Managing Some Motorised Recreational Boating Challenges in South African Estuaries: A Case Study at the Kromme River Estuary

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Abstract

Estuaries in South Africa face negative crowding effects with respect to motorised boat use, due to competing demand. This paper proposes this be managed through user charges and that the setting of these charges be informed by applying a choice experiment to estimate user preferences for reduced motorized boat congestion on the Kromme River Estuary, Eastern Cape. The application of this method led the paper to deduce that users are willing to pay an additional supplementary charge of R483 per annum during peak periods in order to experience a decrease in negative crowding effects and an improvement in overall welfare.

1 Introduction

Open access to estuarine recreational areas has led to congestion and overuse (Birol and Cox, 2007). Increased human recreational demand at any given estuary will not necessarily reduce the recreational appeal of that estuary. Because of the social element in recreation, people are often more an attraction than detraction, especially within the younger cohorts. However, certain types of recreational activity are prone to negative crowding effects. Within estuaries there is a trade-off between motorised boat use and also between motorised boat users and other categories of users, like shore based fishers, residents and owners of other craft, because the space available is limited (Hay, Hosking and McKenzie, 2008). This demand competition presents the relevant authorities with a complex management scenario, requiring the development of an estuarine management plan in which all the identified use issues are addressed.

Methods available to authorities for managing motorised boat congestion on estuaries include (1) the use of zoning regulations, (2) spacing standards to

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generate safety guidelines, and (3) access to the estuary on a "first-come-first-served" basis (Sowman and Fuggle, 1987; Forbes, 1998; Field, 2001). The merit of these management approaches is that they indicate the maximum quantity of boats that can safely be accommodated on the estuary at any one time. The disadvantage of these approaches is that they have a high associated cost, with no compensating income inflow. They require extra enforcement personnel and they may arbitrarily place the estuary users' recreational experience in jeopardy if access is limited or denied when the user arrives at the estuary (for example, on a first-come first-served basis).

Currently, recreational demand at the estuary is mainly regulated with rules for use and minimally through the use of registration fees, permits and levies. Should this balance be changed to a more market driven alternative by adjusting access cost (i.e. the pricing instrument) to a level that regulates demand to the desired level automatically? This price rationing mechanism would not only limit the use of the estuary, but would also yield a revenue flow that can be used to manage recreation in the area.

This paper aims to inform management of the required change in the current boat license (i.e. the pricing instrument) to optimise special use (by motorised boat users) of an Eastern Cape estuary (EC), namely the Kromme River one. The required change is estimated in this study through the use of a stated preference technique, namely the choice experiment (CE) method. More broadly, the latter estimates the economic value that recreational users attach to selected estuarine characteristics (attributes) and recommends the use of these values as inputs to amending the existing user charge structure. To the authors' knowledge, this is the first formal attempt in South Africa to value estuarine recreational attributes by means of a CE generally and a reduction in motorised boat congestion specifically. It is hoped that the results of this study will aid future policy-making regarding estuarine management. Sections two and three of this paper discuss the CE technique and international examples of its application; section four briefly discusses estuarine management in South Africa; section five discusses the context of the research and the sampling method employed in this paper; section six discusses the empirical results of the paper and section seven concludes the paper.

2 The CE method

The most frequently used tool for modelling the choices that individuals make is the discrete choice model based on random utility theory (Bateman, Carson, Day, Hannemann, Hanley, Hett, Jones-Lee, Loomes, Mourato, Özdemiroglu, Pearce, Sugden and Swanson, 2002; Hensher, Rose and Greene, 2005). Consumers are assumed to be rational decision makers (Howard and Sheth, 1969; Abelson and Levy, 1985; Engel, Blackwell and Miniard, 1995). When they are faced with a set of possible consumption bundles of goods, they assign preferences to each of these bundles and select (randomly) the most preferred bundle from the set of affordable alternatives. This choice optimizes the consumer's utility and provides the basis for the demand function and the indirect utility function. The latter shows the maximum amount of utility that a consumer can achieve, given prices and income.

The attributes of a good determine the utility derived from the good, and therefore that utility may be expressed as a function of the attributes of the good (Lancaster, 1966). This theory assumes that consumers behave in a deterministic manner. Random utility theory introduced the concept that a consumer's behaviour is inherently probabilistic (Luce, 1959). Even though consumers can exercise discrimination when making choices, they do not have complete information and an element of uncertainty must be taken into account. Following this line of thinking, the utility function may be considered as the sum of two parts, an observed or measurable component, and an unobserved or random component (McFadden, 1974; McFadden, 1984):

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

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 and Bennett, 2007).

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

$$Viq = \beta_{1i} f_1(s_{1iq}) + ... + \beta_{ki} f_k(s_{kiq}) \tag{2}$$

where:

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

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

Equation (1) is expanded to become:

$$U_{iq} = \beta_{1i} f_1(s_{1iq}) + ... + \beta_{ki} f_k(s_{kiq}) + \varepsilon_{iq} \tag{3}$$

This random utility model may be 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 $P\left[(V_{iq} + \varepsilon_{iq}) > (V_{jq} + \varepsilon_{jq})\right]$, 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, Hensher and Swait, 2000; Nam Do and Bennett, 2007).

The probability of consumer $q$choosing option i from a choice set may be estimated by means of the maximum likelihood estimation (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 and 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 independent of irrelevant alternatives (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 is simplified by integrating the random component 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 multinomial logit (MNL) or (more correctly) the conditional logit (CL) choice model (Hanley, Mourato and Wright, 2001; Hanley, Bergmann and Wright, 2004). The CL model has the following form (Louviere *et al.,* 2000):

$$P(i|A) = \frac{1}{\sum_{j=1}^{j} \exp -(V_i - V_j)} \tag{4}$$

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 assumes, inter alia, that scale parameters have constant variance (typically equal to 1 (Ben-Akiva and Lerman, 1985). If this assumption 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):

$$P_{iq} = \frac{\exp(V_{iq}/\lambda_i)}{\sum_{j=1}^{j} \exp(V_{jq}/\lambda_j)} \tag{5}$$

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 and 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 i^{th} alternative in a choice set (A), but relaxes the assumption of independence among the random components. Substituting z in place of (ε_i/λ_i), the HEV specification of the choice is:

$$P_i = \int_{z=-\infty}^{z=+\infty} \prod_{j \in C, j \neq 1} F\left[\frac{V_i - V_j + \lambda_i z}{\lambda_j}\right] f(z)dz \tag{6}$$

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 and 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[1]. 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 and Rao, 1999; Hensher and Greene, 2002; Carlsson, Frykblom and Liljenstolpe, 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 and Bennett, 2008). A generalised version of the RPL choice model is (Louviere *et al.,* 2000):

$$P(j|\mu_i) = \frac{\exp(\alpha_{ji} + \theta_j \mathbf{z}_i + \delta_j \mathbf{f}_{ji} + \beta_{ji} \mathbf{x}_{ji})}{\sum_{j=1}^{J} \exp(\alpha_{ji} + \theta_j \mathbf{z}_i + \delta_j \mathbf{f}_{ji} + \beta_{ji} \mathbf{x}_{ji})} \tag{7}$$

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; $\mu_i$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.

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

[1] 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.

(Anderson, 2003). The latter choice is favoured for two reasons: firstly, the distribution of the marginal willingness-to-pay (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).

3 Using stated CE's to value estuarine recreational attributes

The CE technique is appropriate for this type of study as it has been developed for the valuation of environmental goods and services (Adamowicz, 1995; Bennett and Adamowicz, 2001; Hanley *et al.,* 2001; Hensher *et al.,* 2005). Numerous international CE studies have been conducted into the valuation of wetland, estuary and river attributes in different countries in order to investigate the feasibility of various management options, including Vietnam (Nam Do and Bennett, 2007), Sweden (Eggert and Olsson, 2004), Greece (Birol, Karousakis and Koundouri, 2006), England and Wales (Luisetti, Turner and Bateman, 2008), Australia and Tasmania (Kragt and Bennett, 2009) and the United States of America and Canada (Smyth, Watzin and Manning, 2009).

Nam Do and Bennett (2007) estimated wetland biodiversity values by applying a choice model to the Mekong River Delta in Vietnam. WTP values were estimated for Tram Chim National Park, one of the many wetlands found in the Delta. 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.

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. 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 at developing a strategic management plan aimed at preventing biodiversity loss.

In Greece, a CE was applied by Birol *et al.* (2006) to estimate the value of changes in different social, ecological and economic functions that the Cheimaditida wetland provides to the citizens. Study results revealed that the public derived positive and significant WTP values of enjoyment from the conservation and sustainable management of this wetland.

Luisetti *et al.* (2004) utilised an ecosystem approach to assess managed realignment coastal policies on the east coast of England. These coastal management strategies included 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 key finding of the study was that site specific value estimates derived through the use of the CE had yielded results similar to those used by other cost-benefit analyses of managed realignment, which lent support to the use of this approach for assessing future coastal management strategies.

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 assessed community preferences for different proposed management scenarios aimed at improving the quality of the catchment environment. The study revealed that Tasmanians were willing to pay for increased protection of native riverside vegetation and rare native animal and plant species in the George catchment.

Smyth *et al.* (2009) investigated public preferences for alternative management scenarios for Lake Champlain, situated in Vermont and New York, and bordering on Quebec, Canada. It was found that, although water quality and beach closures were important management issues, the public wanted policy measures aimed at improving the safety of fish for consumption.

Unfortunately, an extensive literature review produced only one example of an international CE study that investigated congestion as one of its attributes – the Banzhaf, Johnson and Mathews (2001)[2] study. The Banzhaf *et al.* (2001) study assigned two levels to the congestion attribute, namely "Many people or boats in sight" and "Some people or boats in sight". All other international congestion studies employed the contingent valuation method (CVM) and other revealed preference techniques (such as the travel cost method). The Anderson and Bonsor (1974) study[3] proposed the use of the travel cost method to estimate a 'congestion cost'. Hindsley, Landry, Bin and Vogelsong (2007) addressed the issue of congestion by means of a random utility model (RUM) of site choice. The Cicchetti and Smith (1976) study was the first CVM that investigated the impact of congestion on WTP for a once-per-season-outing. Other CVM examples include McConnell (1977), Walsh and Gilliam (1982), Walsh, Miller and Gilliam (1983), and Michael and Reiling (1997).

4 Estuarine management in South Africa

South African policies for wetland management and conservation are mainly governed by the National Water Act (Act 36 of 1998), and the National Environmental Management: Integrated Coastal Management Act (Act 24 of 2008) (NWA, 1998). The National Environmental Management: Integrated Coastal Management Act (ICMA), which was promulgated in December of 2009, requires coordinated and efficient management of estuaries in South Africa (ICMA, 2008). The ICMA is in the process of developing a National Estuarine Man-

[2] Unfortunately, this study did not estimate implicit prices for the various attributes included in the CE.

[3] This study did not calculate the congestion cost.

agement Protocol (NEMP), which will be responsible for establishing individual estuarine management plans (ICMA, 2008). In order for a management plan to integrate all aspects of the estuarine environment, management must incorporate both supply-side and demand-side factors. While supply-side measures (for example, resource directed measures) aim to limit the use of the resource in order to maintain the required level of functionality, demand side analysis aims for the optimal use of the resource.

As far as the Kromme River Estuary waterways are concerned, control is exercised by two different authorities. The canals and a section of coastline from the low-water mark to 200m offshore, are controlled by the St Francis Bay Municipality. The Kromme River itself falls under the jurisdiction of the Western Districts Council.

5 Context and the research method of the Kromme River Estuary study

5.1 *Context of the research*

A South African estuary system currently facing high motorised boat demand competition is the Kromme River Estuary. It is a popular tourist destination and intensively used for recreational purposes. Located in the EC approximately 80 kilometers (km) west of Port Elizabeth, it flows into St Francis Bay, in the Indian Ocean. It is one of the larger estuaries situated in the EC province and is classified as permanently open (Scharler and Baird, 2003). It faces, inter alia, reductions in navigability, disagreement about the use of jet skis and motorised boat congestion. Although all three of these management issues are captured as part of the CE, this paper has motorised boat congestion as its locus.

There are no access restrictions limiting the movements of boats through the Kromme River Estuary. Recreational use is concentrated over relatively short peak holiday periods, less than 30 days. Approximately 65 percent of people using the estuary own some form of water craft and the most popular recreational activities are leisure cruising and water skiing (Forbes, 1998). 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.

In 1998 it was estimated that 1 400 residents and 13 500 visitors made use of the estuary for recreational purposes (Forbes, 1998), while 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). With this large number of users of the estuary, and the limited space available (and possibly diminishing due to increased sedimentation), the occurrence of conflict between boat users of the estuary was inevitable (Lee, 2012).

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 by employing the recommended space standards (RSS)[4] defined by Sowman and Fuggle (1987) (see Appendix 1), 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[5] (see Figure 1) in the estuary in 1998 was calculated to be 295 water craft (Forbes, 1998).

This figure included both motorised and non-motorised water craft[6]. Forbes (1998) estimated the limit for water-based recreational activity to be approximately 115 craft at any given time.

In order to calculate the current physical carrying capacity for motorised recreational activities only[7], the RSS for motorised activities need to be converted to a zonal figure and compared to the current revised estimates of motorised craft usage on the estuary. The total physical carrying capacity for all zones, based on the RSS, is estimated at no more than 10.29 motorised water craft on the estuary at any given point in time (Lee, 2012). Total motorised boat usage across all zones appears to exceed physical carrying capacity by approximately 20 motorised water craft when compared to the revised recommendations for safe motorised craft usage (Lee, 2012). In all zones the physical carrying capacity is exceeded, but the excess is worst in zones A and D.

Rationing motorised boat use through the implementation of a quota is difficult to implement and enforce. A more market driven option for managing congestion is to adjust access cost to a level that regulates demand to the desired level automatically. This price rationing mechanism not only limits the use of the estuary, but it also yields a revenue flow that can be used to manage recreation in the area. As the external congestion cost is only typically incurred during peak demand periods, it is only necessary to implement an allocation mechanism (in the form of a supplementary tariff) during peak use periods.

[4] The RSS applied above assumes only one motorised recreational activity is taking place 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.

[5] These zones, starting from the mouth of the estuary, stretch for approximately 8km. Various recreational activities take place on this stretch of water, but some are focused within specific zones.

[6] The different forms of boat usage identified by Forbes (1998) were: high powered motorised activities (HPMA), for example, water skiing and jet skiing; high powered non-motorised activities (HPNMA), for example, windsurfing; low powered motorised activities (LPMA), for example, leisure cruising; oaring activities (OA), for example, rowing, canoeing and paddle skiing; sailing activities (SA); and recreational boat angling (A). Motorised boating activity occurs in all the estuary zones, but is most intense in zone D.

[7] Motorised recreational activities include leisure cruising, water skiing, jet skiing and boat fishing.

5.2 *The design of and sampling method for the Kromme River Estuary CE*

The design phase of the CE began with interviews and meetings in order to select the most policy relevant recreational attributes and their choice levels. The attributes and their levels found to be most relevant to the Kromme River Estuary residents in 2010 are presented in Table 1.

The three non-monetary attributes were each stated at two relative levels of magnitude. Focus group discussions revealed that the use of relative levels was more intuitive as opposed to percentages or absolute numbers. The monetary attribute (price) levels were based on the Kromme River Estuary's existing boat license fee of R169 per annum (2010/2011)[8].

Each respondent was presented with an introductory letter and a questionnaire. The development of the questionnaire followed the design steps proposed by Hasler, Lundhede, Martinsen, Neye and Schou (2005). These steps include (1) collecting of introductory information from the respondent through the use of an introductory section, (2) setting out of the CE with relevant descriptions of the attributes and levels, (3) provision of follow-up questions, which allow for reliability and validity checks, and (4) collection of socio-demographic information from the respondent.

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 and Carlsson, 2004; Birol *et al.,* 2006; Nam Do and Bennett, 2007). 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 the questionnaire.

A full factorial design was generated using SPSS, yielding 32 different treatment combinations or alternatives. For the purposes of this study, two alternatives per choice set (see Appendix 2) were adopted. These alternatives were randomly allocated to 32 different questionnaires. Each questionnaire contained four choice sets. For each choice set, the respondent had to choose between two alternatives or scenarios, each including a price. A "status quo" or "opt-out" option was not included in this study because it was impossible to define the existing levels of two of the non-monetary attributes, namely navigability and motorised boat congestion. These attributes remain in a constant state of flux without proper management intervention measures.

[8] An anonymous referee queried why the high-end of the scale is 3 times the license fee, while the option of double the license fee is not included. The referee argued that this may cause an upward bias. The authors followed Hensher *et al.'s* (2005) recommendation "...to identify the attribute-level label extremes..." The stakeholder interviews and pilot survey revealed these values to be R0 and R507 (3 times the existing fee). In order to minimise the cognitive burden on respondents, the authors decided to limit the number of levels for the cost attribute, which necessitated the exclusion of a cost twice the license fee – this was a strategic design decision not uncommon to CE studies.

To accommodate the current situation in terms of the cost attribute, the existing license fee was included as a level (i.e. a zero increase) – it was believed that this would avoid an upward bias in the WTP estimates[9].

The target population included all individuals who, at the time of the survey, made use of the Kromme River Estuary for recreational purposes, as well as those individuals who had high potential to make use of the estuary for recreational purposes in the future. A sample frame for the estuary could not be compiled, as the population does not reveal itself until it visits the estuary. For this reason, the sample selection process that was followed used underlying knowledge of the specific target population. 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, Smyth and Christian, 2009). On-site sampling, also known as an intercept survey, was employed and estuary users were identified when they were actually engaged in carrying out their recreational activities (Bateman *et al.,* 2002).

Sample size was determined through the use of a non-probabilistic sampling technique, known as the *rule of thumb* (Hensher *et al.,* 2005). A "*rule of thumb*" guideline commonly applied is a sample of 50 respondents, if each respondent faces 16 choice sets (Bennett and Adamowicz, 2001). This translates into a sample of 200 respondents if they are being offered 4 choice sets each. In total, 244 completed questionnaires were collected. The personal interview method was adopted as 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 (Mitchell and Carson, 1989). The questionnaire was administered on-site by seven trained interviewers during December, 2010. Every n^{th} recreational user encountered was approached and asked to participate in the study.

6 Results

6.1 *Characteristics of respondents*

The Forbes (1998) and the Sale (2007) studies provide the latest comprehensive analyses of the characteristics of recreational users to the Kromme River Estuary against which to judge the representativeness of this sample of users in the CE survey. If the characteristics of the users in this study and the users in the Forbes (1998) and Sale (2007) studies correspond then reasonable confidence can be placed in the ensuing estimates of implicit prices for the recreational attributes. Comparison with the Forbes (1998) data is possible for residential location, whilst the Sale (2007) study provided information about the average recreational user's education and income per annum.

Fifty-nine percent of visitors in this study came from areas more than 50km away from the estuary, as opposed to 75.5 percent in the Forbes (1998) study.

[9] An anonymous referee was concerned that the absence of an explicit status quo option would bias the WTP estimates upwards.

Local residents made up 27 percent of the sample surveyed in this study compared to 18.9 percent in the Forbes (1998) study. The current study reflects a growth in the recreational use of the estuary of visitors from cities or towns less than 200km away. The middle-income earners' gross income for the sample in this study was R222 000, whereas the Sale (2007) study found an average gross income of about R257 000 per year (adjusted for inflation). Of the respondents sampled in this study, the average number of years of education was 13.8 years compared to the 13 years recorded in the Sale (2007) study. The majority (64 percent) of recreational users surveyed were males over the age of 35[10]. Therefore, the sample survey data in this study appeared to broadly correspond with the characteristics of the Forbes (1998) and Sale (2007) studies.

6.2 *Model estimation*

Three different choice model specifications were estimated: a CL model, an HEV model and an 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 two different options: option A and option B. 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. Table 2 gives the estimated model results.

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 95 percent confidence level (at least).

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 cost. The significant coefficients of the CL model can be interpreted by estimating their odds ratios. An increase in boat congestion will result in a 0.3 percent decrease in the probability of a respondent choosing this option.

Like the CL model, the results of the HEV 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: "Navigability", "Congestion" and "Cost".

Table 2 reports the results for two RPL models. Two of the recreational attributes were treated as random variables; "Navigability" and "Congestion". A normal distribution was selected for both the random parameters specified in the first RPL model. In the second RPL model, these random parameters assumed a uniform distribution.

Allowing the preferences for these two recreational attributes ("Navigability" and "Congestion") to vary across respondents shows that there is unexplained heterogeneity in respondent preferences. In both models, the standard deviation coefficients are statistically significant, indicating statistically dissimilar preferences for these attributes across respondents. In other words, the random

[10] Unfortunately, there are no data to compare these values to.

variables specified in the RPL models indicate that respondents were divided in their views regarding the need to increase estuary navigability, and reduce boat congestion.

The RPL models indicate the presence of unobserved heterogeneity, but fail to explain the sources of the heterogeneity (Adamowicz and 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 inclusion of interactions can improve model fit (Revelt and Train, 1998). A series of respondent-specific control variables were included in the RPL specification[11]. 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 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).

6.3 *Estimation of WTP values*

From the estimated RPL models, the marginal WTP values (implicit prices) can be estimated. 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 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 jet ski or wet bike access to the potential use of jet skis and wet bikes on the estuary. Table 3 reports the implicit prices, or marginal WTP, for each of the Kromme River Estuary's recreational attributes estimated using the Delta method (Wald procedure) in LIMDEP NLOGIT Version 4.0 (Greene, 2007). WTP estimates are calculated using the first RPL model where the random parameters were normally distributed, namely "Navigability" and "Congestion".

The maximum amount, on average, that a person is willing to pay in order to reduce the level of boat congestion on this estuary was calculated to be R483 per annum (2010 price level). Unfortunately, data on the average number of motorised boat days per boater per annum is not available – thus, a daily WTP per boater to avoid congestion could not be calculated. Due to the uniqueness of the study, the attributes valued, the study site, and a lack of data, comparisons with similar studies are not possible. Despite this, the results from a few CVM congestion studies are discussed below.

[11] 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".

The McConnell (1977) study showed that the average visitor's surplus per day is reduced by approximately 25 percent for an additional 100 people per acre on the average beach. Walsh and Gilliam (1982) estimated that the WTP for hiking and backpacking at Indian Peaks, Colorado would decrease by \$0.21 per day and \$0.27 per day, respectively with each extra person encountered. Walsh *et al.* (1983) estimated the reductions in WTP due to the presence of an additional skier per acre on the ski slopes of three sites. This reduction was equal to \$0.22, \$0.18 and \$0.09, respectively at the Vale, Copper Mountain and Loveland Basin sites. The Michael and Reiling (1997) study showed that the WTP to see fewer groups than expected during wilderness visits is \$43.37 for weekday visitors and \$15.06 for weekend visitors.

A common trend among all these studies, including the current one, is that the congestion variable's coefficient had a negative sign – thus, visitors to recreation sites are generally willing to pay to avoid congestion.

7 Conclusion

Increased human recreational demand at any estuary can lead to negative crowding effects. Rationing boat use through the implementation of a quota, or relying on self-regulation (automatic market resolution), are not always the most appropriate options for reducing boat congestion (Field, 2001; Flaaten, 2010). Quotas can be difficult to implement due to practical considerations. For example, high costs and the absence of competent physical enforcement may make it difficult to implement them (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 and Bulte, 2000). Under these circumstances, the use of prices is an attractive management option by which to ration use. Adding a congestion cost (in the form of a supplementary tariff) to the existing boat license fee structure is only required during peak use periods. This paper calculates that respondents at the Kromme River Estuary are willing to trade-off decreased peak period boat congestion with an increase in license fee costs of R483 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 R483 for boat use during the months from November to February (using 2010 prices). The application of this management control initiative would increase the boat license fee to R652 per annum (2010 price level) for those boat owners making use of the estuary between the months of November and February each year, and, by our calculations, leave the boat user community no worse off than they were before the supplementary tariff was imposed.

Based on the results of this study, it appears that the CE method is a viable option for estimating boat users' WTP for reduced boat congestion. As estuaries along the South African coastline differ in terms of their ecological functioning, levels of bank development and levels of recreational use, it is impossible to apply the congestion charge estimated for the Kromme River Estuary universally. It is preferable to conduct a similar valuation study at each South African estuary facing high motorised boat demand competition as the policy intervention should be estuary specific.

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Table 1: Attributes and levels for the Kromme River Estuary

Attribute	Levels	Description of levels
Level of estuary navigability	Ideal navigability	The estuary is completely navigable at any tide
	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
Boat 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
Potential use of jet skis/wet bikes	Unbanned, with enforced regulation	Let jet skis and wet bikes use the estuary, but in a regulated manner with very strict law enforcement
	Banned	Keep the ban on jet skis and wet bikes in place
Cost	R0	A fixed annual sum added to the existing boat license fee. This added sum will be directed back to the Kromme River Estuary as an environmental quality levy.
	R85	
	R169	
	R507	

Table 2: Estimation results of the CE

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*

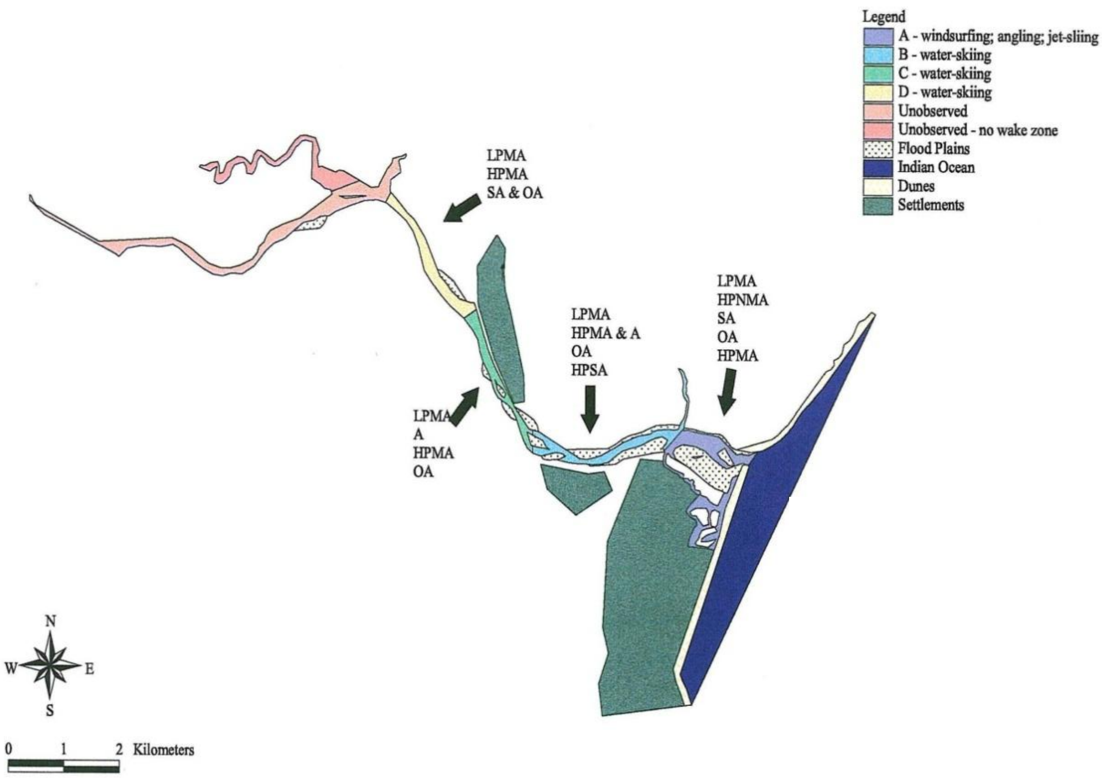
1. *Jet skiing and Cost were specified as non-random parameters in both the RPL models.*
2. *The random parameters were normally distributed in Model 1.*
3. *The random parameters were uniformly distributed in Model 2.*

Table 3: Marginal WTP (MWTP) for attributes (Rands)* and 95 percent confidence intervals (CI) - Kromme River Estuary**

Attribute	**Marginal WTP value**
Navigability	586 (231; 940)
Congestion	-483 (-841; -124)

**Please note that an implicit price was not calculated for the Jet Skiing attribute as the estimated coefficient was statistically insignificant.*
***Confidence intervals in parentheses.*

Figure 1: Recreational zones of the Kromme River Estuary



Source: Forbes (1998)

Appendix 1: Space standards for recreational water activities

Recreational Activity	**Crafts per Hectare (ha)**
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) and Forbes (1998)

Appendix 2: An example of a completed choice set

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)	R0	R169
I would choose (TICK ONE BOX ONLY):	√	□