are also considered plausible, given that WTP is for marginal changes (EFTEC, 2002). Moreover, the results were consistent with economic rationality.

6.5.3.3 Internal assessment of construct and content validity

An internal assessment yielded many similar findings to those derived for the Sundays and Kromme River estuary cases – suggesting an acceptable match between theoretical requirement of the choice modelling objective and the information elicited by the questionnaire administered at the Nahoon River Estuary. However, one notable difference prevented such a conclusion from being drawn – one of the tests for multicollinearity was positive, suggesting that orthogonality of design may have been compromised. Attempts to correct for the problem were unsuccessful.

6.5.4 THE GONUBIE ESTUARY

6.5.4.1 Follow-up questions on the issue of validity of response

In the case of the Gonubie River Estuary, four follow-up questions regarding the respondent's experience of the choice exercise were asked, immediately after the choice task. These questions allowed for the assessment of the perceived complexity of the choice task. They also shed light on the degree of certainty by which the WTP bids and choices can be interpreted.

The first question in this section asked respondents' whether they found it difficult or easy to make the necessary choices (Question 4.1). Respondent answers to this question can indicate overall reliability of the choices made. Table 6.87 below shows the percentage breakdown of responses to this question.

Table 6.87: Respondents' view of choice complexity- Gonubie River Estuary

Complexity level	**Percentage**
Difficult	9
Easy	91

These responses indicate that choice complexity was not a problem for the majority of respondents. It is therefore possible to state with a fair level of certainty that respondents were not forced to adopt simplified decision rules due to a complex choice setting. Furthermore, the completion of the choice task was not considered too time-consuming.

The next question (Question 4.2) was only answered by those respondents who indicated that the choice task was difficult (in other words, those who answered 'Yes' to Question 4.1). Table 6.88 below displays the percentage breakdown of answer-options chosen.

Table 6.88: Reasons why the choice task was difficult – Gonubie River Estuary

Reason	**Percentage**
Could not relate	6
Too much information	28
Several factors important	50
Users should not pay	16
Total	**100**

Although the results of this question (Question 4.2) do not provide conclusive evidence of reliability of responses, they can be used to inform future CE studies with respect to CE interpretation. This question also investigates the issue of validity by considering percentages of respondents who chose the 'several factors (were) important' category. Approximately 50 percent of respondents, who found the task difficult, chose this option. This implies that these particular respondents followed a compensatory decision-making strategy when faced with the choice task[40].

Question 4.3 asked respondents to indicate which of the four attributes they had put greatest weight on when choosing between alternatives in the choice task. Two extra answer categories were given, namely 'varied between choices' and 'Don't know'. Table 6.89 shows the percentage breakdown of respondents for each category.

Table 6.89: Respondents' attribute weights – Gonubie River Estuary

Attribute	**Percent**
Water safety	42
Development along banks	8
Personal security	25
Size of payment	6
Varied between choices	17
Don't know	2
Total	**100**

This question can be used to identify the attributes that were considered most important when making choices. These attributes could potentially have been the focus of non-compensatory decision-making. The issue of water safety was clearly considered most important in the case of the Gonubie River Estuary.

Question 4.4 was a policy-orientated question, which asked the respondent whether they would increase their level of estuary usage if certain recreational estuarine attribute improvements were made. Table 6.90 provides a percentage breakdown of the responses to this question.

Table 6.90: Potential future estuary use – Gonubie River Estuary

Estuary use	**Percent**
Use the same	42
Use more often	58

6.5.4.2 Economic plausibility of response

The WTP estimates for the Gonubie River Estuary were consistent with the study's *a priori* expectations and conform to economic theory. All parameter estimates were significant at the 99 percent level, except for 'Naturalness' which was significant at the 95 percent level. An increase in the cost variable is associated with a decrease in overall welfare. The estimates calculated for the significant attributes are also

[40] See the discussion on compensatory decision-making in the Sundays River Estuary data analysis.

considered plausible, given that WTP is for marginal changes (EFTEC, 2002). Moreover, the results were consistent with economic rationality.

6.5.4.3 Internal assessment of construct and content validity

An internal assessment yielded many similar findings to those derived for the Sundays and Kromme River estuary cases – suggesting an acceptable match between theoretical requirement of the choice modelling objective and the information elicited by the questionnaire administered at the Gonubie River Estuary. However, one notable difference prevented such a conclusion from being drawn – one of the tests for multicollinearity was positive, suggesting that orthogonality of design may have been compromised. Attempts to correct for the problem were unsuccessful.

6.6 CONCLUSION

The results of the four case studies reported in this Chapter show how a profile of an estuary's recreational (demand influencing) attributes can be valued through an application of the CE method. The choice models generated were used to provide three estimates of value: implicit prices for the attributes that make up the recreational profiles, CS estimates that value changes in a single attribute, while holding constant all other attributes within the profile, and CS estimates for an improvement in all attributes contained in the profiles (combinations of attributes).

Validity assessments of the experimental designs yielded positive results at the Sundays and Kromme River estuaries, but tests for multicollinearity were positive for the Nahoon and Gonubie River estuaries.

The following deductions were drawn from the analysis:

- The high levels of fishing effort at the Sundays River Estuary could potentially be controlled through a suggested increase in the boat license fee. The size of an increase that would not decrease welfare was calculated as being R150.21 per user per annum.
- Boat congestion on the Sundays and Kromme River estuaries can be managed through the implementation of a supplementary tariff during peak periods only. This tariff represents the congestion cost, so the size of an increase that would not decrease welfare was calculated as being R33.04 and R302.20 per user per annum for the Sundays River and Kromme River Estuaries, respectively.
- An investment project to improve public access at the Sundays River Estuary may well be feasible. This project entails the development of a nature trail fronting the banks of the estuary. The marginal WTP for the implementation of this project is R33.16 per user per annum.

- In order to improve navigability on the Kromme River Estuary, the option of dredging may be welfare improving. Users' WTP to implement dredging operations was estimated at R436.75 per user per annum.
- The external cost imposed on others by the use of jet skis and wet bikes on the Kromme River Estuary, was estimated at R31.47 per user per annum, should be compared to the welfare gains associated with the use of jet skis and wet bikes on the estuary.
- The willingness of users to pay for improved safety and quality of water in the Nahoon and Gonubie River estuaries provides additional incentive and means for the responsible municipalities to undertake the required remedial actions.

CHAPTER SEVEN: SELECTED CONCLUSIONS AND RECOMMENDATIONS

7.1 CONCLUSION

South African estuaries face a variety of challenges, most of which are ultimately caused by demand pressure and open access. A RDM approach to managing them is currently very popular and supported by Law. However, the RDM approach is more suited to target setting for estuaries than it is to managing the causes of the problem – demand pressure and open access. Managing demand pressure for estuary inputs and services and containing 'tragedy of the commons' problems requires the appropriate economic instruments to be applied. When circumstances dictate that the management has to be through government regulation, prominent among these instruments is license fees. As this instrument can reduce social welfare and recreational value if improperly applied, it is important that its use be informed by adequate and appropriate analysis. CE analysis is well suited to this task.

This Report demonstrates at four estuaries how CE analysis can be applied to inform management of demand pressure. The information takes the form of advice on the setting of license fee increases that would not be expected to reduce social welfare. The estuaries are the Sundays, Kromme, Nahoon and Gonubie River estuaries. All the estuaries are common property resources, where there is ease of access and are largely administered by municipal authorities. Problems of multicollinearity were detected in the models of choice estimated for the Nahoon and Gonubie River estuaries. Given this problem, no license fee adjustments were calculated or proposed for the latter two estuaries. It was nevertheless noted that at the Gonubie and Nahoon River estuaries pollution through inadequate waste water management has undermined the recreational appeal of the estuaries, as has inadequate public protection against criminal activity and municipal neglect of recreational support services.

No serious validity concerns were detected with respect to the choice models estimated for the Sundays and Kromme River estuaries, and welfare improving license fee adjustments are calculated for managing demand problems identified at these estuaries (through focus group assessments).

The lower reaches of the Sundays River Estuary are highly developed. This estuary experiences high boat use during peak holiday seasons, and is also the victim of recreational over-fishing, particularly the dusky kob, white steenbras and spotted grunter (Whitfield, 2008; Cowley *et al.* 2009). The high level of boat congestion and lack of public access to the Sundays River Estuary affects its overall recreational appeal as a tourist destination.

The Kromme Estuary is freshwater starved (Baird, 2002). The development of two major dams on the Kromme River, as well as increased water abstraction upstream, have restricted water flows and caused increased sedimentation, and thus reduced navigability on the estuary. There has also been a significant increase in residential and visitor populations, and there has been concern expressed over whether the estuary's motorised craft carrying capacity is being exceeded. Another recreational disturbance to users of the Kromme River Estuary is jet skis and wet bikes. They are noisy and threaten the safety of other users.

The CE methodology facilitated a scientific assessment of these problems – the relevant objectives were unpacked as options (levels) and economic control variables (license fees and rates) were identified by which to pursue welfare improving modifications to public choices.

Three different choice model specifications were estimated for the estuaries: a CL model, a HEV model and a RPL model. In the case of the Sundays River Estuary, the results from the RPL, HEV and CL models (the magnitudes, signs and statistical significance of the coefficients) were similar. Allowing preferences for recreational attributes to vary across respondents showed that there was very little unexplained heterogeneity in respondent preferences. The random variables specified in the RPL indicated a demand to increase the physical size of fish stocks, for less boat congestion, and for increased public access. The attributes' implicit prices, or marginal WTP (MWTP), for the three model specifications are shown in Table 7.1.

Table 7.1: Implicit prices (MWTP) for attributes (Rands) and 95 percent confidence intervals (CI)* – Sundays River Estuary

Attributes	**CL**	**HEV****	**RPL**
	MWTP	**MWTP**	**MWTP**
Physical Size of Fish Stock	154 (109 - 200)	150	174 (95 – 253)
Congestion	-33 (-60 - -6)	-34	-35 (-62 - -8)
Public Access	33 (8 – 59)	33	34 (8 – 59)

** Confidence intervals in parentheses.*
*** Confidence intervals not calculated for HEV due to the presence of fixed parameters.*

The implicit prices indicate that respondents valued most highly increasing 'physical size of fish stock'. The differences in WTP among the three models were not very large, perhaps with the exception of that relating to increasing the 'physical size of fish stock'. The respective marginal WTP value for the RPL model is R174, as compared to the marginal WTP values of R154 and R150 respectively, for the CL and HEV models.

For the Kromme River Estuary, the RPL model indicated the presence of unobserved heterogeneity, but it failed to explain the sources of the heterogeneity (Adamowicz & Boxall, 2001). In this case, complete reliance was placed on the fixed mean and standard deviation of the parameter estimates, with the latter representing all sources of preference heterogeneity around the mean (Hensher *et al.* 2005). The attributes' implicit prices, or marginal WTP (MWTP), are shown in Table 7.2 below.

Table 7.2: Implicit prices (MWTP) for attributes (Rands)* and 95 percent confidence intervals (CI) – Kromme River Estuary**

Attributes	**CL**	**HEV*** **	**RPL Model 1**	**RPL Model 2**
	MWTP	**MWTP**	**MWTP**	**MWTP**
Navigability	437 (256 – 617)	450	586 (231 – 940)	692 (211 – 1173)
Congestion	-304 (-463 - -144)	-302	-483 (-842 - -124)	-576 (-1023 - -129)
Jet Skiing	-35 (-161 – 92)	-31	-37 (-69 – 143)	45.08 (-59 – 149)

**Please note that the estimated coefficient for the jet ski attribute was statistically insignificant for all four models estimated. Implicit prices were calculated to inform policy analysis.*
***Confidence intervals in parentheses.*
**** Confidence intervals not calculated for HEV due to the presence of fixed parameters.*

The sizes of the implicit prices indicated that respondents valued most highly improved 'navigability'. The differences in the WTP estimates among the four models are not particularly large, except for the WTP figures reported for the second RPL model estimated. These models are utilized to inform management of demand pressure on all the issues raised through the focus group phase of the CE method application.

7.1.1 MANAGING THE DEMAND FOR FISHING

The stocks of the fish targeted by recreational users in the Sundays River Estuary are over-exploited and face potential collapse. Most fishery management initiatives aim at controlling fishing effort levels through restricting access, implementing catch limits, and using transferable catch quotas. These initiatives relate to the management of a commercial fishery and not a recreational one. Management options are limited in the case of a recreational fishery and thus an alternative approach is proposed. In the case of an exploited recreational fishery, such as the Sundays River Estuary fishery, falling stock sizes, falling stock levels, and a decrease in overall fishing quality will not necessarily reduce the demand for angling licenses, as recreational fishing is driven by utility and not by revenue yield. In order to decrease fishing effort and restore stock levels, in the absence of revenue maximising behaviour by recreational anglers, some mechanism must be implemented to force anglers to decrease their demand for licenses per day, i.e. decrease quantity demanded. In order to get quantity demanded to drop to a point where harvest levels are at their maximum sustainable yield (MSY), the price i.e. the license fee structure will have to increase. The CE method indicates what type of increase would induce this demand trade-off (effort reduction) – the WTP for increased physical size of fish stocks was estimated to be R150 (at 2010 price levels) per annum.

7.1.2 MANAGING THE DEMAND FOR BOAT SPACE

Increased human recreational demand at any estuary does not necessarily reduce the recreational appeal of that estuary, but can lead to negative crowding effects, i.e. congestion externalities. This is the case for motorised boat use. Three options for reducing these externalities include: self-regulation through the internalisation of the costs of congestion, rationing through the use of a quota system, and rationing through the use of a pricing structure. Rationing boat use through the implementation of a quota or relying on self-regulation (automatic market resolution) were not considered viable options to reduce boat congestion (Field, 2001; Flaaten, 2010). Quotas can be difficult to implement due to practical considerations, and self-regulation will not work if one or a few of the boat users act selfishly and do not take other boat users into account (Field, 2001). The management option considered most feasible was the use of prices to ration use. The option of price rationing during congested time periods was reported in Chapter Three. The price adjustment proposed for both estuaries was to add a congestion cost (in the form of a supplementary tariff) to the existing boat license fee structure during peak use periods only.

In addition to the existing boat license fee, a supplementary tariff was estimated for the Sundays River Estuary through the application of a CE. The results reported in Chapter six showed that respondents were willing to trade-off an increase in costs of between R33 and R35 per annum to decrease boat congestion (from seeing and hearing lots of boats to seeing and hearing fewer boats). Congestion on the estuary occurs during the peak demand periods of the year. These costs need to be worked into the cost structure for the peak period only. In addition to the boat license fee of R94 per annum, there is a WTP for a once-off supplemental tariff of R33 (conservative estimate) covering the months from November to February.

In addition to the existing boat license fee, a supplementary tariff was estimated for the Kromme River Estuary through the application of a CE. The results reported in Chapter six showed that respondents were willing to trade-off decreased boat congestion (from seeing and hearing lots of boats to seeing and hearing fewer boats) with an increase in costs of between R302 and R576 per annum. It was deduced that, in addition to the boat license fee of R169 per annum, there is a WTP for a once-off supplementary tariff of R302 (conservative estimate) covering the months from November to February.

7.1.3 DEMAND FOR PUBLIC ACCESS

In their status quo assessment Afri-Coast Engineers (2004) argued that the introduction of a nature trail fronting the banks of the Sundays River Estuary would be an attractive complementary investment for both local residents and tourists. This investment would improve the recreational appeal of the estuary's banks and open up further areas for other recreational activities, such as bird watching and walking. The marginal WTP for an investment in a nature trail was estimated to be R33 per user per annum. As no project cost information was available for the development of this trail, it is unknown whether this project is efficient or not.

7.1.4 DEMAND FOR MORE USABLE BOAT SPACE

The level of navigability on the Kromme River Estuary is a negative function of the level of estuary sedimentation, *inter alia*. Two management options to improve navigability are: increasing freshwater inflows and dredging the main estuary channel. If the total mean annual run-off (105.5 million m^3 per annum) was made available to the estuary it probably would be navigable at any tide. This amount of run-off could possibly restore navigability to pre-settlement levels.

However, this option is unattractive because the demand value is higher than it is for the freshwater that flows into the estuary because of water abstracted upstream from the estuary. The water abstracted is used mainly for domestic and agricultural consumption. Two big storage dams located on the Kromme River are a physical testimony to this value.

A marginal WTP value of freshwater inflows was derived from the demand response to improving the level of navigability from its current state to a pre-settlement one (Chapter six). The marginal WTP value was estimated to be R437 per household per annum. Like the Sale (2007) study, the annual value of freshwater inflows per m^3 was estimated by dividing the product of the marginal WTP and the number of households (R437 x 3 200 = R1 398 400) by the required specified change in river water inflow (105.5 million m^3 – 11 000 m^3 = 105 489 000 per annum). It was calculated to equal R0.013 per m^3 per annum. Comparing this benefit estimate to the cost of the best alternative use of this freshwater forgone (R0.275 per m^3 charged by the Gamtoos Irrigation Board), shows that the marginal (and total) benefit of instream flow protection in the Kromme River Estuary is well below the marginal (and total) cost at every instream flow level.

These results are consistent with the findings of the Sale (2007) study, and point to a conclusion that allocations based on marginal cost probably do not safeguard the functionality of estuaries; notwithstanding the advocacy of this method by Hosking (2008), because, although recreational demand is increasing, so too is urban and agricultural demand. The marginal WTP value for improving the level of navigability from its current state to one closer to pre-settlement norms was estimated to be R437 per annum. With this amount of revenue, dredging operations in the main estuary channel seem likely to be more efficient than instream purchases, providing prawn and fish habitat damage is low.

7.1.5 DEMAND CONFLICTS BETWEEN JET SKI USERS AND OTHER USERS

There are individuals who believe that jet skis/wet bikes should have complete access to the Kromme River Estuary, yet there are others, however, who believe that these activities on the estuary should remain banned. Efforts have been made by concerned jet skiers and wet bikers to have the use of jet skis and wet bikes reinstated on the Kromme River Estuary. There is strong opposition to this course of action by individuals who believe that these jet-propelled water craft cause high levels of noise and are driven in a reckless manner that constitutes a safety hazard for other recreational users of the estuary. The CE results (Chapter six) showed that the ‘Jet Skiing’ variable’s coefficient was statistically insignificant and negative. This result reflects the existence of two opposing forces among the recreational users of the Kromme River Estuary – one group lobbying for jet ski and wet bike usage, and the other, lobbying to keep jet skis and wet bikes banned. Although this issue is a highly emotive one, the focus group discussions revealed that it was a major concern among recreational users, and thus warranted inclusion as an attribute in the CE. Focus groups comprised different membership organisations, as well as other interested parties, and were largely representative of the resident and visitor populations. The insignificant result does not imply that the CE method is incapable of handling conflicting issues, but rather indicates that the opposing groups are similar in terms of size and thus fairly equally represented in the collected data. In effect, the two opposing user groups’ preferences surrounding this issue have largely been cancelled out. The negative result could, however, indicate that recreational users have a slightly higher preference for a continued ban on all jet ski and wet bike activity on the estuary, i.e. the preferences of those opposed to jet skiing and wet biking marginally outweigh the preferences of those who wish for increased access. To this extent, the results of this study could support the theory that external costs are imposed by jet ski/wet bike users on other recreational users of the estuary. An alternative view on this result is that it shows CE analysis was unsuited to guiding the management of situations where there is *conflicting* demand as against *competing* demand, because in the former situation emotion gets in the way of making calculated trade-offs[41].

[41] The Research Team thanks the Reference Group for this insightful alternative interpretation of the findings.

Theoretically speaking, the negative estimated WTP implies that the external cost imposed on others (AB0 in Figure 3.9) exceeds the welfare gain ($p_s p_0$A in Figure 3.9). The CE estimate of this price (per capita WTP) is R31 per annum (conservative estimate). If this amount (R31) was added to the marginal private cost of motor boat access (p_p= R169), the socially efficient charge for jet ski/wet bike access would be a boat license fee of R200 (p_s in Figure 3.9). This analysis is subject to a major qualification: the WTP per user (implicit price) was derived from a statistically insignificant estimated coefficient for the jet ski/wet bike variable.

7.2 KEY MANAGEMENT RECOMMENDATIONS

No amount of estuary management advice generated will be useful if the laws and regulations set by municipalities and other government organizations are not enforced. At all four estuaries studied, there was found a degree of slackness in the way the municipalities approached enforcement. In the absence of effective enforcement and implementation, the problem of open access will most likely not be solvable through instruments of government. For this reason, a precondition for the success of the recommendations below is effective enforcement and implementation by the responsible government authorities.

Subject to this qualification, the following license fee adjustments and other recommendations are made.

- The boat license fee structure for the Sundays River Estuary be increased by R150 per annum (to decrease fishing effort).
- There be more effort put into increasing public awareness of the sustainability issues facing the Sundays River Estuary fishery.
- In addition to the standard boat license fee, a once-off per annum peak period supplementary tariff payable by peak period boat users, covering the months of November to February, should be implemented in order to discourage congestion during this peak period. The supplementary tariffs recommended for the Sundays River and Kromme River Estuaries respectively are R33 and R302 (2010 price levels).
- A cost-benefit analysis be conducted on the feasibility of, a nature trail fronting the banks of the Sundays River Estuary.

Adding together all the marginal WTP value adjustments (the overall additional levies) takes the overall levy up by:

- R183 per annum for boat users of the Sundays River Estuary, from R94 to R277 (2010 price levels).
- R739 per annum for boat users of the Kromme River Estuary, from R169 to R908 (2010 price levels).

The application of CEs to natural resource valuation, and specifically to valuing estuarine attributes, in South Africa is a recent development. There are examples of applying the CE method to value estuarine attributes, for example Oliver (2010), but they have design and estimation limitations. The results for the estuaries choice models which yielded valid estimates show that the process and output of the CE method can generate valuable and useful insights into managing demand pressure problems. This method to value estuarine attributes is its ability to "generate multiple value estimates from a single application" (Bennett & Blamey, 2001).

The particular advice generated and reported above for the Sundays and Kromme River estuaries cannot be extrapolated to all other estuaries because the situations of each estuary differ. However, this form of advice can readily be generated for other estuaries, and we do not entirely exclude the scope for benefit transfer. The scope for the latter exists between estuaries that have the same or some similar management issues, the same or some similar attributes and statistically similar user populations. If this method is applied elsewhere it should add significantly to the capacity to managing the problems caused by excess and competing recreational demand at the relevant estuaries, and greatly complement the advice being generated within the RDM inspired research framework.

The CE method, by its very nature, requires the identification of the demand problems, in the surveys forces recreational users to make trade-offs among estuarine attributes, and in the estimation process reveals which trade-offs are welfare improving. This information is vital in the context of management for maximizing welfare and recreational value.

For those that seek to replicate what we did above, several matters need to be carefully considered when applying this method. The researcher must pay special attention to the identification and definition of the attributes and their associated levels. In this regard, focus group discussions are a cornerstone (foundation) of the method. These groups play a major role in determining the number of alternatives per choice set and the number of attributes (and levels) per alternative during the experimental choice design phase. If the design and the resultant choice tasks are too complex, respondents could experience 'respondent fatigue' (Bennett & Blamey, 2001; Hanley *et al.* 2001) and the results of the experiment will merely reflect respondents resorting to simple decision rules. The design needs to be tested through robust focus group and pilot studies. A correctly specified section on "cheap talk" should be included in order to remind respondents of their other financial commitments (a budget constraint reminder). Perhaps the biggest challenge in applying a CE to value estuarine recreational attributes is the identification of an appropriate sample population (Smyth *et al.* 2009).

Notwithstanding the advantages of the method, it is not a generally preferred valuation method. Where revealed preference valuation lends itself to the objective one is seeking to value, it has the enormous advantage of being less susceptible to error induced through strategic behaviour, and when a particular environmental change is being valued, the CVM remains an attractive option, albeit even more prone to the distorting effects of strategic behaviour.

LIST OF REFERENCES

AADLUND, D. & CAPLAN, A.J. 2003. Willingness to pay for curbside recycling with detection and mitigation of hypothetical bias. *American Journal of Agricultural Economics,* 85(2): 492-502.

ABELSON, R.P. & LEVY, A. 1985. Decision making and decision theory. (*In* Lindzey, G. & Aronsom, E. (eds). *Handbook of Social Psychology 1*. New York: Random House. p. 231-309.)

ABOU-ALI, H. & CARLSSON, F. 2004. *Evaluating the Welfare Effects of Improved Water quality using the Choice Experiment Method.* Goteborg: Goteborg University (Working Paper in Economics, No. 131).

ADAMOWICZ, W., LOUVIERE, J. & WILLIAMS, M. 1994. Combining stated and revealed preference methods for valuing environmental amenities. *Journal of Environmental Economics and Management,* 26(3): 271-292.

ADAMOWICZ, W. 1995. Alternative valuation techniques: A comparison and movement to a synthesis. (*In* Willis, K.G. & Corkindale, J.T. (eds). *Environmental Valuation: New Perspectives*. New York: Cab International. p. 144-159.)

ADAMOWICZ, W., BOXALL, P., WILLIAMS, M. & LOUVIERE, J. 1998. Stated preference approaches for measuring passive use values: choice experiments and contingent valuation. *American Journal of Agricultural Economics,* 80(1): 64-75.

ADAMOWICZ, W. & BOXALL, P. 2001. *Choice Experiments: A New Approach to Environmental Valuation*. Paper presented at future directions of stated choice methods for environmental valuation conference: London, United Kingdom.

ADAMS, J.B., BATE, G.C. & O'CALLAGHAN, M. 1999. Primary producers: estuaries of South Africa. (*In* Allanson, B.R. & Baird, D. (eds). *Estuaries of South Africa*. Cambridge: Cambridge University Press. p. 91-118.)

AFRI-COAST ENGINEERS. 2004. *Colchester Status Quo Assessment Report*. Port Elizabeth: Nelson Mandela Metropolitan Municipality (Report No. P1577/01).

AKOTO, W. 2008. Valuing preferences for freshwater inflows into selected Western and Southern Cape Estuaries. Port Elizabeth: Nelson Mandela Metropolitan University. (MCom dissertation).

ALBERINI, A. & KAHN, R. 2006. *Handbook on Contingent Valuation.* Cheltenham: Edward Elgar Publishing.

ALLANSON, B.R. & BAIRD, D. 1999. *Estuaries of South Africa*. Cambridge: Cambridge University Press.

ALPIZAR, F., CARLSSON, F. & MARTINSSON, P. 2001. *Using Choice Experiments for Non-market Valuation*. Goteborg: Goteborg University (Working Paper in Economics, No. 52).

AMEMIYA, T. 1985. *Advanced Econometrics*. Cambridge: Harvard University Press.

ANDERSON, C.M. 2003. *Policy Implication of Alternative Economic Approaches to Population Heterogeneity in Stated Preference Surveys*. Paper presented at the American Agricultural Economics Association Meetings: United States of America.

ARROW, K.J., SOLOW, R., PORTNEY, P.R., LEAMER, E.E., RADNER, R. & SCHUMAN, H. 1993. Report of the National Oceanic and Atmospheric Administration (NOAA) panel on contingent valuation. *Federal Register*, 58(10): 4601-4614.

BAIRD, D., MARAIS, J.F. & BATE, G.C. 1992. *An Environmental Analysis for the Kromme River Area to Assist in the Preparation of Structure Plan*. Port Elizabeth: Institute for Coastal Research (Report No. C16).

BAIRD, D. & PEREYRA-LAGO, R. 1992. Nutrient status and water quality assessment of the Marina Glades canal system, Kromme Estuary, St. Francis Bay. *Water South Africa,* 18(1): 37-42.

BAIRD, D. 2002. *Estuaries of South Africa*. Port Elizabeth: University of Port Elizabeth.

BANZHAF, M.R., JOHNSON, F.R. & MATHEWS, K.E. 2001. Opt-out alternatives and anglers' stated preferences. (*In* Bennett, J. & Blamey, R. (eds). *The Choice Modelling Approach to Environmental Valuation*. Cheltenham: Edward Elgar Publishing. p. 157-177.)

BATEMAN, I.J., CARSON, R.T., DAY, B., HANEMANN, M., HANLEY, N., HETT, T., JONES-LEE, M., LOOMES, G., MOURATO, S., ÖZDEMIROGLU, E., PEARCE, D.W., SUGDEN, R. & SWANSON, J. 2002. *Economic Valuation with Stated Preference Techniques. A Manual*. Cheltenham: Edward Elgar Publishing.

BATEMAN, I.J., COLE, M.A., GEORGIOU, S. & HADLEY, D.J. 2005. Comparing contingent valuation and contingent ranking: A case study considering the benefits of urban river water quality improvements. *Journal of Environmental Management,* 79 (2006): 221-231.

BATSELL, R.R. & LOUVIERE, J.J. 1992. Experimental choice analysis. *Marketing Letters* 2(3): 199-214.

BEN-AKIVA, M. 1973. Structure of travel passenger demand models. Cambridge: Massachusetts Institute of Technology. (PhD thesis).

BEN-AKIVA, M. & LERMAN, S. 1985. *Discrete Choice Analysis: Theory and Application to Travel Demand*. Cambridge: MIT Press.

BEN-AKIVA, M., MCFADDEN, D., GARLING, T., GOPINATH, D., WALKER, J., BOLDUC, D. A., BORSCH-SUPAN, A., DELQUIE, P., LARICHEV, O., MORIKAWA, T., POLYDOROPOULOU, A. & RAO, V. 1999. Extended framework for modeling choice behaviour. *Marketing Letters,* 10(3): 187-203.

BENNETT, J. & ADAMOWICZ, W. 2001. Some fundamentals of environmental choice modelling. (*In* Bennett, J. & Blamey, R.K. (eds). *The Choice Modelling Approach to Environmental Valuation.* Cheltenham: Edward Elgar Publishing. p. 37-69.)

BENNETT, J. & BLAMEY, R. 2001. *The Choice Modelling Approach to Environmental Valuation*. Cheltenham: Edward Elgar Publishing.

BERKES, F. & FARRER, T.M. 1989. *Introduction and Overview – Common Property Resources: Ecology and Community-Based Sustainable Development.* London: Belhavan Press.

BHAT, C.R. 1995. A Heteroskedastic Extreme Value model of intercity travel mode choice. *Transportation Research B,* 29(6): 471-483.

BHAT, C.R. 1997. Accommodating flexible substitution patterns in multi-dimensional choice modeling: formulation and application to travel mode and departure time choice. *Transportation Research B,* 32(7): 455-466.

BHAT, C.R. 2000. Flexible model structures for discrete choice analysis. (*In* Hensher, D.A. & Button, K. J. (eds). *Handbook of Transport Modelling, Vol. 1: Handbooks in Transport*. Oxford: Pergamon Press. p. 71-90.)

BHAT, C. R. 2001. Quasi-random maximum simulated likelihood estimation of the mixed multinomial logit model. *Transportation Research B,* 35(7): 677-695.

BICKERTON, I.B. & PIERCE, S.M. 1988. Krom (CMS 45), Seekoei (CMS 46) and Kabeljous (CMS 47). (*In* Heydorn, A.E.F. & Morant, P.D. (eds). *Estuaries of the Cape Part II: Synopses of Available Information on Individual Systems.* Stellenbosch: CSIR Research Report No. 432.)

BIROL, E., KAROUSAKIS, K. & KOUNDOURI, P. 2006a. Using economic valuation techniques to inform water resources management: a survey and critical appraisal of available techniques and an application. *Science of the Total Environment,* 365: 105-122.

BIROL, E., KAROUSAKIS, K. & KOUNDOURI, P. 2006b. Using a choice experiment to account for preference heterogeneity in wetland attributes: the case of Cheimaditida wetland in Greece. *Ecological Economics,* 60(1): 145-156.

BLAMEY, R.K., BENNETT, J.W., LOUVIERE, J.J., MORRISON, M.D. & ROLFE, J. 2000. A test of policy labels in environmental choice modeling studies. *Ecological Economics,* 32(2): 269-286.

BLAMEY, R.K., ROLFE, J.C., BENNETT, J.W. & MORRISON, M.D. 1997. *Environmental Choice Modelling: Issues and Qualitative Insights*. Australia: The University of New South Wales (Research Report No.4).

BOCCARA, B. 1989. Modeling choice set formation in discrete choice models. Cambridge: Massachusetts Institute of Technology. (PhD thesis).

BOXALL, P.C., ADAMOWICZ, W., SWAIT, J., WILLIAMS, M. & LOUVIERE, J. 1996. A comparison of stated preference methods for environmental valuation. *Ecological Economics,* 18(3): 243-253.

BREEN, C. & MCKENZIE, M. 2001. *Managing Estuaries in South Africa*. Durban: Institute of Natural Resources.

BROMLEY, D.W. 1991. *Environment and Economy: Property Rights and Public Policy.* Oxford: Oxford University Press.

CAMERON, A.C. & TRIVEDI, P.K. 2005. *Microeconometrics: Methods and Applications*. New York: Cambridge University Press.

CARLSSON, F., FRYKBLOM, P. & LILJENSTOLPE, C-J. 2003. Valuing wetland attributes: an application of choice experiments. *Ecological Economics,* 47(1): 95-103.

CARLSSON, F. & MARTINSSON, P. 2003. Design techniques for stated preference methods in health economics. *Health Economics,* 12(4): 281-294.

CARLSSON, F., FRYKBLOM, P. & LAGERKVIST, C-J. 2004. *Using Cheap-talk as a Test of Validity in Choice Experiments*. Goteborg: Goteborg University (Working Papers in Economics, No. 128).

CARLSSON, F. & MARTINSSON, P. 2006. *Do Experience and Cheap Talk Influence Willingness to Pay in an Open-ended Contingent Valuation Survey?* Goteborg: Goteborg University (Working Papers in Economics, No. 190).

CARSON, R. & MITCHELL, R.C. 1993. The issue of scope in contingent valuation studies. *American Journal of Agricultural Economics*, 75(5): 1263-1267.

CARSON, R., HANEMANN, W.M., KOPP, R.J., KROSNICK, J.A., MITCHELL, R.C., PRESSER, S., RUUD, P.A. & SMITH, V.K. 1997. Temporal reliability of estimates from contingent valuation. *Land Economics*, 73(2): 151-163.

CARSON, R.T., FLORES, N.E. & MEADE, N.F. 2001. Contingent valuation: controversies and evidence. *Environmental and Resource Economics*, 19(2): 173-210.

CENTRE FOR INTERNATIONAL ECONOMICS (CIE). 2001. *Review of Willingness to Pay Methodologies*. [Online]. Available: www.ipart.nsw.giv.au/PDF/CIE.pdf. [20 February 2010]

CHAMP, P.A. 2003. Collecting survey data for non-market valuation. (*In* Champ, P.A., Boyle, K.J. & Brown, T.C. (eds). *A Primer on Non-Market Valuation.* London: Kluwer Academic publishing. p. 59-98.)

CHANDLER, G. 2011. Unpublished data. Collected at the Nahoon River Estuary (September 2010-March 2011) and the Gonubie River Estuary (January-June 2011).

CHEGE, J. 2009. Valuing preferences for freshwater inflows into five Eastern Cape and Kwazulu-Natal estuaries. Port Elizabeth: Nelson Mandela Metropolitan University. (MA dissertation).

CHOPRA, K., KADEKODI, C. & MURTHY, M. 1989. People’s participation and common property resources. *Economic and Political Weekly,* 24 (A):189-195.

COETZEE, J.C., ADAMS, J.B. & BATE, G.C. 1997. A botanical importance rating of selected Cape estuaries. *Water SA*, 23: 81-93.

COLLOTY, B.M. 2000. Botanical importance of estuaries of the former Ciskei/Transkei region. Port Elizabeth: University of Port Elizabeth. (PhD thesis).

COOPER, J.A.G. 1993. *An Evaluation of the Aesthetic Health Index: A Component of the Estuarine Health Index*. Pretoria: CSIR Research Report.

COOPER, J.A.G., RAMM, A.E.L. & HARRISON, T.D. 1994. The estuarine health index: a new approach to scientific information transfer. *Ocean and Coastal Management,* 25: 103-141.

COSTANZA, R., D'ARGE, R., DE GROOT, R., FARBER, S., GRASSO, M., HANNON, B., LIMBURG, K., NAEEM, S., O'NEILL, R.V., PARUELO, J., RASKIN, R.G., SUTTON, P. & VAN DEN BELT, M. 1997. The value of the world's ecosystem services and natural capital. *The Nature Journal,* 387: 253-260.

COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH (CSIR). 1987. *Basic Physical Geography/Hydro Data for Cape Southeast 'Estuaries'.* Stellenbosch: NRIO Data Report D8703.

COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH (CSIR). 2004. *Eastern Cape State of the Environment Report*. Durban: CSIR Division of Water, Environment and Forestry Technology.

COWLEY, P.D., CHILDS, A-R. & BENNETT, R.H. 2009. *A Survey of Fishery Resource Utilization and Recreational Activities on the Sundays Estuary, With Implications for Management*. Grahamstown: South African Institute for Aquatic Biodiversity (World Wildlife Fund – South Africa Report).

CUMMINGS, R.G. & TAYLOR, L.O. 1999: Unbiased value estimates for environmental goods: A cheap talk design for the contingent valuation method. *American Economic Review*, 89(3): 649-665.

DAY, J.H. 1980. What is an estuary? *South African Journal of Science,* 76: 198.

DEMSETZ, H. 1967. Towards a theory of property rights. *American Economic Review,* 52 (2): 347- 379.

DEPARTMENT OF WATER AFFAIRS AND FORESTRY (DWAF). 2003. *Overview of Water Resources: Availability and Utilization*. (*Prepared by* Basson, M.S. & Rossouw, J.D (Pty) Ltd, on behalf of the Directorate: National Water Research Planning. Department of Water Affairs and Forestry Report No. P WMA 1/000/00/0203 – P WMA 19/000/00/0203.)

DEPARTMENT OF WATER AFFAIRS AND FORESTRY (DWAF). 2004. *Internal Strategic Perspective: Amatole to Kei Water Management Area*. (*Prepared by* Tlou & Matji (Pty) Ltd, WRP (Pty) Ltd, and DMM (cc) on behalf of the Directorate: National Water Research Planning (East). Department of Water Affairs and Forestry Report No. P WMA 12/000/00/0404.)

DEPARTMENT OF WATER AFFAIRS (DWA). 2010. *Resource Directed Measures for Protection of Water Resources: Methods for the Determination of the Ecological Reserve for Estuaries.* Pretoria: Water Resource Protection and Assessment Policy Implementation Process, Volume 3.

DEPARTMENT OF WATER AND ENVIRONMENTAL AFFAIRS (WEA). 2012. *Draft National Estuarine Management Protocol.* Pretoria: Department of Water and Environmental Affairs, Oceans and Coasts. Government Gazette no. 336.

DESHAZO, J.R. & FERMO, G. 2002. Designing choice sets for stated preference methods: the effects of complexity on choice consistency. *Journal of Environmental Economics and Management*, 44(1): 123-143.

DESVOUSGES, W.H., JOHNSON, F.R., DUNFORD, R.W., BOYLE, K.J., HUDSON, S.P. & WILSON, K.N. 1993. Measuring natural resource damages with contingent valuation: tests of validity and reliability. (*In* Hausman, J.A. (ed). *Contingent Valuation: A Critical Assessment*. *Contributions to Economic Analysis,* (220). Amsterdam: Emerald Group Publishing Limited. p. 91-164.)

DHAR, R. & SIMONSON, I. 2001. *The Effect of Forced Choice on Choice*. United States: Yale University (Working Paper).

DIKGANG, J. 2007. A comparison of the values of water inflows into selected South African Estuaries: the Heuningnes, Kleinmond, Klein, Palmiet, Cefane, Kwelera and Haga Haga. Port Elizabeth: Nelson Mandela Metropolitan University. (MCom dissertation).

DILLMAN, D.A., SMYTH, J.D. & CHRISTIAN, L-M. 2009. *Internet, Mail and Mixed-Mode Surveys: The Tailored Design Method.* New Jersey: Wiley and Sons.

DOLLAR, E.S.J., BROWN, C.A., TURPIE, J.K., JOUBERT, A.R., NICOLSON, C.R. & MANYAKA, S. 2006. *The Development of the Water Resource Classification System (WRCS). Volume 1: Overview and 7-step Classification Procedure.* Pretoria: CSIR, Department of Water Affairs and Forestry.

ECONOMICS FOR THE ENVIRONMENT CONSULTANCY LTD (EFTEC). 2002. *Valuation of Benefits to England and Wales of a Revised Bathing Water Quality Directive and Other Beach Characteristics Using the Choice Experiment Methodology*. London: EFTEC (Report to the Department for Environment, Food and Rural Affairs).

EGGERT, H. & OLSSON, B. 2004. *Heterogenous Preferences for Marine Amenities: A Choice Experiment Applied to Water Quality*. Goteborg: Goteborg University (Department of Economics Working Papers in Economics Series, No. 126).

EMMERSON, W.D. 1989. The nutrient status of the Sundays River estuary, South Africa. *Water Research,* 23(8): 1059-1067.

ENVIRONMENTAL EVALUATION UNIT (EEU). 1986. *Recreational Management Plan for the Kromme River, St Francis Bay*. Cape Town: EEU (Draft Report).

ENGEL, J.F. & BLACKWELL, R.D. 1982. *Consumer Behaviour.* 4th ed., New York: The Dryden Press.

ENGEL, J.F., BLACKWELL, R.D. & MINIARD. P.W. 1995. *Consumer Behaviour.* 8th ed., New York: The Dryden Press.

FENNY, D., BERKES, F., McCAY, B.J. & ACHESON, J.M. 1998. The tragedy of the commons: Twenty-two years later. (*In* Baden, J. & Noonan, D. (Eds). *Managing the Commons.* Indiana: Indiana University Press.)

FIELD, B.C. 2001. *Natural Resource Economics: An Introduction.* New York: McGraw-Hill Publishers.

FLAATEN, O. 2010. *Fisheries Economics and Management.* Norway: The Norwegian College of Fishery Science, University of Tromso.

FORBES, V.R. 1998. Recreational and resource utilization of Eastern Cape estuaries and development towards a management strategy. Port Elizabeth: University of Port Elizabeth. (MSc dissertation).

FORBES, V.R. & WOOLDRIDGE, T.H. 1999. *Management Recommendations for Recreational Activity on Eastern Cape Estuaries*. Port Elizabeth: ICR.

FOSTER, V. & MOURATO, S. 1999. *Elicitation Format and Part-whole Bias: Do Contingent Valuation and Contingent Ranking Give the Same Result?* London: CSERGE (Working Paper No. GEC 99 – 17).

FOSTER, V. & MOURATO, S. 2000. Valuing the multiple impacts of pesticide use in the United Kingdom: A contingent ranking approach. *Journal of Agricultural Economics*, 51(1): 1-21.

GAN, C. & LUZAR, E.J. 1993. A conjoint analysis of waterfowl hunting in Louisiana. *Journal of Agricultural and Applied Economics*, 25(2): 36-45.

GARROD, G. & WILLIS, K.G. 1998. Using contingent ranking to estimate the loss of amenity value for inland waterways from public utility service structures. *Environmental and Resource Economics*, 12(2): 241-247.

GARROD, G. & WILLIS, K.G. 1999. *Economic Valuation of the Environment. Methods and Case Studies.* Cheltenham: Edward Elgar Publishing.

GOPINATH, D.A. 1995. Modeling heterogeneity in discrete choice processes: application to travel demand. Cambridge: Massachusetts Institute of Technology. (PhD Dissertation).

GREEN, P. 1984. Hybrid models for conjoint analysis: An expository review. *Journal of Marketing Research*, 21: 155-169.

GREEN, P.E. & SRINIVASAN, V. 1978. Conjoint analysis in consumer research: Issues
and outlook. *Journal of Consumer Research*, 5: 103-123.

GREENE, W.H. 1997. *Econometric Analysis*. 3rd ed. New Jersey: Prentice Hall.

GREENE, W.H. 2000. *Econometric Analysis.* 4th ed. New Jersey: Prentice Hall.

GREENE, W.H. 2007. *NLOGIT: Version 4.0, User manual*. New York: Econometric Software, Inc.

GRIFFITHS, M.H. 1997. Management of the South African dusky kob *Argyrosomus japonicas* (Sciaenidae) based on per-recruit models. *South African Journal of Marine Science*, 18: 213-228.

HAAB, T.C. & MCCONNELL, K.E. 2002. *Valuing Environmental and Natural Resources: The Econometrics of Non-Market Valuation*. Cheltenham: Edward Elgar Publishing.

HAIR, J.F., BLACK, W.C., BABIN, B.J. & ANDERSON, R.E. 2010. *Multivariate Data Analysis*. 7th ed. New Jersey: Prentice Hall.

HANEMANN, W.M. 1984. Discrete/continuous models of consumer demand. *Econometrica,* 52(3): 541-561.

HANEMANN, W.J. 1994. Valuing the environment through contingent valuation. *Journal of Economic Perspectives,* 8(4): 19-43.

HANEMANN, M. 1996. Theory versus data in the contingent valuation debate. (*In* Bjornstad, D.J. & Kahn, J.R. (eds). *The Contingent Valuation of Environmental Resources.* Brookfield: Edward Elgar Publishing. p. 38-60.)

HANLEY, N., MACMILLAN, D., WRIGHT, R., BULLOCK, C., SIMPSON, I., PARRISON, D. & CRABTREE, B. 1998a. Contingent valuation versus choice experiments: Estimating the benefits of environmentally sensitive areas in Scotland. *Journal of Agricultural Economics*, 1(15): 1-15.

HANLEY, N., WRIGHT, R.E. & ADAMOWICZ, W. 1998b. Using choice experiments to value the environment: Design issues, current experience and future prospects. *Environmental and Resource Economics*, 11(3-4): 413-428.

HANLEY, N.D., MOURATO, S. & WRIGHT, R.E. 2001. Choice modelling approaches: A superior alternative for environmental valuation? *Journal of Economic Surveys*, 15(3): 435-462.

HANLEY, N., ADAMOWICZ, W. & WRIGHT, R. 2002. *Do Choice Experiments Pass the Scope Test? A Test of Scope Experiment Examining the Benefits of Water Quality Improvements*. Paper presented at the EAERE/AERE World Congress: Monterey, California.

HANLEY, N., WRIGHT, R.E. & KOOP, G. 2002. Modelling recreation demand using choice experiments: Climbing in Scotland. *Environmental and Resource Economics,* 22(3): 449-466.

HANLEY, N., BERGMANN, A. & WRIGHT, R. 2004. *Valuing the Attributes of Renewable Energy Investments in Scotland*. Stirling: University of Stirling.

HANLEY, N., WRIGHT, R. & ALVAREZ-FARIZO, B. 2006. Estimating the economic value of improvements in river ecology using choice experiments: an application to the water framework directive. *Journal of Environmental Management,* 78(2): 183-193.

HARDIN, G. 1968. The Tragedy of the Commons. *Science*, 162.

HARRISON, T.D., COOPER, J.A.G. & RAMM, A.E.L. 2000. *State of South African Estuaries: Geomorphology, Ichthyofauna, Water Quality and Aesthetics*. Pretoria: Department of Environmental Affairs and Tourism (State of the Environment Series, Report No. 2).

HARRISON, T.D. & WHITFIELD, A.K. 2006. Application of a multimetric fish index to assess the environmental condition of South African estuaries. *Estuaries and Coasts*, 29: 1108-1120.

HASLER, B., LUNDHEDE, T., MARTINSEN, L., NEYE, S. & SCHOU, S.J. 2005. *Valuation of Groundwater Protection Versus Water Treatment in Denmark by Choice Experiments and Contingent Valuation*. Denmark: National Environmental Research Institute. NERI Technical Report No 543. [Online]. Available: http://technical-reports.dmu.dk. [15 February 2010]

HATTINGH, R., WHITFIELD, A., VAN DRIEL, D., ARCHIBALD, C., HAY, D., BATE, G. & SCHUMANN, E. 2002. *Consortium for Estuarine Research and Management (CERM) Research Priorities*. [Online]. Available: www.upe.ac.za/cerm/cerm6.html [17 August 2010]

HAY, D., HOSKING, S.G., & MCKENZIE, M. 2008. *Estuaries, Economics and Freshwater: An Introduction*. Pretoria: Water Research Commission.

HEBERLING, M., SHORTLE, J. & FISHER, A. 2000. *The Effect of the Number of Choice Sets on Responses in a Stated Choice Survey*. Paper presented at the American Agricultural Economics Association Annual Meeting: Miami, Florida.

HENSHER, D.A. & JOHNSON, L.W. 1981. *Applied Discrete Choice Modelling*. New York: Wiley & Son Publishing.

HENSHER, D. & GREENE, W.H. 2002. *The Mixed Logit Model: The State of Practice and Warnings for the Unwary*. Sydney: University of Sydney (Institute of Transportation Studies Working Paper, No 01-02).

HENSHER, D., ROSE, J.M. & GREENE, W.H. 2005. *Applied Choice Analysis: A Primer*. Cambridge: Cambridge University Press.

HEYDORN, A.E.F. 1972. *An Assessment of the State of the Estuaries of the Cape and Natal in 1972/73*. Pretoria: CSIR.

HEYMANS, J. 1992. Energy flow model and network analysis of the Kromme Estuary, St. Francis Bay, South Africa. Port Elizabeth: University of Port Elizabeth. (MSc dissertation).

HOLMES, T. & ADAMOWICZ, W. 2003. Attribute based methods. (*In* Champ, P., Brown, T. & Boyle, K. (eds). *A Primer on the Economic Valuation of the Environment*. London: Kluwer Academic publishing. p. 171-219.)

HOSKING, S.G., WOOLDRIDGE, T. H., DIMOPOULOS, G., MLANGENI M., LIN, C-H., SALE, M. & DU PREEZ, M. 2004. *The Valuation of Changes to Estuary Services in South Africa as a Result of Changes to Freshwater Inflow*. Pretoria: Water Research Commission (Report No. 1304/1/04).

HOSKING, S.G. 2008. An economic approach to allocating river water to estuaries in South Africa. *Coastal Management,* 36: 35-46.

HOSKING, S.G. 2011. Estuaries: in the eye of the storm. *Water South Africa* (forthcoming).

HOWARD, J.A. & SHETH, J.N. 1969. *The Theory of Buyer Behaviour*. New York: Wiley and Sons Publishing.

HOWARD, J.A. 1977. *Consumer Behaviour: Application of Theory*. New York: McGraw-Hill Publishing.

HOWARD, J.A. 1989. *Consumer Behaviour in Marketing Strategy*. New Jersey: Prentice Hall.

HUBER, J. & ZWERINA, K. 1996. The importance of utility balance in efficient choice designs. *Journal of Marketing Research,* 33(3): 307-317.

JOHNSON, O.E.G. 1972. Economic analysis, the legal framework and land tenure systems. *Journal of Law and Economics,* 15: 259-276.

KAHN, J.R. 1998. *The Economic Approach to Environmental and Natural Resources.* 2nd ed. New York: The Dryden Press.

KAHNEMANN, D. & KNETSCH, J.L. 1992. Valuing public goods: The purchase of moral satisfaction. *Journal of Environmental Economics and Management*, 22(1): 57-70.

KINNEAR, T.C. & TAYLOR, J.R. 1991. *Marketing Research: An Applied Approach.* 4th ed. New York: McGraw-Hill Publishing.

KLEIN, L.R. 1962. *An Introduction to Econometrics*. New Jersey: Prentice-Hall.

KONTOLEON, A. & YABE, M. 2003. Assessing the impacts of alternative 'opt-out' formats in choice experiment studies: Consumer preferences for genetically modified content and production information in food. *Journal of Agricultural Policy Research*, 5: 1-43.

KRAGT, M.E., BENNETT, J., LLOYD, C. & DUMSDAY, R. 2007. *Comparing Choice Models of River Health Improvement for the Goulburn River*. Paper presented at the 51th Conference of the Australian Agricultural and Resource Economics Society: Queenstown, Australia.

KRAGT, M.E. & BENNETT, J.W. 2008. *Developing a Questionnaire for Valuing Changes in Natural Resource Management in the George catchment, Tasmania*. Canberra: Australian National University (Environmental Economics Research Hub Research Report No. 8).

KRAGT, M.E. & BENNETT, J.W. 2009. *Using Choice Experiments to Value River and Estuary Health in Tasmania with Individual Preference Heterogeneity*. Canberra: Australian National University (Environmental Economics Research Hub Research Report No. 0916).

KRINSKY, I. & ROBB, A. 1986. On approximating the statistical properties of elasticities. *Review of Economics and Statistics*, 68: 715-719.

KUHFELD, W.F., TOBIAS, R.D. & GARRATT, M. 2004. Efficient experimental design with marketing research applications. (*In* Kuhfeld, W. F. (ed). *Marketing Research Methods in SAS. Experimental Design, Choice, Conjoint, and Graphical Techniques*. Cary: SAS Institute Incorporated. p. 69-90.)

LAMBERTH, S. & TURPIE, J. 2003. *The Role of Estuaries in South African Fisheries: Economic Importance and Management Implications*. Pretoria: Water Research Commission.

LANCASTER, K. 1966. A new approach to consumer theory. *Journal of Political Economy*, 74(2): 132-157.

LAYTON, D. 2000. Random coefficient models for stated preference surveys. *Journal of Environmental Economics and Management*, 40(1): 21-36.

LEE, C.K. & HAN, S.Y. 2002. Estimating the use and preservation values of national parks' tourism resources using a contingent valuation method. *Tourism Management,* 23(5): 531-540.

LEE, D.E. 2011. Unpublished data. Collected at the Sundays River Estuary (August 2010- January 2011) and the Kromme River Estuary (December 2010-March 2011).

LIST, J.A. 2001. Do explicit warnings eliminate the hypothetical bias in elicitation procedures? Evidence from field auctions for sports cards. *American Economic Review,* 91(5): 1498-1507.

LIST, J.A., SINHA, P. & TAYLOR, M.H. 2006. Using choice experiments to value non-market goods and services: evidence from field experiments. *Advances in Economic Analysis and Policy,* 6(2): 1-39.

LOOMIS, J.B. 1989. Test-retest reliability of the contingent valuation method: a comparison of general population and visitor responses. *American Journal of Agricultural Economics,* 71(1): 76-84.

LOOMIS, J.B. 1998. Estimating the public values for instream flow: Economic techniques and dollar values. *Journal of the American Water Resources Association,* 34(5): 1007-1014.

LOTZE, H.K., LENIHAN, H.S., BOURQUE, B.J., BRADBURY, R.H., COOKE, R.G., KAY, M.C., KIDWELL, S.M., KIRBY, M.X., PETERSON, C.H. & JACKSON, J.B.C. 2006. Depletion, degradation, and recovery potential of estuaries and coastal seas. *Science Magazine,* 312(5781): 1806-1809.

LOUVIERE, J. & HENSHER, D.A. 1983. Using discrete choice models with experimental design data to forecast consumer demand for a unique cultural event. *Journal of Consumer Research,* 10(3): 348-361.

LOUVIERE, J.J. 1988. Conjoint analysis modelling of stated preferences: A review of theory, methods, recent developments and external validity. *Journal of Transport Economics and Policy,* 22(1): 93-119.

LOUVIERE, J.J., HENSHER, D.A. & SWAIT, J.D. 2000. *Stated Choice Methods: Analysis and Application*. Cambridge: Cambridge University Press.

LUCE, D. 1959. *Individual Choice Behaviour*. New York: Wiley & Son Publishing.

LUISETTI, T., TURNER, K. & BATEMAN, I. 2008. *An Ecosystem Services Approach to Assess Managed Realignment Coastal Policy in England*. London: CSERGE (Working Paper ECM – 0804).

MACKAY, H.M. & SCHUMANN, E.H. 1990. Mixing and circulation in the Sundays River Estuary, South Africa. *Estuarine Coastal Shelf Sciences,* 31(2): 203-216.

MACDONALD, D.H., BARNES, M., BENNETT, J., MORRISON, M. & YOUNG, M.D. 2005. Using a choice modelling approach for customer services standards in urban water. *Journal of the American Water Resources Association,* 41(3): 719-728.

MACMILLAN, D.G., DUFF, E. & ELSTON, D.A. 2001. Modelling the nonmarket environmental costs and benefits of biodiversity projects using contingent valuation data. *Environmental and Resource Economics,* 18(4): 391-410.

MALLAWAARACHCHI, T., BLAMEY, R.K., MORRISON, M.D., JOHNSON, A.K.L. & BENNETT, J.W. 2001. Community values for environmental protection in a cane farming catchment in Northern Australia: A choice modelling study. *Journal of Environmental Management,* 62(2): 301-316.

MANGHAM, L.J., HANSON, K. & MCPAKE, B. 2009. How to do (or not to do)… Designing a choice experiment for application in a low-income country. *Health Policy and Planning,* 24(2): 151-158.

MANSKI, C. 1977. The structure of random utility models. *Theory and Decision,* 8(3): 229-254.

MARSCHAK, J. 1960. *Binary Choice Constraints on Random Utility Indicators*. Paper presented at the Stanford Symposium on Mathematical Methods in the Social Sciences: Stanford, Stanford University Press.

MCFADDEN, D. 1974. Conditional logit analysis of qualitative choice behaviour. (*In* Zarembka, P. (ed). *Frontiers in Econometrics*, New York: Academic Press. p. 105-142.)

MCFADDEN, D. 1981. Econometric models for probabilistic choice. (*In* Manski, C. & McFadden, D. (eds). *Structural Analysis of Discrete Data with Econometric Applications.* Harvard: Harvard University Press. p. 198-272.)

MCFADDEN, D. 1984. Econometric analysis of qualitative response models. (*In* Griliches, Z. & Intriligator, M.D. (eds). *Handbook of Econometrics II.* New York: Elsevier Science Publishers. p. 1395-1457.)

MCFADDEN, D. 1986. The choice theory approach to marketing research. *Marketing Science,* 5(4): 275-297.

MCFADDEN, D. & TRAIN, K. 2000. Mixed MNL models for discrete response. *Journal of Applied Econometrics,* 15(5): 447-470.

MITCHELL, R.C. & CARSON, R.T. 1989. *Using Surveys to Value Public Goods: The Contingent Valuation Method.* Washington D.C.: Resources for the Future.

MORRISON, M.D., BENNETT, J.W. & BLAMEY, R.K. 1997. *Designing Choice Modelling Questionnaire Using Focus Groups: Results from the Macquarie Marshes and Gwydir Wetlands Case Studies*. Sydney: The University of New South Wales (Choice Modelling Research Report No. 5).

MORRISON, M. & BENNETT, J. 2004. Valuing New South Wales rivers for use in benefit transfer. *The Australian Journal of Agricultural and Resource Economics,* 48(4): 591-611.

MURPHY, J.J., STEVENS, T. & WEATHERHEAD, D. 2003. *An Empirical Study of Hypothetical Bias in Voluntary Contribution Contingent Valuation: Does Cheap Talk Matter?* Amherst: University of Massachusetts (Working Paper No. 2003-2).

MURRAY, A. 2011. [Personal communication]. 10 July.

NAM DO, N.T. & BENNETT, J. 2007. *Estimating Wetland Biodiversity Values: A Choice Modelling Application in Vietnam's Mekong River Delta*. Canberra: The Australian National University (Economics and Environmental Network Working Paper No. EEN0704).

NATIONAL ENVIRONMENTAL MANAGEMENT: INTEGRATED COASTAL MANAGEMENT ACT (ICMA). 2008. *Act Number 24 of 2008.* Pretoria: Department of Water and Environmental Affairs – Government printers.

NATIONAL WATER ACT (NWA). 1998. *Act Number 36 of 1998.* Pretoria: Department of Water Affairs and Forestry – Government printers.

NATURAL RESOURCE DAMAGE ASSESSMENT, INC. (NRDA). 1994. *Prospective Interim Lost Use Value Due to PCB and DDT Contamination in the Southern California Bight*. La Jolla: California (A Report of Natural Resource Damage Assessment, Inc. and Industrial Economics, Inc. to the National Oceanic and Atmospheric Administration, Task Order 56-DGNC-3-50070 of NOAA Contract No. 50-DGNC-1-00007, Volume 1).

NUNES, P.A.L.D. & VAN DEN BERGH, J.C.J.M. 2001. Economic valuation of biodiversity: sense or nonsense? *Ecological Economics*, 39(2): 203-222.

NYABOGA, D. 2011. Valuing preferences for freshwater inflows into the Gqunube, St. Lucia and Uilkraalsmond Estuaries. Port Elizabeth: Nelson Mandela Metropolitan University. (MCom dissertation).

OLIVER, C. 2010. Comparing a contingent valuation of the river inflows into the Bushmans estuary with a choice experiment valuation. Port Elizabeth. Nelson Mandela Metropolitan University. (MSc dissertation).

OPALUCH, J., GRIGALUNAS, T., DIAMANTIDES, J., MAZZOTTA, M. & JOHNSTON, R. 1999. *Recreational and Resource Non-market Values for the Peconic Estuary System*. Peacedale, RI: Economic Analysis Inc.

POE, G.L., CLARK, J.E., RONDEAU, D. & SCHULZE, W.D. 2002. Provision point mechanisms and field validity tests of contingent valuation. *Environmental and Resource Economics,* 23(1): 105-131.

PORTNEY, P.R. 1994. The contingent valuation debate: Why economists should care. *Journal of Economic Perspectives,* 8(4): 3-17.

PRITCHARD, D. W. 1967. What is an estuary, physical viewpoint. (*In* Lauf, G.F. (ed). *Estuaries.* Washington D.C: American Association for the Advancement of Science, Publication No. 83. p. 3-5.)

QIN, P. 2008. *Forestland Reform in China: What Do the Farmers Want? A Choice Experiment on Farmers' Property Rights Preferences*. Beijing: China (Environment for Development Discussion Paper No. 08 – 35).

RED CAP INVESTMENTS (RCI). 2010. *Economic Impact Assessment for a Wind Farm in the Kouga Local Municipality*. Port Elizabeth: Rand International Capital.

REDDERING, J.S.V. & ESTERHUYSEN, K. 1981. *Sedimentation in the Sundays Estuary*. Port Elizabeth: University of Port Elizabeth (ROSIE Report No. 3).

REDDERING, J.S.V. & ESTERHUYSEN, K. 1983. *Sedimentation in the Kromme Estuary*. Port Elizabeth: University of Port Elizabeth (ROSIE Report No. 6).

REDDERING, J.S.V. & ESTERHUYSEN, K. 1986. The sedimentary nature of three East London estuaries. (*In* Wooldridge, T.H. (Ed.) *East London Programme – Final Report*. Institute for Coastal Research, Report No. 7. Port Elizabeth: University of Port Elizabeth.)

REDDERING, J.S.V. & ESTERHUYSEN, K. 1987. The effects of river floods on sediment dispersal in small estuaries: a case study from East London. *South African Journal of Geology,* 90: 458-470.

REVELT, D. & TRAIN, K. 1998. Mixed logit with repeated choices: Households' choice of appliance efficiency level. *Review of Economics and Statistics,* 80(4): 647-657.

ROSEN, S. 1974. Hedonic prices and implicit markets: product differentiation in pure competition. *Journal of Political Economy,* 82(1): 34-55.

RYAN, M., BATE, A., EASTMOND, C.J. & LUDBROOK, A. 2001. Use of discrete choice experiments to elicit preferences. *Quality in Health Care,* 10(Suppl I): i55- i60.

SALE, M.C. 2007. The value of freshwater inflows into the Kowie, Kromme and Nahoon estuaries. Port Elizabeth: Nelson Mandela Metropolitan University. (MCom dissertation).

SAMNALIEV, M., STEVENS, T. & MORE, T. 2003. *A Comparison of Cheap Talk and Alternative Certainty Calibration Techniques in Contingent Valuation*. Amherst: University of Massachusetts (Department of Resource Economics Working Paper No. 2003-11).

SCARPA, R., WILLIS, K.G., ACUTT, M. & FERRINI, S. 2004. *Monte Carlo Simulation Evidence on the Effect of the Status-quo in Choice Experiment Models for Water Supply*. Paper presented at the 13th Annual European Association of Environmental and Resource Economists Conference: Budapest, Hungary.

SCHARLER, U.M., BAIRD, D. & WINTER, P.E.D. 1998. *Diversity and Productivity of Biotic Communities in Relation to Freshwater Inputs in Three Eastern Cape Estuaries*. Pretoria: Water Research Commission (Report No. 463/1/89: 1-197).

SCHARLER, U.M. & BAIRD, D. 2003. The influence of catchment management on salinity, nutrient stoichiometry and phytoplankton biomass of Eastern Cape estuaries, South Africa. *Estuarine Coastal and Shelf Science,* 56(3-4): 735-748.

SMITH, R. 1981. Resolving the Tragedy of the Commons by creating private property rights in wildlife. *CATO Journal,* (1): 439-468.

SMYTH, R.L., WATZIN, M.C. & MANNING, R.E. 2009. Investigating stakeholder preferences for managing Lake Champlain using a choice experiment. *Journal of Environmental Management,* 90(1): 615-623.

SOUTH AFRICAN RESERVE BANK (SARB). 2011. *Quarterly Bulletin*. June.

SOWMAN, M.R. 1987. A procedure for assessing recreational carrying capacity in coastal resort areas. *Landscape and Urban Planning*, 14(14): 331-344.

SOWMAN, M.R. & FUGGLE, R.F. 1987. Assessing recreational carrying capacity: A case study of the Kromme River Estuary, South Africa. *Journal of Shoreline Management*, 3(1): 53-75.

STATSSA. 2001. *South African Standard Classification of Occupations (SASCO).* Pretoria: Statistics South Africa.

STATSSA. 2007. Labour Force Survey. September 2007. *Electronic Data.* Pretoria: Statistics South Africa.

ST. FRANCIS BAY RATEPAYERS ASSOCIATION (SFBRA). 2011. *General Motorised Boating Regulations for the Kromme River*. [Online]. Available: www.sfbra.co.za. [1 June 2011]

SUH, J. 2001. An economic evaluation of environmental recovery of the skier-dominated area in the Mount Togyu National Park in South Korea. Queensland: The University of Queensland. (PhD dissertation).

SWAIT, J. & ADAMOWICZ, W. 2001. The influence of task complexity on consumer choice: a latent class model of decision strategy switching. *Journal of Consumer Research*, 28(1): 135-148.

TEISL, M.F., BOYLE, K.J., MCCOLLUM, D.W. & REILING, S.D. 1995. Test-retest reliability of contingent valuation. *American Journal of Agricultural Economics*, 77(3): 613-619.

TERAWAKI, T., KURIYAMA, K. & YOSHIDA, K. 2003. *The Importance of Excluding Unrealistic Alternatives in Choice Experiment Designs*. Japan: Ritsumeikan University (Discussion Paper No. 03002).

THORPE, H. 2010. [Personal communication]. 10 July.

THURSTONE, L. 1927. A law of comparative judgement. *Psychological Review*, 34: 273-286.

TURPIE, J.K. 2004. *South African National Spatial Biodiversity Assessment 2004: Technical Report. Volume 3: Estuary Component.* Pretoria: South African National Biodiversity Institute.

TURPIE, J.K., CLARK, B.M, KNOX, D., MARTIN, P., PEMBERTON, C. & SAVY, C. 2004. *Improving the biodiversity rating of South African estuaries: Volume 1*. Contributions to information requirements for the implementation of Resource Directed Measures for estuaries. Pretoria: Water Research Commission Report No. 1247/1/04.

TURPIE, J.K, ADAMS, J.B., JOUBERT, A., HARRISON, T.D., COLLOTY, B.M., MAREE, R.C., WHITFIELD, A.K., WOOLDRIDGE, T.H., LAMBERTH, S.J., TALJAARD, S. & VAN NIEKERK, L. 2002. Assessment of the conservation priority status of South African estuaries for use in management and water allocation. *Water SA*, 28(2): 191-206.

TURPIE, J.K. & CLARK, B.M. 2007. *Development of a Regional Conservation Plan for Temperate South African Estuaries on the basis of Biodiversity Importance, Ecosystem Health and Economic Costs and Benefits.* Report prepared for C.A.P.E. Regional Estuarine Management Programme. Cape Town: Anchor Environmental Consultants CC.

UNIT FOR INTEGRATED ENVIRONMENTAL AND COASTAL MANAGEMENT (IECM). 2010. *Regional Estuarine Management Programme: Sundays River Management Plan*. Port Elizabeth: Nelson Mandela Metropolitan University.

VAN DER WESTHUIZEN, H. 2007. Valuing preferences for freshwater inflows into the Bira, Bushmans, Kasouga, Keiskamma, Kleinemond East, Nahoon and Tyolomqa estuaries. Port Elizabeth: Nelson Mandela Metropolitan University. (MCom dissertation).

VAN KOOTEN, G.C. & BULTE, E.H. 2000. *The Economics of Nature: Managing Biological Assets.* Oxford: Blackwell Publishers Ltd.

WADE, R. 1987. The management of common property resources: Collective action as an alternative to privatisation or state regulation. *Cambridge Journal of Economics*, 11: 95-106.

WATSON, V., PHIMISTER, E. & RYAN, M. 2004. *Testing the Assumption of Compensatory Decision-making in Discrete Choice Experiments: An Application to the Decommissioning of Off-shore Oil Installations*. Paper prepared for the 13th Annual European Association of Environmental and Resource Economists Conference: Budapest, Hungary.

WHITEHEAD, J.C. 2006. A practitioner's primer on contingent valuation. (*In* Alberini, A. & Kahn, J. (eds). *Contingent Valuation Handbook*. Cheltenham: Edward Elgar Publishing. p. 66-91.)

WHITFIELD, A.K. 1992. A characterization of Southern African estuarine systems. *South African Journal of Aquatic Science,* 18: 89-103.

WHITFIELD, A.K. 1998. *Biology and Ecology of Fishes in Southern African Estuaries.* Grahamstown: J.L.B. Smith Institute of Icthyology.

WHITFIELD, A.K. 2000. *Available Scientific Information on Individual Estuarine Systems*. Pretoria: Water Research Commission (Report No. 577/3/00).

WHITFIELD, A.K. 2008. *Fishes of the Sundays Estuary*. Grahamstown: J.L.B. Smith Institute of Icthyology (Ecological Water Requirements Study: Sundays Estuary, Specialist Report).

WHITFIELD, A.K., BATE, G., COLLOTY, B. & TAYLOR, R. 2011. *Consortium for Estuarine Research and Management: Photohouse*. [Online]. Available: www.nmmu.ac.za/cerm. [15 May 2011]

WINDLE, J. & ROLFE, J. 2004. *Assessing Values for Estuary Protection with Choice Modelling using different Payment Mechanisms.* Paper presented at the 48th Annual Conference of the Australian Agricultural and Resource Economics Society: Melbourne, Australia.

WINDLE, J. & ROLFE, J. 2009. *Comparing Responses from Web and Paper-based Collection Modes in a Choice Modeling Experiment*. Canberra: The Australian National University (Environmental Economics Research Hub Research Reports No. 45).

WISEMAN, K.A., BURNS, M.E.R. & VERNON, C.J. 1993. Nahoon (CSE 44), Qinira (CSE 45) and Gqunube (CSE 46). (*In* Morant, P.D. (ed). *Estuaries of the Cape Part II: Synopses of Available Information on Individual Systems.* Stellenbosch: CSIR Research Report No. 441.)

WOOLDRIDGE, T.H. 1986. (Ed.) *East London Programme – Final Report.* Institute for Coastal Research, Report No. 7. Port Elizabeth: University of Port Elizabeth.

WOOLDRIDGE, T.H. 2010. [Personal communication]. 14 May.

YACOB, M.R. & SHUIB, A. 2009. Assessing the preference heterogeneity in marine ecotourism attributes by using choice experiments. *International Journal of Economics and Management,* 3(2): 367-384.

APPENDICES

APPENDIX A: PROPOSAL FOR THE REINSTATEMENT OF JET SKI USE ON THE KROMME RIVER ESTUARY

The Secretary
P.O. Box 26
St Francis Bay, 6312 E-Mail:
granitecreations1@telkomsa.net
Chairman: Chris Hattingh
Cell: 083 310 8120
Fax: 042 2940 405
Date: 18 February 2009

Dear Sir

PROPOSAL TO HAVE JETSKIS REINSTATED ON THE KROMME RIVER

A jet ski club, which is affiliated to the Port St Francis Ski Boat and Yacht Club, has been formed with its constitution and set of rules. The Port St Francis Ski Boat and Yacht Club is affiliated to the National Body SADSA who in turn is affiliated to SAMSA.

Our proposal, which needs to be confirmed with the Council, is that all jet ski owners will have to become members of this club, before they will be allowed to launch, either in the canals or in the river. All members will be issued with a club identification number and a set of rules to be signed for which will deem the member to have acknowledged receipt, understanding of and, agreement to adhere to the set of rules. All craft will have to be surveyed annually by an accredited safety officer and the skipper will need to have a valid skipper's license. All members will be encouraged to police each other thereby easing the burden on our current law enforcement officers.

Any member who does not obey the rules will be brought before a disciplinary committee and will disciplined according to the constitution of the Ski Boat & Yacht Club which could result in either a fine being issued or suspension from the Club. This will mean that the offender would no longer be allowed to use the canals, river or sea.

Going forward the Council should only issue a jet ski permit for the canals and river if the following documents are produced:

1. Current Port St Francis Ski Boat and Yacht Club boat membership card.
2. Valid seaworthy certificate.
3. Valid skippers ticket.

The Port St Francis Ski Boat and Yacht Club will issue all these documents.

The jet ski club is also considering drawing up a roster whereby its members could be called upon to assist with lifesaving duties over the festive season.

LIST OF CONTACT DETAILS

Chris Hattingh	Chairman and Safety Surveyor	083 310 8120
Pieter Grobbelaar	Canal Manager and Law Enforcement	073 180 5529
John Robson	Vice Chairman SFBRHA	082 888 2387
Colin Beckley	Director SFBRHA	083 654 3232
Mike Beattie	Safety and Surveying Officer	082 657 5126

If you have any queries please do not hesitate in contacting John, Colin or Chris.

APPENDIX B: CHOICE EXPERIMENT QUESTIONNAIRE – SUNDAYS RIVER ESTUARY

RECREATIONAL RESOURCE MANAGEMENT IN THE SUNDAYS RIVER ESTUARY: A SURVEY OF RECREATIONAL USER ATTITUDES

Question 1: Your attitude towards the environment.

Below is a range of statements on the Sundays River Estuary. Please indicate how strongly you agree or disagree with each statement by making a cross[X] in the relevant box.

1.1 One of the most important responsibilities of national, provincial and local government is the protection of estuaries in a sustainable manner. This includes the protection of resources for recreational use.

Strongly disagree	Don't know
Disagree	Indifferent
Agree	Strongly agree

1.2 The level of congestion, due to all forms of motorised boating, jet skiing etc. taking place on the Sundays River Estuary, is a threat to the quality of the recreational services provided by the Estuary.

Strongly disagree	Don't know
Disagree	Indifferent
Agree	Strongly agree

1.3 Recreational over-fishing, especially in nursery areas, is a threat to the quality of the recreational services provided by the Sundays River Estuary.

Strongly disagree	Don't know
Disagree	Indifferent
Agree	Strongly agree

1.4 The level of public access to the Sundays River Estuary is sufficient.

Strongly disagree	Don't know
Disagree	Indifferent
Agree	Strongly agree

1.5 The Sundays River Estuary should provide a sustainable habitat for animal and plant-life.

Strongly disagree
Disagree
Agree
Don't know
Indifferent
Strongly agree

Question 2: Your use of the Sundays River Estuary.

2.1 Have you visited the Sundays River Estuary in the last year?

Please indicate one choice only by making a cross[X] in the relevant box.
Never visited...
Visited only once ....
Visited two to ten times ………...
Visited eleven to twenty times……………………………………………….……………
Visited more than twenty times...
I live in Colchester/Cannonville ....

2.2. When you visited the Sundays River Estuary, which of the following things did you do?

Please indicate your choice(s) by making a cross[X] in all the relevant boxes.
Recreational shore fishing……………….……..
Recreational boat fishing..
Power/Speed boating….…….. ....
Water skiing……….…. ....
Paddling (rowing, canoeing, kayaking)..
Jet skiing…………..………….. ....
Swimming..…………. ....
Bird watching...…..……. ....

Other (please specify):
____

2.2.1 If you marked recreational fishing as one of the things you did, do you know what the size and bag limits are for keeping the Dusky Kob, Spotted Grunter and White Steenbras fish? ***(Please make a cross[X] in the relevant box)***

Yes
No

2.3 When it comes to the Sundays River Estuary, which of the following options would you prefer: ***(Please make a cross[X] in the relevant box)***

Free public access to all jetty's allowed by Management…..…………………………………
The payment of a levy for the sole usage of a jetty……..……….……………………………..
No payment required for sole usage of a jetty, only permission…………………………….

Question 3: Study of recreational use alternatives.

You will now be asked to choose among recreational use alternatives for the Sundays River Estuary. Each alternative varies with respect to:

- Physical sizes of recreational fish
- Congestion on the Estuary
- Public access to the Estuary
- The size of the recreational estuary users' environmental quality levy

Physical sizes of recreational fish:
Three main fish species are targeted by recreational fishers in the Sundays River Estuary, namely Dusky Kob, Spotted Grunter and White Steenbras. It has been documented that the stocks of these three species have declined over the past five years. It has also become apparent that the fish species mentioned above are not being allowed to reach their adult size, due to over-fishing and high retention rates. Please consider the following two options when it comes to recreational fishing in the Sundays River.

Catch and keep small fish now: Catch and retain whatever fish species you want 'today'.
Keep no undersize fish now but more and bigger fish next year: Catch bigger and more fish in one year's time.

The level of congestion on the estuary:
For the years 2007 and 2008, a total of 774 and 812 boats, respectively, were registered to use the Pearson Park Resort slipway. At any one time, a maximum of about 40 boats use the estuary. Other forms of motorised activity include jet skiing. At times, especially during peak season periods, the estuary appears to be overcrowded. The following two levels of congestion are identified for the Sundays River Estuary.

Not congested: The recreational user sees and hears a few boats.
Congested: The recreational user sees and hears many boats.

The level of public access to the estuary:
Access to the estuary is limited due to steep inaccessible banks, private homes, private land, and a lack of vehicle access. It is also limited, due to the privatization of access to the estuary, for example, jetty's and limits to movements along the banks. In order to improve safe public access for all recreational users, the establishment of a path along the water's edge is proposed. With this in mind, the following two options for public access are identified for the Sundays River Estuary.

More public access? Yes – establish a path access along the banks of the estuary
More public access? No – do not establish a path access along the banks of the estuary

Size of recreational user's environmental quality levy:
It is assumed that the cost of providing these recreational use alternatives is **partly** covered by the Sundays River Estuary's fishing and boat license holders. SANPARKS will cover the **majority** of the costs. We ask you to imagine that all fishing and boat license holders will contribute equally by means of a fixed annual sum added to the existing license structure, and this annual sum will then be directed back to the Sundays River Estuary. This annual sum can take four different values, namely R0 (current situation), R45, R90 and R120.

Selection of recreational use alternatives
You will be asked to make four (4) choices in total. Within each choice set, you will be asked to choose between two (2) recreational use alternatives. In other words, you will have to choose one combination of recreational use options out of a possible two combinations of recreational use options (Option A vs. Option B). The recreational use alternatives vary according to the physical size of the recreational fish, the level of congestion, the level of public access, and the price of these recreational use options. **It is important to remember that this recreational use management project is only one of many such projects in South Africa. Also, be aware that spending more money on any alternative would mean that you would have less money to spend on all other goods and services, i.e. you face a budget constraint.**

Please note that the choices are hypothetical, but plausible (based on advice from scientists). It is important to treat each of your four choices as if they were **real**, and **independent** from each other.

Please consider the example of a completed choice set given below.

Attribute	**Option A**	**Option B**
Physical size of fish caught	**Mostly small fish now**	**None now but bigger and more fish next year**
Congestion	**Hear and see few boats**	**Hear and see few boats**
More public access	**Yes**	**No**
Cost to you(R)	**R45**	**R0**
I would choose (TICK ONE BOX ONLY):		

Please continue to make your choices now – we hope you find the experience enjoyable.

Question 3.1

Attribute	Option A	Option B
Physical size of fish	**None now but bigger and more fish next year**	**Mostly small fish now**
Congestion	**Hear and see few boats**	**Hear and see few boats**
More public access	**No**	**Yes**
Cost to you(R)	**R0**	**R120**
I would choose (TICK ONE BOX ONLY):		

Question 3.2

Attribute	Option A	Option B
Physical size of fish	**None now but bigger and more fish next year**	**Mostly small fish now**
Congestion	**Hear and see many boats**	**Hear and see many boats**
More public access	**Yes**	**No**
Cost to you(R)	**R0**	**R120**
I would choose (TICK ONE BOX ONLY):		

Question 3.3

Attribute	Option A	Option B
Physical size of fish	**Mostly small fish now**	**None now but bigger and more fish next year**
Congestion	**Hear and see many boats**	**Hear and see many boats**
More public access	**Yes**	**No**
Cost to you(R)	**R0**	**R120**
I would choose (TICK ONE BOX ONLY):		

Question 3.4

Attribute	Option A	Option B
Physical size of fish	**Mostly small fish now**	**None now but bigger and more fish next year**
Congestion	**Hear and see few boats**	**Hear and see few boats**
More public access	**Yes**	**No**
Cost to you(R)	**R0**	**R45**
I would choose (TICK ONE BOX ONLY):		

Question 4: Follow-up to question 3.

4.1. Did you find it easy or difficult to make the choices in Question 3? ***(Please make a cross[X] in the relevant box)***

Difficult
Easy

4.2. If you answered “Difficult” in question 4.1, what made the choices hard?

Please indicate your reason(s) by making a cross[X] in all the relevant boxes.
I could not relate to the questions ....
I think there was too much information to consider ....
I did not understand the questions ....
I think the alternatives were too expensive ....
It was difficult to choose as several factors were important..
I do not believe Estuary users should pay to ensure a healthy Estuary.....................................
Other (please specify):

____

Don’t know …..

4.3. Which item did you put greatest weight on, in your choices in Question 3?

Please indicate one item only by making a cross[X]in the relevant box.
The level of congestion…...…..
The population size of recreational fish stocks.........………..
Public access………………..
Size of the annual environmental levy...
It varied from choice to choice ....

Don’t know ....

4.4. If the recreational services of the Sundays River Estuary were improved, would you use the Estuary more often or would your Estuary usage remain the same? ***(Please make a cross[X] in the relevant box)***

Remain the same
Use more often

Section 5: Background questions.

5.1 What is your gender?

Male Female

5.2 How old are you?

___Years

5.3 In which city or town do you live? ____

5.4 Please state your current, or if retired, your previous occupation *(please be as specific as possible)*.

____

5.5 What is the size of your household's total annual gross income? Please note: This should be income before any tax deductions.

Please indicate one income category only by making a cross[X]in the relevant box.

Less than R50 000...
R 50 000- 99 999 ....
R 100 000-149 999..
R 150 000-199 999..
R 200 000-249 999..
R 250 000-299 999..
R 300 000-349 999..
R 350 000-399 999..
R 400 000-449 999..
R 450 000-499 999..
R 500 000-749 999..
R 750 000-999 999..
R 1 000 000 or above ....
Refuse to answer………………………….……………………………………….……………

5.5 What is your highest level of educational attainment?

Please indicate one level of education only by making a cross[X] in the relevant box.

No education………………………...
Primary school education…..
Secondary school education..……..
Matriculation.…………………... …………..………...……...
Technikon diploma...
University degree..
University post-graduate degree...

The questionnaire is now finished. Thank you for your help!

APPENDIX C – RECREATIONAL RESOURCE MANAGEMENT IN THE NAHOON ESTUARY: A SURVEY OF RECREATIONAL USER ATTITUDES

Question 1: Your attitude towards the environment.

Below is a range of statements on the Nahoon River Estuary. Please indicate how strongly you agree or disagree with each statement by making a cross[X] in the relevant box.

1.1 One of the most important responsibilities of national, provincial and local government is the protection of estuaries in a sustainable manner. This includes the protection of resources for recreational use.

Strongly disagree		Don't know	
Disagree			
Indifferent			
Agree			
Strongly agree	x		

1.2 The level of public access to the Nahoon Estuary is sufficient.

Strongly disagree		Don't know	
Disagree			
Indifferent			
Agree	x		
Strongly agree			

1.3 The water in the Nahoon River Estuary is safe for swimming, boating and fishing.

Strongly disagree	x	Don't know	
Disagree			
Indifferent			
Agree			
Strongly agree			

1.4 The Nahoon Estuary should be a secure environment (crime free) for recreation users.

Strongly disagree		Don't know	
Disagree			
Indifferent			
Agree			
Strongly agree	x		

1.5 A water quality advisory (signs, etc.) for the Nahoon Estuary should be set up.

Strongly disagree		Don't know	
Disagree			

Indifferent	0
Agree	x
Strongly agree	

1.6 The money needed to enforce the quality of recreational experience at the Nahoon Estuary should be raised by:

An annual fixed levy added to all BCM residents' rates accounts. Yes [x] No [ ]

A monthly variable (a percentage of the rates value) levy added to all the BCM residents' rates accounts. Yes [ ] No [ ]

A voluntary payment collected and managed by an independent NGO (Non-Government Organization) or CBO (Community Based Organization). Yes [ ] No [ ]

Question 2: Your use of the Nahoon River Estuary.

2.1 Have you visited the Nahoon Estuary in the last year?

Please indicate one choice only by making a cross[X] in the relevant box.

Never visited………………………………………….. [ ]

Visited only once……………………………………. [ ]

Visited two to ten times………………………………. [ ]

Visited eleven to twenty times………………………... [ ]

Visited more than twenty times………………………. [X]

I live on the banks of the Nahoon River……………… [ ]

2.2. When you visited the Nahoon Estuary, which of the following things did you do?

Please indicate your choice(s) by making a cross[X] in all the relevant box(es).

Recreational shore fishing.. [ ]

Recreational boat fishing…... [ ]

Power/Speed boating….……………….......................... [ ]

Water skiing……………….. [ ]

Paddling (rowing, canoeing, kayaking)....................... [X]

Jet skiing……………………...................................... [ ]

Swimming..……………….. [ ]

Bird watching..……..…... [ ]

Camping.……………………………………………... [ ]

Other (please specify): ____

2.3 The condition the Nahoon Estuary:
(Please indicate one choice only by making a cross[X] in the relevant box.)

- Has not changed and thus I have continued to use the Nahoon Estuary as much as I ever did…	☐
- Has got much worse to the extent that it has stopped me visiting it as regularly as I used to…..……..	X
- Is horrible and if there was an alternative estuary to use I would not use Nahoon at all………………	☐

Question 3: Study of recreational use alternatives.

You will now be asked to choose among recreational use alternatives for the Nahoon Estuary. Each alternative varies with respect to:

1. The safety for recreation of the water in the estuary, i.e. its quality.
2. Public investment in facilities to enhance the recreational experience.
3. Personal security of recreation users of the estuary on its banks.
4. Payment for monitoring and enforcing quality standards at the estuary.

1. The safety for recreation of the water in the Nahoon Estuary

Water quality in the Nahoon Estuary has been compromised due to:

- Under-capacity of the sewerage infrastructure;
- Inadequate management and maintenance of the storm water and sewerage transfer infrastructure;
- Pollution by the local population and failed refuse collection, which ultimately leads to this refuse finding its way into the storm water system; and
- An inadequate volume of water flowing from upstream, i.e. poor instream inflow.

Reduced water quality makes swimming, boating and fishing hazardous. With this in mind, the following three levels for water quality are identified for the Nahoon Estuary.

Level 1: **Not safe for any activity involving skin contact with water, nor eating fish.**
Level 2: **Safe for all recreation activities except ones with high water contact, e.g. swimming.**
Level 3: **Safe for all recreation activities.**

2. **Public interest in facilities to enhance the recreational experience**

The Nahoon Estuary has a limited recreational experience due to steep banks, private land ownership and poorly planned and maintained facilities. In order to enhance the recreational experience, one could improve public access, develop a waterfront nature trail, possibly on both sides of the estuary banks, and restore the Nahoon campsite and surrounding facilities.

With this in mind, the following three levels for improved public recreational experience are identified for the Nahoon Estuary.

Level 1: **Leave the public recreational facilities as they are.**

Level 2: **Improve public facilities by upgrading and restoring the camping and other recreational facilities at the mouth of the Nahoon Estuary.**

Level 3: **Improve public facilities by upgrading and restoring the camping and other recreational facilities at the mouth of the Nahoon Estuary and improve public access to walkers along the banks by developing a waterfront nature trail on both sides of the estuary banks.**

3. **Security at the Nahoon Estuary:**

The level of security and support services at the mouth of the Nahoon Estuary has deteriorated over time. The area looks uncared for and an increase in vagrants living in the estuary area has correlated with an increase in incidence of opportunistic criminal activity. To improve security, some residents voluntarily contribute towards the cost of patrolling guards (currently R165 per month).

With this in mind, the following two levels are identified for the security services of the area.

Level 1: **Leave the personal security service levels as they are (current police and municipal service level plus supplementation by volunteer contributions).**

Level 2: **Increase personal security services at the Nahoon Estuary Mouth area, by e.g. reducing the scope for vagrancy and increasing patrolling by security personnel.**

4. **Payment for choice at the Nahoon Estuary:**

The cost of providing recreational use alternatives at the Nahoon Estuary is covered by the local East London rate payers, grants from National Government and voluntary contributions from residents and recreation users.

In order to improve the situation (and create new choices) some intervention is needed. It is proposed that this intervention be in the form of an agency appointed and funded by government whose function it is to monitor and enforce regulations relating to the quality of the Nahoon Estuary and recreational enhancing initiatives related to the estuary. In order to finance this agency an extra payment will have to be collected by the municipality. This payment would be in addition to the current rates and service tariffs.

With this in mind, the following three levels are identified for payments to monitor and enforce regulations relating to the Nahoon Estuary.

Level 1: **Payment of R120 per property to the municipality by all parties identified as interested and affected users of the Nahoon Estuary, conditional to these funds being used to employ an agency whose job is to monitor and enforce standards of support for recreation at the Nahoon Estuary.**

Level 2: **Payment of R50 per property to the municipality by all parties identified as interested and affected users of the Nahoon Estuary, conditional to these funds being used to employ an agency whose job is to monitor and enforce standards of support for recreation at the Nahoon Estuary.**

Level 3: **No additional payment.**

Selection of recreational use alternatives

You will be asked to make four (4) choices in total. Within each of the four (4) choice sets, you will be asked to make one choice between two (2) recreational use alternatives. In other words, you will have to choose one combination of recreational use levels out of a possible two combinations of recreational use options (Choose only ONE of Option A or Option B). The recreational use alternatives vary according to:

1. The safety of the water in the estuary.
2. Public interest in recreational support facilities.
3. Security management relating to recreation at the estuary.
4. Payment for monitoring and enforcement service.

It is important to remember that this recreational use management project is only one of many such projects in South Africa. Also, be aware that spending more money on any alternative would mean that you would have less money to spend on all other goods and services, i.e. you face a budget constraint.

Please note that the choices are hypothetical, but plausible (based on advice from scientists). It is important to treat each of your four choices as if they were **real**, and **independent** from each other.

Please consider the example of a completed choice set given below, drawn randomly by design from Table 3.1 below, a summary of all the attributes and levels.

Attribute	Option A	Option B
Safe use of water	**Not safe for any activity involving skin contact with water, nor eating fish**	**Safe for all recreation activities**
Interest in support facilities	**No change**	**Restore camping, other facility and build new nature trails**
Public safety	**Increase security effort**	**No change**
Payment for choice	**R50.00 per year extra**	**Nothing extra**
I would choose (TICK ONE BOX ONLY):		√

TABLE 3.1 ATTRIBUTES AND LEVELS SUMMARY.

Attribute	Level 1	Level 2	Level 3
Safe use of water	**Not safe for any activity involving skin contact with water, nor eating fish**	**Safe for all recreation activities except ones with high water contact, e.g. swimming**	**Safe for all recreation activities**
Interest in support facilities	**No change**	**Restore the camping and other facility**	**Restore camping, other facility and build new nature trails**
Public safety	**No change**	**Increase security effort**	
Payment for choice	**R120.00 per year extra**	**R50.00 per year extra**	**Nothing extra**

Please continue to make your choices now – we hope you find the experience enjoyable.

3.1

Attribute	Option A	Option B
Safe use of water	**Safe for all recreation activities**	**Safe for all recreation activities**
Interest in support facilities	**Restore the camping and other facility**	**Restore camping, other facility and build new nature trails**
Public safety	**No change**	**Increase security effort**
Payment for choice	**R120.00 per year extra**	**R50.00 per year extra**
I would choose (Tick ONE BOX ONLY):		✓

3.2

Attribute	Option C	Option D
Safe use of water	**Not safe for any activity involving skin contact with water, nor eating fish**	**Safe for all recreation activities**
Interest in support facilities	**No change**	**Restore camping, other facility and build new nature trails**
Public safety	**No change**	**Increase security effort**
Payment for choice	**R120.00 per year extra**	**Nothing extra**
I would choose (Tick ONE BOX ONLY):	✓	

3.3

Attribute	Option E	Option F
Safe use of water	**Safe for all recreation activities**	**Safe for all recreation activities**
Interest in support facilities	**No change**	**Restore the camping and other facility**
Public safety	**Increase security effort**	**No change**
Payment for choice	**R50.00 per year extra**	**R50.00 per year extra**
I would choose (Tick ONE BOX ONLY):	✓	

3.4

Attribute	Option G	Option H
Safe use of water	**Not safe for any activity involving skin contact with water, nor eating fish**	**Safe for all recreation activities except ones with high water contact, e.g. swimming**
Interest in support facilities	**Restore camping, other facility and build new nature trails**	**No change**
Public safety	**Increase security effort**	**Increase security effort**
Payment for choice	**R50.00 per year extra**	**R120.00 per year extra**
I would choose (Tick ONE BOX ONLY):	✓	

Question 4: Follow-up to question 3.

4.1. Did you find it easy or difficult to make the choices in Question 3?

Difficult……. ☐
Easy………… ☒ (x)

4.2. If you answered "Difficult" in question 4.1, what made the choices hard?

Please indicate your reason(s) by making a cross[X] in all the relevant boxes.

I could not relate to the questions.. ☐
I think there was too much information to consider... ☐
I did not understand the questions.. ☐
I think the alternatives were too expensive... ☐
It was difficult to choose as several factors were important.............................. ☐
I do not believe estuary users should pay to ensure a healthy estuary.............. ☐

Other (please specify): ____________________

Don't know …... ☐

4.3. Which item did you attach the most importance to, in your choices in Question 3?

Please indicate one item only by making a cross[X]in the relevant box.

The quality of the water in the estuary.. ☒ (x)
Investment in support facilities……………………..……...………............ ☐
Personal security.. ☐
Size of the payment.. ☐
It varied from choice to choice... ☐

Don't know.. ☐

4.4. If the recreational services of the Nahoon Estuary were improved, would you use the estuary more often, or would your estuary usage remain the same?

Remain the same………………………………………………………………. ☐
Use more often……………………………………………………………… ☒ (X)

Section 5: Background questions.

5.1 What is your gender? Male [X] Female [ ]

5.2 How old are you? __58_Years

5.3. In which suburb of East London do you live?
__GONUBIE____________________________or do not live in East London)…………

5.4 Please state your current occupation ___Engineering Geologist___________

5.5 What is the size of your household's total annual gross income? Please note: This should be income before any tax deductions.

Please indicate one income category only by making a cross[X]in the relevant box.

Less than R50 000...	[ ]
R 50 000-99 999	[ ]
R 100 000-149 999...	[ ]
R 150 000-199 999...	[ ]
R 200 000-249 999...	[ ]
R 250 000-299 999...	[ ]
R 300 000-349 999...	[ ]
R 350 000-399 999...	[ ]
R 400 000-449 999...	[ ]
R 450 000-499 999...	[ ]
R 500 000-749 999...	[X]
R 750 000-999 999...	[ ]
R 1 000 000 or above	[ ]

5.6 What is your highest level of educational attainment?

Please indicate one level of education only by making a cross[X] in the relevant box.

No education…………………………..	☐
Primary school education…...	☐
Secondary school education..…………...	☐
Matriculation.…………………..………………………………..	☐
Technikon diploma..	☐
University degree..	☐
University post-graduate degree..	X

5.7 Do you have any further comment you may like to add regarding issues relevant to the maintenance of a healthy estuary and/or the effective management of the Nahoon Estuary?

Kindly explain on the back of this questionnaire… or, … kindly email your contribution to gchandler@wsu.ac.za

The questionnaire is now finished. Thank you so much for your valued contribution!

APPENDIX D – RECREATIONAL RESOURCE MANAGEMENT IN THE KROMME RIVER ESTUARY: A SURVEY OF RECREATIONAL USER ATTITUDES

Question 1: Your attitude towards the environment.

Below is a range of statements on the Kromme River Estuary, i.e. the tidal portion. Please indicate how strongly you agree or disagree with each statement by making a cross[X] in the relevant box.

1.1 An important responsibility of national, provincial and local government is the protection of estuaries in a sustainable manner. This includes the protection of resources for recreational use.

Strongly disagree
Disagree
Agree
Don't know
Indifferent
Strongly agree

1.2 The level of boat congestion, due to motorised boating (excl. jet skiing), taking place on the Kromme River Estuary during peak season, is a threat to the quality of the recreational services provided by the Estuary.

Strongly disagree
Disagree
Agree
Don't know
Indifferent
Strongly agree

1.3 Reduced navigability, due to sedimentation, is a threat to the quality of the recreational services provided by the Kromme River Estuary.

Strongly disagree
Disagree
Agree
Don't know
Indifferent
Strongly agree

1.4 The potential use of jet skis/wet bikes on the Kromme River Estuary is a threat to the quality of the recreational services provided by the Estuary.

Strongly disagree
Disagree
Agree
Don't know
Indifferent
Strongly agree

1.5 The Kromme River Estuary should provide a sustainable habitat for marine, animal and plant-life.

Strongly disagree
Disagree
Agree
Don't know
Indifferent
Strongly agree

1.6 Uncontrolled, commercial and illegal bait harvesting is a threat to the quality of the recreational services provided by the Kromme River Estuary.

Strongly disagree
Disagree
Agree
Don't know
Indifferent
Strongly agree

Question 2: Your use of the Kromme River Estuary.

2.1.1 Have you visited the Kromme River Estuary in the last year?

Please indicate one choice only by making a cross[X] in the relevant box.
Never visited...
Visited only once ....
Visited two to ten times ………...
Visited eleven to twenty times………………….....…………………………....................
Visited more than twenty times...
I live in St. Francis Bay/on the Kromme River..

2.1.2 If you live in St Francis Bay/on the Kromme River or in the near surrounds, please be more specific in terms of your area of residence.

Please indicate one choice only by making a cross[X] in the relevant box.
I live on the canals...
I live in St Francis Village..
I live on the Kromme River………..
I live in Cape St. Francis………..……….....……………………………………………....
Other(please specify)____

2.1.3 Are you a:

Please indicate one choice only by making a cross[X] in the relevant box.
Permanent resident………..
Holiday home owner……..
Day visitor………………..……...
Multiple day visitor…………….……………………….………………………....……....

2.2. When you visited the Kromme River Estuary, which of the following things did you do?

Please indicate your choice(s) by making a cross[X] in all the relevant boxes.
Recreational shore fishing…………………..……..
Recreational boat fishing… ....
Power/Speed boating….………….. ....
Water skiing……………… ....
Wind/Kite surfing……………………………………….....…………………….…..…
Paddling (rowing, canoeing, kayaking)..
Sailing…………………………………………….......…………………………...…..
Jet skiing (access to sea only)...….. ....
Swimming...……………………...
Bird watching...……. ....
Walking……………………………………………………………………………...
Other (please specify): ____

Please indicate how strongly you agree or disagree with the following statement by making a cross[X] in the relevant box.

2.3. The boat access facilities for the public, i.e. the condition of the launching site and road at the bridge, are adequate.

Strongly disagree
Disagree
Agree
Don't know
Indifferent
Strongly Agree

2.4.1 Are you aware of the fact that JET BOATS are treated as a conventional boat and not as a jet ski/wet bike? ***(Please make a cross[X] in the relevant box)***

Yes No

If you answered "Yes" to question 2.4.1, please proceed to question 2.4.2.

2.4.2, Do you believe that all jet propelled water craft (jet boats) should be treated in the same manner (similar to jet skis/wet bikes)? ***(Please make a cross[X] in the relevant box)***

Yes No Indifferent

Question 3: Study of recreational use alternatives.

You will now be asked to choose among recreational use alternatives for the Kromme River Estuary. Each alternative varies with respect to:

- The level of estuary navigability
- Boat congestion on the Estuary
- The potential use of jet skis on the Estuary
- The size of the recreational estuary users' environmental quality levy

The level of estuary navigability:
Navigation is considered to be hazardous on the Kromme River Estuary due to increased levels of sedimentation. Possible causes of the increased levels of sedimentation are the absence of scouring events due to river flooding, the deposition of sand from the Sand River during flood events, and sand delivered by the incoming tide. If this problem is not dealt with, it could lead to the point where the Kromme River Estuary ceases to be navigable at any tide, tidal flow is reduced to the point where the mouth closes, and the entire canal system becomes landlocked. A possible solution to this problem could entail a 20 percent regular release of water from the Mpofu Dam every 3 years in order to scour the canal system and improve navigability. Alternatively, dredging could occur on a regular basis to cope with this sedimentation issue, also improving navigability.

Current navigability: Parts of the estuary are not navigable at low tide. At mid to high tide, it is navigable only with detailed knowledge of fluctuating channels.

Ideal navigability: The estuary is completely navigable at any tide.

The level of boat congestion on the estuary:
For the payment year 2009/10, a total of 1100 boats were registered to use the Kromme River Estuary. At times, especially during peak season periods, the estuary appears to be overcrowded. The following two levels of congestion are identified for the Kromme River Estuary.

Not congested: The recreational user sees and hears a few boats.
Congested: The recreational user sees and hears many boats.

The potential use of jet skis on the estuary:
The use of jet skis on the Kromme River Estuary is currently banned. This is partly because of the perception that these motorised vehicles are noisy, and partly because there is a high proportion of irresponsible and reckless drivers that create disturbances too close to

swimming, fishing or skiing areas. Their use can, however, be regulated in such a way as to minimize their perceived negative impact. This type of regulation, for example, could entail the application of the rules and regulations that currently govern general boat use, as well as very strict law enforcement in order to make sure that these rules and regulations are adhered to. With this in mind, the following two options for the use of jet skis and wet bikes are identified for the Kromme River Estuary.

Banned: Keep the ban on jet skis and wet bikes in place
Unbanned but regulated: Let jet skis and wet bikes use the estuary, but in a regulated manner with very strict law enforcement

Size of recreational user's environmental quality levy:
It is assumed that the cost of providing these recreational use alternatives is **partly** covered by the Kromme River Estuary's boat license holders. We ask you to imagine that all boat license holders will contribute equally by means of a fixed annual sum added to the existing boat license structure, and this annual sum will then be directed back to the Kromme River Estuary. This annual sum can take four different values, namely R169 (boat license payment for 2010/2011 year), R254, R338 and R676.

Selection of recreational use alternatives
You will be asked to make four (4) choices in total. Within each choice set, you will be asked to choose between two (2) recreational use alternatives. In other words, you will have to choose one combination of recreational use options out of a possible two combinations of recreational use options (Option A vs. Option B). The recreational use alternatives vary according to the level of estuary navigability, the level of boat congestion, the potential use of jet skis and wet bikes on the estuary, and the price of these recreational use options. **It is important to remember that this recreational use management project is only one of many such projects in South Africa. Also, be aware that spending more money on any alternative would mean that you would have less money to spend on all other goods and services, i.e. you face a budget constraint.**

Please note that the **choices are hypothetical, but plausible** (based on advice from scientists). It is important to treat each of your four choices as if they were **real**, and **independent** from each other. **Please consider the example of a completed choice set given below.**

Attribute	Option A	Option B
Level of estuary navigability	**Ideal navigability**	**Current navigability**
Boat congestion	**Hear and see few boats**	**Hear and see few boats**
Potential use of jet skis and wet bikes	**Unbanned, with enforced regulation**	**Banned**
Cost to you(R)	**R169**	**R338**
I would choose (TICK ONE BOX ONLY):	√	

Please continue to make your choices now – we hope you find the experience enjoyable.

Question 3.1

Attribute	Option A	Option B
Level of navigability	Ideal navigability	Current navigability
Boat congestion	Hear and see few boats	Hear and see few boats
Potential use of jet skis/wet bikes	Banned	Unbanned, with enforced regulation
Cost to you(R)	R169	R676
I would choose (TICK ONE BOX ONLY):		

Question 3.2

Attribute	Option A	Option B
Level of navigability	Ideal navigability	Current navigability
Boat congestion	Hear and see many boats	Hear and see many boats
Potential use of jet skis/wet bikes	Unbanned, but regulated	Banned
Cost to you(R)	R169	R676
I would choose (TICK ONE BOX ONLY):		

Question 3.3

Attribute	Option A	Option B
Level of navigability	Current navigability	Ideal navigability
Boat congestion	Hear and see many boats	Hear and see many boats
Potential use of jet skis/wet bikes	Banned	Banned
Cost to you(R)	R169	R676
I would choose (TICK ONE BOX ONLY):		

Question 3.4

Attribute	Option A	Option B
Level of navigability	Current navigability	Ideal navigability
Boat congestion	Hear and see few boats	Hear and see few boats
Potential use of jet skis/wet bikes	Unbanned, with enforced regulation	Banned
Cost to you(R)	R169	R254
I would choose (TICK ONE BOX ONLY):		

Question 4: Follow-up to question 3.

4.1. Did you find it easy or difficult to make the choices in Question 3? ***(Please make a cross[X] in the relevant box)***

Difficult Easy

4.2. If you answered "Difficult" in question 4.1, what made the choices hard?

Please indicate your reason(s) by making a cross[X] in all the relevant boxes.

I could not relate to the questions ....
I think there was too much information to consider ....
I did not understand the questions ....
I think the alternatives were too expensive ....
It was difficult to choose as several factors were important...
I do not believe Estuary users should pay to ensure a healthy Estuary....................................
Other (please specify): ____
Don't know …..

4.3. Which item did you put greatest weight on, in your choices in Question 3?

Please indicate one item only by making a cross[X]in the relevant box.

The level of estuary navigability...
The level of boat congestion……………......………...………..
The absence/presence of jet skis and wet bikes ....
Size of the annual environmental levy..
It varied from choice to choice ....
Don't know ....

4.4. If the recreational services of the Kromme River Estuary were improved, would you use the Estuary more often or would your Estuary usage remain the same? ***(Please make a cross[X] in the relevant box)***

Remain the same Use more often

Section 5: Background questions.

5.1 What is your gender? Male Female

5.2 How old are you? ___Years

5.3 In which city or town do you live? ____

5.4 Please state your current, or if retired, your previous occupation ***(please be as specific as possible)*****.**
____

5.5 What is the size of your household's total annual gross income? Please note: This should be income before any tax deductions.

Please indicate one income category only by making a cross[X]in the relevant box.

Less than R50 000...
R 50 000-99 999 ....
R 100 000-149 999..
R 150 000-199 999..
R 200 000-249 999..
R 250 000-299 999..
R 300 000-349 999..
R 350 000-399 999..
R 400 000-449 999..
R 450 000-499 999..
R 500 000-749 999..
R 750 000-999 999..
R 1 000 000 or above ....
Refuse to answer……………………………………………………………………….

5.6 What is your highest level of educational attainment?

Please indicate one level of education only by making a cross[X] in the relevant box.

No education……………………..
Primary school education.…..
Secondary school education...………..
Matriculation.…………………... …………………....…...
Technikon diploma..
University degree...
University post-graduate degree...

The questionnaire is now finished. Thank you for your help!

APPENDIX E – RECREATIONAL RESOURCE MANAGEMENT IN THE GONUBIE ESTUARY: A SURVEY OF RECREATIONAL USER ATTITUDES.

Question 1: Your attitude towards the environment.

Below is a range of statements on the Gonubie Estuary. Please indicate how strongly you agree or disagree with each statement by making a cross[X] in the relevant box.

1.1 One of the most important responsibilities of national, provincial and local government is the protection of estuaries in a sustainable manner. This includes the protection of resources for recreational use.

Strongly disagree ☐ Don't know ☐
Disagree ☐
Indifferent ☐
Agree ☐
Strongly agree ☐

1.2 The level of public access to the Gonubie Estuary is sufficient.

Strongly disagree ☐ Don't know ☐
Disagree ☐
Indifferent ☐
Agree ☐
Strongly agree ☐

1.3 The water in the Gonubie Estuary is safe for swimming, boating and fishing.

Strongly disagree ☐ Don't know ☐
Disagree ☐
Indifferent ☐
Agree ☐
Strongly agree ☐

1.4 The Gonubie Estuary should be a secure environment (crime free) for recreation users.

Strongly disagree ☐ Don't know ☐
Disagree ☐
Indifferent ☐
Agree ☐
Strongly agree ☐

1.5 A water quality advisory (signs, etc.) for the Gonubie Estuary should be set up.

Strongly disagree ☐ Don't know ☐

Disagree
Indifferent
Agree
Strongly agree

1.6 The money needed to enforce the quality of recreational experience at the Gonubie Estuary should be raised by:

An annual fixed levy added to all BCM residents' rates accounts.

A monthly variable (a percentage of the rates value) levy added to all the BCM residents' rates accounts.

A voluntary payment collected and managed by an independent NGO (Non-Government Organization) or CBO (Community Based Organization).

Question 2: Your use of the Gonubie River Estuary.

2.1 Have you visited the Gonubie Estuary in the last year?

Please indicate one choice only by making a cross[X] in the relevant box.

Never visited…………………………………………..
Visited only once………………………………………
Visited two to ten times……………………………….
Visited eleven to twenty times………………………...
Visited more than twenty times……………………….
I live on the banks of the Gonubie River………………

2.2. When you visited the Gonubie Estuary, which of the following things did you do?

Please indicate your choice(s) by making a cross[X] in all the relevant box(es).

Recreational shore fishing..
Recreational boat fishing…..
Power/Speed boating………………..........................
Water skiing………………......................................
Paddling (rowing, canoeing, kayaking).......................
Jet skiing……………………....................................
Swimming..………………..
Bird watching.……...…..
Camping.……………………………………………...

Other (please specify): ____

2.3 The condition the Gonubie Estuary:
(Please indicate one choice only by making a cross[X] in the relevant box.)

- Has not changed and thus I have continued to use the Gonubie Estuary as much as I ever did… ☐
- Has got much worse to the extent that it has stopped me visiting it as regularly as I used to…..…….. ☐
- Is horrible and if there was an alternative estuary to use I would not use Gonubie at all……………… ☐

Question 3: Study of recreational use alternatives.

You will now be asked to choose among recreational use alternatives for the Gonubie Estuary. Each alternative varies with respect to:

1 The safety for recreation use of the water in the estuary, i.e. its quality.
2 Public interest in the serenity of the Gonubie Estuary as an asset to enhance the recreational experience.
3 Personal security of recreation users of the estuary on its banks.
4 Payment for monitoring and enforcing quality standards at the estuary.

1. **The safety for recreation of the water in the Gonubie Estuary. (Water Quality).**

Water quality in the Gonubie Estuary has been compromised due to:

- Under-capacity of the sewerage infrastructure;
- Inadequate management and maintenance of the storm water and sewerage transfer infrastructure;
- Inadequate control of agricultural fertilizer and farmland soil erosion discharged into the estuary.
- Pollution by the local population and failed refuse collection, which ultimately leads to this refuse finding its way into the storm water system; and
- An inadequate volume of water flowing from upstream, i.e. poor in stream inflow.

Reduced water quality makes swimming, boating and fishing hazardous. With this in mind, the following three levels for water quality are identified for the Gonubie Estuary.

Level 1: **Not safe for any activity involving skin contact with water or eating fish.**
Level 2: **Safe for all recreation activities except ones with high water contact, e.g. swimming – status quo.**
Level 3: **Safe for all recreation activities.**

2. **Public interest in serenity to enhance the recreational experience**

The Gonubie Estuary is a small estuary and thus has a limited recreational experience for the use of speed boating and heavy recreational activity. The views and setting along the estuary are naturally beautiful and the serenity of this setting, its tranquillity and calm aura are in themselves natural recreational assets. In order to enhance the recreational experience, one should address the further development along the estuary. Plans to improve public access to identified points where the serenity of the estuary can be enjoyed need focus. Serenity needs to be a serious consideration when further development is considered. Even the existing recreational facilities (for example the Gonubie caravan park), need to be analyzed in order to capture, within these facilities, the serenity aspect of the estuary and enhanced accordingly.

With this in mind, the following three levels for improved public recreational experience are identified for the Gonubie Estuary.

Level 1: **Allow no further development along the Gonubie estuary – status quo.**
Level 2: **Allow limited further development on the estuary only if thoroughly analyzed and approved / authorized.**
Level 3: **Development is important and further development should be unrestricted and encouraged along the Gonubie Estuary.**

3. **Security at the Gonubie Estuary:**

The level of security and support services at the mouth of the Gonubie Estuary has deteriorated over time. The area looks uncared for, the boardwalk is neglected and an increase in vagrants in the estuary area has correlated with an increase in incidence of opportunistic criminal activity.

With this in mind, the following two levels are identified for the security services of the area.

Level 1: **Leave the personal security service levels as they are (current police and municipal service level plus supplementation by volunteer contributions) – status quo.**
Level 2: **Increase personal security services at the Gonubie Estuary Mouth area, by e.g. reducing the scope for vagrancy and increasing patrolling by security personnel.**
Level 3: **Ensure complete personal security through permanent visible policing and high-tech surveillance monitoring.**

4. **Payment for choice at the Gonubie Estuary:**

The cost of providing recreational use alternatives at the Gonubie Estuary is covered by the local East London rate payers, grants from National Government and voluntary contributions from residents and recreation users.

In order to improve the situation (and create new choices) some intervention is needed. It is proposed that this intervention be in the form of an agency appointed and funded by government whose function it is to monitor and enforce regulations relating to the quality of the Gonubie Estuary and recreational enhancing initiatives related to the estuary. In order to finance this agency an extra payment will have to be collected by the municipality. This payment would be in addition to the current rates and service tariffs.

With this in mind, the following three levels are identified for payments to monitor and enforce regulations relating to the Gonubie Estuary.

Level 1: **Payment of R120 per property to the municipality by all parties identified as interested and affected users of the Gonubie Estuary, conditional to these funds being used to employ an agency whose job is to monitor and enforce standards of support for recreation at the Gonubie Estuary.**

Level 2: **Payment of R50 per property to the municipality by all parties identified as interested and affected users of the Gonubie Estuary, conditional to these funds being used to employ an agency whose job is to monitor and enforce standards of support for recreation at the Gonubie Estuary.**

Level 3: **No additional payment – status quo.**

The current status of the Gonubie Estuary:

…as it relates to:

1. The safety for recreation use of the water in the estuary, i.e. the water quality.
2. Public interest in the serenity of the Gonubie Estuary as an asset to enhance the recreational experience. Is this as asset actually used or just a good idea?
3. Personal security of recreation users of the estuary on its banks.

Selection of recreational use alternatives

You will be asked to make four (4) choices in total. Within each choice set, you will be asked to choose between three (3) recreational use alternatives. In other words, you will have to choose one combination of recreational use levels out of a possible three combinations of recreational use options (Option A vs. Option B vs. Option C). The recreational use alternatives vary according to:

1. The safety of the water in the estuary.
2. Public interest in serenity as an asset to enhance the recreational experience.
3. Security management relating to recreation at the estuary.
4. Payment for monitoring and enforcement service.

It is important to remember that this recreational use management project is only one of many such projects in South Africa. Also, be aware that spending more money on any alternative would mean that you would have less money to spend on all other goods and services, i.e. you face a budget constraint.

Please note that the choices are hypothetical, but plausible (based on advice from scientists). It is important to treat each of your four choices as if they were **real**, and **independent** from each other.

Please consider the example of a completed choice set given below, drawn randomly by design from Table 3.1 below, a summary of all the attributes and levels.

Attribute	Option A	Option B	Option C
Safe use of water	**Not safe for any activity involving skin contact with water, nor eating fish**	**Safe for all recreation activities**	**Leave things as they are.**
Serenity	**No change No further development**	**Unrestricted / encouraged development**	**Leave things as they are.**
Public safety	**Increase security effort**	**No change**	**Leave things as they are.**
Payment for choice	**R50.00 per year extra**	**Nothing extra**	**Leave things as they are.**
I would choose (TICK ONE BOX ONLY):		√	

TABLE 3.1 ATTRIBUTES AND LEVELS SUMMARY.

Attribute	Level 1	Level 2	Level 3
Safe use of water	**Not safe for any activity involving skin contact with water, nor eating fish**	**Safe for all recreation activities except ones with high water contact, e.g. swimming**	**Safe for all recreation activities**
Serenity	**No change No further development**	**Limited authorized development**	**Unrestricted / encouraged development**
Public safety	**No change**	**Increase security effort**	**Completely secure.**
Payment for choice	**R120.00 per year extra**	**R50.00 per year extra**	**Nothing extra**

Please continue to make your choices now – we hope you find the experience enjoyable.

3.1

Attribute	Option A	Option B	Option C
Safe use of water			
Serenity			
Public safety			
Payment for choice			
I would choose (Tick ONE BOX ONLY):			

3.2

Attribute	Option A	Option B	Option C
Safe use of water			
Serenity			
Public safety			
Payment for choice			
I would choose (Tick ONE BOX ONLY):			

3.3

Attribute	Option A	Option B	Option C
Safe use of water			
Serenity			
Public safety			
Payment for choice			
I would choose (Tick ONE BOX ONLY):			

3.4

Attribute	Option A	Option B	Option C
Safe use of water			
Serenity			
Public safety			
Payment for choice			
I would choose (Tick ONE BOX ONLY):			

Question 4: Follow-up to question 3.

4.1. Did you find it easy or difficult to make the choices in Question 3?

Difficult……. ☐
Easy………… ☐

4.2. If you answered "Difficult" in question 4.1, what made the choices hard?

Please indicate your reason(s) by making a cross[X] in all the relevant boxes.

I could not relate to the questions.. ☐
I think there was too much information to consider... ☐
I did not understand the questions... ☐
I think the alternatives were too expensive... ☐
It was difficult to choose as several factors were important.............................. ☐
I do not believe estuary users should pay to ensure a healthy estuary.............. ☐
Other (please specify):

Don't know ….. ☐

4.3. Which item did you attach the most importance to, in your choices in Question 3?

Please indicate one item only by making a cross[X]in the relevant box.

The quality of the water in the estuary.. ☐
A focus on serenity ……………………..............…….……….......... ☐
Personal security.. ☐
Size of the payment.. ☐
It varied from choice to choice.. ☐
Don't know.. ☐

4.4. If the recreational services of the Gonubie Estuary were improved, would you use the estuary more often, or would your estuary usage remain the same?

Remain the same……………………………………………………………. ☐
Use more often…………………………………………………………… ☐

Question 5: Background questions.

5.1 What is your gender? Male ☐ Female ☐

5.2 How old are you?

- Less than 20 years old ☐
- 20-29 years old ☐
- 30-39 years old ☐
- 40-49 years old ☐
- 50-59 years old ☐
- 60-69 years old ☐
- Older than 69 years old ☐

5.3. Do you live in:

- **Gonubie** ☐
- **East London** ☐

or you are a visitor, living outside of the Buffalo City area? ☐

5.4 Please state your current occupation ____

5.5 What is the size of your household's total annual gross income? Please note: This should be income before any tax deductions.

Please indicate one income category only by making a cross[X]in the relevant box.

Less than R50 000.. ☐
R 50 000-99 999 .... ☐
R 100 000-149 999... ☐
R 150 000-199 999... ☐
R 200 000-249 999... ☐
R 250 000-299 999... ☐
R 300 000-349 999... ☐
R 350 000-399 999... ☐
R 400 000-449 999... ☐
R 450 000-499 999... ☐
R 500 000-749 999... ☐
R 750 000-999 999... ☐
R 1 000 000 or above .... ☐

5.6 What is your highest level of educational attainment?
Please indicate one level of education only by making a cross[X] in the relevant box.

No education……………………………….. ☐
Primary school education….. ☐
Secondary school education..………….. ☐
Matriculation.………………….…………………………….. ☐
Technikon diploma.. ☐
University degree.. ☐
University post-graduate degree.. ☐

5.7 Do you have any further comment you may like to add regarding issues relevant to the maintenance of a healthy estuary and/or the effective management of the Gonubie Estuary?

Kindly explain on the back of this questionnaire… or, … kindly email your contribution to gchandler@wsu.ac.za *This will be used in confidence should you so wish and added into the report on the Gonubie Estuary if deemed fitting.*

The questionnaire is now finished.
Thank you so much for your valued contribution!

APPENDIX F – TESTING FOR SOURCES OF HETEROGENEITY: AN RPL MODEL FOR THE KROMME RIVER ESTUARY

RANDOM PARAMETERS MODEL – ATTEMPTS TO EXPLAIN HETEROGENEITY

DEPENDENT VARIABLE: CHOICE

INDEPENDENT VARIABLES:
NAVIGABILITY (RANDOM: UNIFORM DISTRIBUTION)
CONGEST (RANDOM: UNIFORM DISTRIBUTION),
JETSKIS (NON-RANDOM)
COST (NON-RANDOM)

INDEPENDENT VARIABLES INTERACTED WITH:
RESIDENT TYPE (LIV)
GENDER (GEN)
AGE
HOMETOWN (LIV1)
OCCUPATION (OCC)
INCOME (INC)
EDUCATION (EDU)

ESTIMATION RESULTS

Variable	Coefficient	Standard Error	b/St Er	P[|Z| > z]
Random parameters in utility functions				
NAVIG	3.97614137	2.57397202	1.545	.1224
CONGEST	.32451470	2.78921517	.116	.9074
Non-random parameters in utility functions				
USEJET	.15652081	.18818384	.832	.4056
COST	-.00341745	.00061790	-5.531	.0000
Heterogeneity in mean, Parameter: Variable				
NAVI: RES	.27576904	.39603677	.696	.4862
NAVI: GEN	.00044965	.70857616	.001	.9995
NAVI: AGE	-.01091321	.02660452	-.410	.6817
NAVI: LIV	-.01041100	.06513371	-.160	.8730
NAVI: OCC	.15158140	.14208494	1.067	.2860
NAVI: INC	.14151045	.10802049	1.310	.1902
NAVI: EDU	-.51325632	.34196534	-1.501	.1334
NAVI: LIV1	-.08180610	.20451836	-.400	.6892
CONG: RES	.05468433	.53522029	.102	.9186

Variable	**Coefficient**	**Standard Error**	**b/St Er**	**P[|Z| > z]**
CONG: GEN	.37689383	.88233535	.427	.6693
CONG: AGE	-.02682220	.03324031	-.807	.4197
CONG: LIV	-.06381171	.09322796	-.684	.4937
CONG: OCC	-.21929895	.18236255	-1.203	.2292
CONG: INC	.02478229	.11753002	.211	.8330
CONG: EDU	.01895687	.39192311	.048	.9614
CONG: LIV1	-.03534087	.25030421	-.141	.8877
Derived standard deviations of parameter distributions				
UsNAVIG	6.21427085	2.84470406	2.185	.0289
UsCONGES	9.39370944	3.84989387	2.440	.0147

APPENDIX G: CAPACITY BUILDING REPORT

Table G.1: Capacity building through Project K5/1924

Student name	Employment	Degree (year awarded)	Title of thesis
Deborah Lee	Lecturer, Nelson Mandela Metropolitan University, Port Elizabeth	PhD (2012)	An application of the choice experiment method to estimate willingness-to-pay for and guide management on estuarine recreational services
Geoff Chandler	Lecturer, Walter Sizulu University, East London	PhD (not yet submitted)	A market analysis of attributes of demand for the Nahoon and Gonubie estuaries
Radu Mihailescu	Lecturer, Stenden University, Port Alfred.	PhD (not yet submitted)	The application of choice experiments to guide the tourism management of the Kowie estuary