Valuing estuarine recreational attributes: an application of the choice experiment method to the Sundays River Estuary

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Abstract

The recreational interest in estuaries is increasing and as a result they need to be managed carefully. The extent of use of an estuary depends partly on the number and quality of recreational attributes it possesses. In order to manage an estuary, policy-makers need information about the values of different recreational attributes. Conducting a choice experiment on the Sundays River Estuary, we are able to identify attributes that increase and decrease recreational users' value of the estuary. Using a random parameter logit model we find that the physical size of the fish stock is the greatest contributor to welfare.

Keywords: Estuary, choice modeling, attribute, level, willingness-to-pay, conditional logit model

1. Introduction

The natural beauty of estuaries, coupled with easy access and the various services provided by these systems makes them a major draw card for the country's population. The recreational, commercial and industrial use of estuaries, and the rivers that sustain them, have led to a partial loss of the environmental service flows supplied by them. The future conservation status of many estuaries around the South African coastline is under severe pressure due to water abstraction, pollution, bank development and overexploitation of estuarine resources. Of the 465 estuaries identified around the South African coastline approximately 250 are deemed functional (Day, 1980). The condition of

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South African estuaries has been a concern since the 1970s when it was revealed that a minor number of estuaries remained in their natural state (Heydorn, 1972). The loss of environmental service flows has adverse economic consequences - the residential and holiday recreational appeal of the estuaries is diminished.

One estuarine system currently under pressure is the Sundays River one. Over time, the lower reaches of the Sundays River Estuary have been significantly developed. This estuary also experiences high boat use during peak holiday seasons. It is also the victim of recreational over-fishing, which is threatening the future availability of estuarine fish species. Public access to the estuary is also limited.

The primary objective of this study is twofold: first, to determine the extent of the recreational over-fishing, boat congestion and public access with respect to the Sundays River Estuary; and second, to devise possible management strategies based on a choice modeling experiment of estuary user behaviour.

In what follows, other estuary valuation studies are described, the Sundays River Estuary choice experiment's design and data collection is described, the estimation results presented and conclusions and recommendations provided.

2. Estuary valuation studies

The primary valuation method proposed for this study is the choice experiment (CE) technique. It is a survey based method that models preferences for goods and services, where these goods and services are represented in terms of different levels of attributes. More specifically, the CE technique was initially developed for the analysis of markets (Batsell and Louviere, 1992; Louviere, 1988), but further development allowed for the increased use of this technique in valuing non-market goods (Adamowicz, 1995; Boxall, Adamowicz, Swait, Williams and Louviere, 1996; Hanley, Macmillan, Wright, Bullock, Simpson, Parrison and Crabtree, 1998a; Hanley, Wright and Adamowicz, 1998b; Hanley, Mourato and Wright, 2001). The conceptual roots of this technique can be found in

Lancaster's 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 modeling of choice, target populations i.e. respondents, are presented with alternative packages of attributes and levels. They are then asked to make a choice between these alternative packages. When the price of the composite good is included as one of the attributes within an alternative package, it is possible to then determine willingness-to-pay (welfare) values for each attribute within the alternative (Hanemann, 1984).

Numerous international choice modeling studies have been conducted into the valuation of wetland, estuary and river attributes in a variety of countries including Vietnam (Nam Do & Bennett, 2007), Sweden (Carlsson, Frykblom & Liljenstolpe, 2003), Japan (Kuriyama, 1998), England and Wales (Georgiou, Bateman, Cole & Hadley, 2000; EFTEC, 2002; Hanley, Adamowicz & Wright, 2002; Luisetti, Turner & Bateman, 2008; Hanley, Wright & Alvarez-Farizo, 2006), Greece (Birol, Karousakis & Koundouri, 2006a, 2006b), Australia and Tasmania (Morrison & Bennett, 2004; Rolfe, Alam, Windle & Whitten, 2004; Rolfe & Windle, 2005; Kragt, Bennett, Lloyd & Dumsday, 2007; Windle & Rolfe, 2009; Mazur & Bennett, 2009), and the United States of America and Canada (Opaluch, Grigalunas, Diamantides, Mazzotta & Johnston, 1999; Heberling, Shortle & Fisher, 2000; Smyth, Watzin & Manning, 2009). Estuary attribute valuation studies in South Africa, however, are limited. The Water Research Commission (WRC) commissioned a study in 2008 to generate information on guiding the allocation of river water to South African estuaries and to investigate the factors that explain willingness to pay for river inflows into South African estuaries (Olivier, 2010). This study applied a choice experiment (CE) to various attributes of the Bushmans Estuary, in the Eastern Cape Province.

For the purpose of estuary management, a choice experiment 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 recreation 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.

3. The Sundays River Estuary choice experiment

3.1 Recreational management issues: the valuation scenarios

The choice experiment concerns a valuation of people's preferences for recreational services provided by the Sundays River Estuary located in the Eastern Cape, South Africa. Figure 1 below shows the Sundays River Estuary with six well-defined spatial zones.

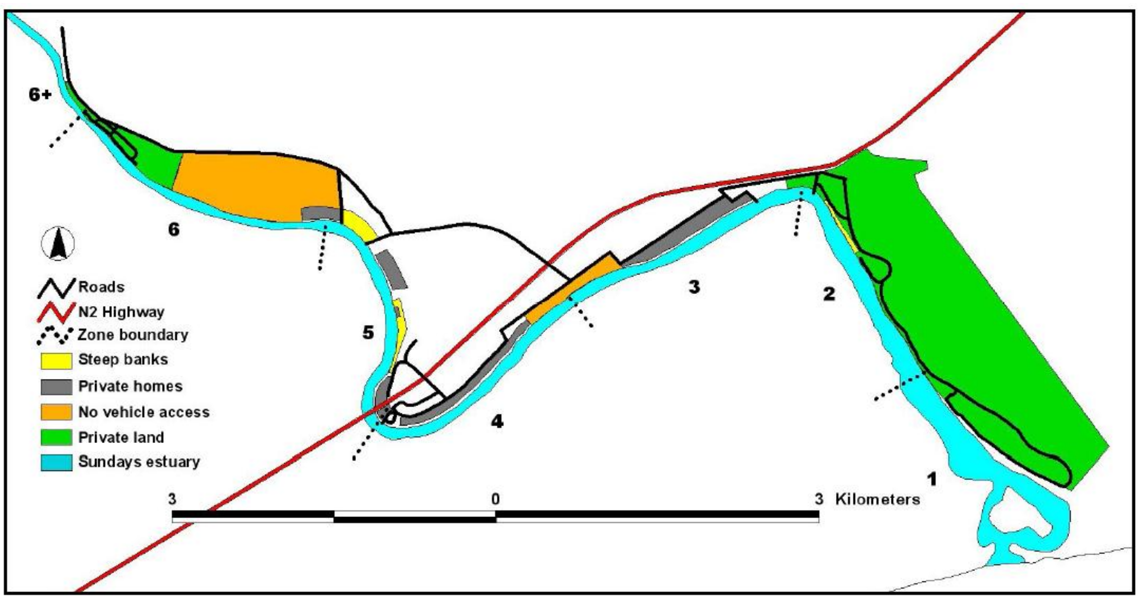

Figure 1: Spatial zones for the Sundays River Estuary
Source: Cowley, Childs & Bennett (2009)

Discussions with estuary experts and users of the Sundays River Estuary (Sundays River Joint River Forum, and Sundays River Ratepayers Association) revealed that the following recreational use issues deserved immediate attention as far as management of the estuary is concerned, namely the physical size of the fish stocks, the level of boat congestion and the level of public access. The current status of each of these issues is discussed below.

Three main fish species are targeted by recreational fishers in the Sundays River Estuary, namely Dusky Kob (*Argyrosomus japonicas*), Spotted Grunter (*Pomadasys commersonnii*) and White Steenbras (*Lithognathus lithognathus*). It has been documented that the stocks of these three species have declined over the past five years (Cowley, Childs and Bennett, 2009). It has also become apparent that these fish species are not being allowed to reach their adult size, due to over-fishing and high retention rates of undersized fish. Of those fish retained by anglers, 63 percent of the Dusky Kob was below the legal size limit, 100 percent of the White Steenbras was below the legal size limit, and 30 percent of the Spotted Grunter was below the legal size limit (Cowley *et al.*, 2009). The combination of over-fishing, high retention rates and high percentages of illegally kept undersized fish has led to the collapse of the Dusky Kob and White Steebras fish populations, while the stock status of the Spotted Grunter is considered to be overexploited within the estuary (Cowley *et al.*, 2009).

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. Motorized boating is not spatially restricted to certain zones within the estuary (see Figure 1), but is, however, concentrated around the two main slipways, representing zones 3 and 4 (Cowley *et al.*, 2009). Other forms of motorized activity also concentrated around zones 3 and 4 include water-skiing and jet-skiing. At times, especially during weekends and peak season periods, these zones within the estuary can become overcrowded with boating activities, and thus pose a safety threat to the general recreational swimmer or paddler.

Land use in the proximity of the estuary is largely residential and agricultural (IECM, 2010). The development of Colchester and Cannonville was poorly planned, however, and this has resulted in development too close to the banks of the estuary. This has led to limited access to the estuary, due to steep inaccessible banks on the eastern side, private homes in general, and private farms on the western edge. There has also been illegal building and privatization of jetty's which further limits movements along the estuary's banks. The building of gabion baskets and built walls to attempt to stabilize the estuary's steep banks, has led to natural habitat destruction, i.e. the loss of bird nesting sites in steep areas. There is, however, a need for more access to the estuary for recreational activities. In order to improve safe public access for all recreational users, and at the same time prevent further development from encroaching on the estuary banks, a Greenbelt Waterfront Nature Trail was proposed (Afri-Coast, 2004). This would preserve a large section of river frontage.

3.2 The survey

The development of the Sundays River Estuary choice experiment questionnaire followed the design steps proposed by Hasler, Lundhede, Martinsen, Neye & Schou (2005) and consisted of four parts. The first part entailed the collection of introductory information from the respondent. The second part involved the setting out of the choice experiment with relevant descriptions of the attributes and levels. The third part asked follow-up questions, which allow for reliability and validity checks as far as the choices are concerned. The final part elicited socio-demographic information from the respondent.

The attributes and their associated levels selected for the Sundays River Estuary choice experiment are presented in Table 1 below. The attribute levels in Table 1 were derived from expert interviews and recreational user discussions.

Table 1: 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 1 above, assumed two different levels. These qualitative attributes have been set in order to assess whether there is increased welfare associated with the choice of one option over the other. The written description of the monetary attribute or cost variable is given below:

“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 choice experiment. It was considered to be ‘credible, relevant, acceptable and non-coercive’ in nature (Bateman, Carson, Day, Hanemann, Hanley, Hett, Jones-Lee, Loomes, Mourato, Özdemiroglu, Pearce, Sugden & Swanson, 2002).

Experimental design occurred once the number of attributes and levels were known. The estuary had 4 attributes. Three of the attributes had 2 levels each, and one had 4 levels. A full factorial design (i.e. 2*2*2*4 = 32) was generated using SPSS which yielded 32 different treatment combinations or alternatives. These alternatives were randomly allocated to 32 different questionnaires containing 4 choice sets each. Each choice set had 2 alternatives.

3.3 Data collection

The population of interest with respect to the Sundays River Estuary was all users and potential users (current non-users) of the recreational services provided by the estuary. A *rule of thumb* was employed in this case where only design attributes were included in the analysis and only unlabelled alternatives were used, namely that a sample of 50 respondents each exposed to 16 choice sets is acceptable (Bennett & Adamowicz, 2001). This translates into a sample of 200 respondents if they are offered 4 choice sets each.

The Sundays River Estuary questionnaire was administered on-site by four trained interviewers during August, 2010. 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. In total, 175 completed questionnaires were collected. Since a face-to-face interview technique was adopted, non-response was zero.

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.

3.4 Econometric specification

In the analysis we applied a random parameter logit (RPL) model, which is a generalisation of the standard multinomial logit. The advantages of using this model are that (1) the alternatives are not independent, i.e. the model does not follow the IIA assumption, and (2) the existence of unobserved heterogeneity can be investigated (Carlsson *et al.*, 2003; Hensher and Greene, 2002). Early studies implementing the RPL model in order to account for preference heterogeneity include Bhat (1997) and Revelt and Train (1999). More recent applications of the RPL model have indicated that it is better than the CL model in terms of fit and overall welfare estimates (Carlsson *et al.*, 2003; Kragt and Bennett, 2008; MacDonald, Barnes, Bennett, Morrison & Young, 2005).

A generalised version of the RPL model is given in equation (1) below (Louviere, Hensher & Swait, 2000):

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

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.

When estimating the RPL, it is necessary to make an assumption about the distribution of each of the random coefficients (Carlsson *et al.*, 2003). All choice attributes can be included in the RPL model as random (Kragt & Bennett, 2008), however, this can lead to convergence problems and poorly defined WTP measures (Brownstone, 2001). The literature suggests fixing at least one variable as non-random, as this can help with stability and identification issues (Revelt & Train, 1999). The random parameters can take on a number of different pre-defined functional forms, the most popular typically exhibiting normal, triangular, uniform and log-normal distributions. The log-normal functional form is usually applied if the response parameter needs to be a specific sign (Louviere *et al.*, 2000; Carlsson *et al.*, 2003). If dummy variables are being used, then a uniform distribution with a (0, 1) bound is considered appropriate. Practically speaking, it can be difficult to determine which variables to distribute and which distributions to choose. A Lagrange Multiplier (LM) test, proposed by McFadden and Train (2000), can be used to determine which parameters should be randomised. This test, however, does not indicate which distribution should be specified for those parameters identified as random. Some applications in the literature only randomise the cost variable (Layton, 2000) whereas others choose to randomise all other non-price variables and leave cost as non-random (Anderson, 2003). The latter choice is favoured for two reasons: first, the distribution of the marginal willingness-to-pay for an attribute is then simply the distribution of that attribute's parameter estimate, and two, the researcher wished to restrict the cost variable to be non-positive for all individuals (Carlsson *et al.*, 2003).

Once the appropriate model has been estimated, the willingness-to-pay (WTP) for each attribute can be derived. These estimates are also known as implicit prices and 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 thus be interpreted as the average marginal willingness-to-pay 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 (2) below:

$$IP = -\left[\frac{\beta_a}{\alpha}\right] \qquad (2)$$

where:

β_a is the parameter estimate of the specific attribute X_a; (Hanley *et al.*, 2006) and

α is the parameter estimate of the price variable.

In order for these welfare estimates to have value, the parameter estimates for each attribute need to be statistically significant (Hensher, Rose & Greene, 2005).

4. Results

4.1 Data cleaning

Once the data collection for the Sundays River Estuary had been completed, the data was captured into MS Excel. There were a total of 175 usable questionnaires. At this point, the data was checked for inconsistencies. An important aspect when checking for inconsistencies are possible correlations within the data. Severe correlations among the design attributes could lead to the problem of multicollinearity in the model. Correlations can be introduced into a model through a loss of design orthogonality. In short, the level of orthogonal loss is a question of correlation, and thus multicollinearity (Hensher *et al.*, 2005). A number of methods are available to the researcher to test for the existence of multicollinearity. Unfortunately, if the presence of multicollinearity is detected there is very little the researcher can do. A very undesirable solution to this problem is to ignore all but one of the affected attributes (Hensher *et al.*, 2005). It is best, however, that multicollinearity be avoided right from the outset.

The test applied in this study used the method of auxiliary regressions (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:

$$R_i = \frac{\left[R^2_{x1x2x3\ldots xk} / (k-2)\right]}{\left[\left(1 - R^2_{x1x2x3\ldots xk}\right) / (n-k+1)\right]} \qquad (3)$$

where:

$R^2_{x1x2x3...xk}$	=	the coefficient of determination of the regression of attribute x_i on the remaining attributes;
k	=	the number of explanatory variables in the model including the constant and;
n	=	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, then the attribute x_i is correlated with the remaining attributes – in other words, multicollinearity is an issue in model estimation (Hensher *et al.*, 2005).

The results of this test for the Sundays River Estuary design are shown in Table 2 below.

Table 2: Results – the method of auxiliary regressions

Dependent variable in auxiliary regression	**Regressors**	**Auxiliary regression R^2**	**R_i**	**F-statistic***
Size of fish	Congestion, Public access, Cost	0.001231897	0.86	3.00
Congestion	Size of fish, Public access, Cost	0.001059133	0.74	
Public access	Size of fish, Congestion, Cost	0.000291632	0.20	
Cost	Size of fish, Congestion, Public access	0.001855189	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 remains 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 2 above, none of the R_i values exceed the associated critical F-statistic (i.e. 3.00). Thus, it can be concluded that multicollinearity is not a problem in this particular case. Moreover, design orthogonality has not been lost, which means that a sound procedure was followed in allocating choice sets to decision-makers.

4.2 Socio-economic characteristics

Summary statistics for the two continuous variables, namely age and income, are presented in Table 3 below. In order to calculate average income, respondents were allocated random income values within their specified income category. This income value was generated by using a random number generator in the statistical package Stata Version 11.0. These values were then summed and divided by the total number of respondents, i.e. 175.

Table 3: Summary statistics for continuous variables

Variable	**Description**	**Mean**	**Std. dev.**	**Min**	**Max**
Age	Age of the respondent, in years	36.8	11.7	18	77
Income	Annual gross income, before tax deductions (rands)	184 979.40	219 465	740.93	1 375 561

Descriptive statistics for the derived categorical variables are presented in Table 4 below. Occupational categories are defined according to the Statistics South Africa classifications. These classifications are in line with the International Standard Classification of Occupations (ISCO) and also represent the South African Standard Classification of Occupations (SASCO).

Table 4: Descriptive statistics for categorical variables

Variable	Description	Category	Percentage
Gender	Respondents gender	Male	84
		Female	16
Education	Respondents highest level of completed education	Completed Primary	0
		Incomplete Secondary	8
		Matriculation	35
		Technikon Diploma	27
		University Degree	21
		University Postgraduate Degree	9
Occupation	Respondents occupational category	Legislators, senior officials, managers	14
		Professionals	12
		Technical and associate professionals	9
		Clerks	5
		Service and market/sales workers	15
		Skilled agricultural and fishery workers	1
		Craft and related trade workers	15
		Plant and Machinery workers	2
		Elementary occupations	1
		Self employed	14
		Student	10
		Unspecified	2

4.3 Non-parametric estimates

Rational respondent behaviour, i.e. decreasing demand in response to increasing prices, was tested non-parametrically. This relationship is shown below by graphing the price of an alternative against the frequency of the alternative being chosen. Figure 2 graphs the number of chosen alternatives (the vertical axis) for a given cost size (the horizontal axis), ignoring the influence from the other three attributes in a choice set.

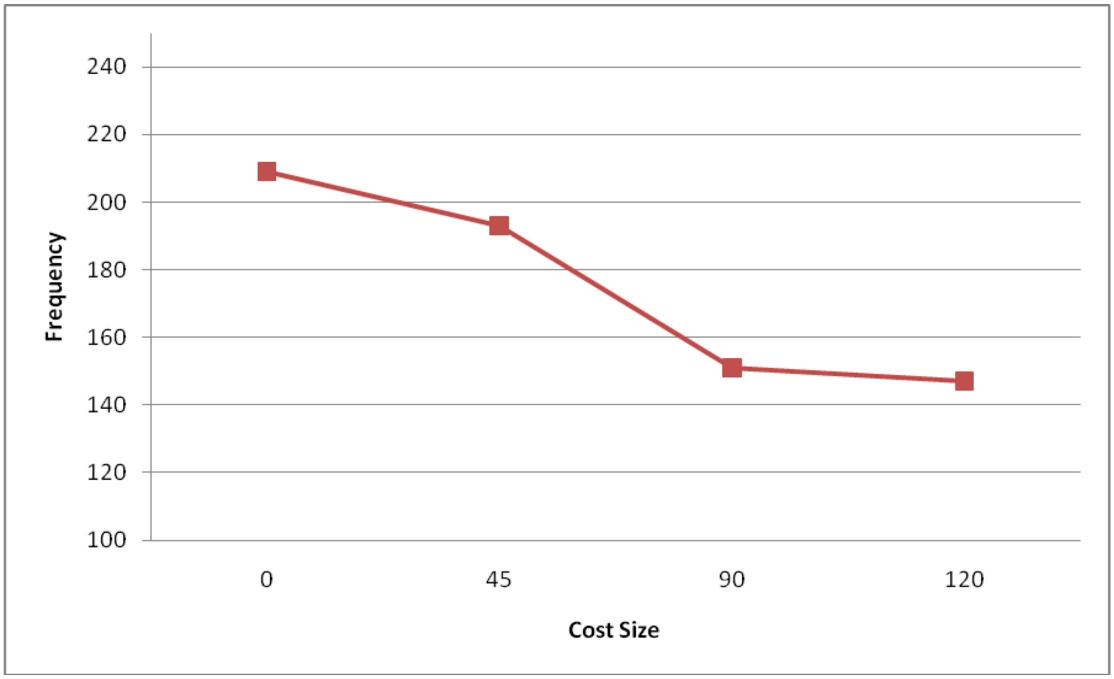

Figure 2: The relationship between cost size and frequency of chosen alternative

It is reasonable to expect that the number of chosen alternatives would drop as the cost associated with that alternative increases. Figure 2 above resembles a normal downward sloping demand curve, and thus confirms this reflection.

4.4 Parametric estimates

Using Limdep Nlogit 4.0 we estimated the RPL with simulated maximum likelihood using Halton draws with 500 replications. For comparison, we also estimated a standard conditional logit model. Both models estimated show the importance of choice set attributes in explaining respondents' choices across the two different options: option A and option B. Two utility functions were derived from the models. Each function represents the utility generated by one of the two options. For these two utility functions, utility is determined by the levels of the four attributes in the choice sets. Thus, the models provide an estimate of the effect of a change in any of these attributes on the probability that one of these options will be chosen.

In the RPL model, recreational attribute parameters are treated as random variables except for the cost variable. In the case of the random variables (i.e. "Physical size of fish stock", "Congestion" and "Public access"), each coefficient includes both a systematic and a random component, and thus, 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[1] was selected for all the random parameters. The "Cost" variable was specified as fixed, and not randomly distributed, for two reasons: first, the distribution of the marginal willingness-to-pay for an attribute is then simply the distribution of that attribute's coefficient, and two, the researcher wished to restrict the cost variable to be non-positive for all individuals.

The results of the RPL model (see Table 5 below) indicate that all the coefficients[2] have the correct *a priori* signs[3] and three of the four coefficients are significantly different from zero at the 99 percent confidence level, namely the "Physical size of fish stock", "Public access" and "Cost".

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 (i.e. cost).

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[1] Other options include a uniform distribution, a triangular distribution, and a lognormal distribution (Hensher *et al.*, 2005).

[2] 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.

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

The RPL model fits the data well - Louviere *et al.* (2000) suggest that a Pseudo R-squared between 0.2 and 0.4 is considered very good.

Table 5: Estimation results of the choice experiment[4]

Variables	**Conditional Logit**		**Random Parameters Logit**	
	Coeff.	**Std err.**	**Coeff.**	**Std err.**
Physical size of fish	1.59225259**	.14157877	1.95816676**	.53555192
Congestion	-.34136177**	.13044418	-.39402824*	.15836246
Public access	.34253510**	.12461801	.38157738**	.14429206
Cost[1]	-.01033063**	.00144555	-.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	
No. of choice sets	700		700	
Pseudo R^2	.22091		.2386784	

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

Comparing the results from the RPL and conditional logit 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. In other words, the random variables specified in the RPL elicit general consensus regarding the need to increase the

[4] The number of iterations taken to fit a model is an important aspect of interpreting Nlogit output (Hensher *et al.*, 2005). It is argued that if more than 25 iterations have occurred in estimating a conditional logit model then the researcher should be suspicious of the final model produced (Hensher et al., 2005). In this case, the number of iterations taken for the conditional and RPL, respectively, were 6 and 18.

physical size of fish stocks, the desire for less boat congestion, and the need for increased public access.

The implicit price results shown in Table 6 below provide relevant input for policy-makers when developing a management plan for the Sundays River Estuary.

Table 6: Marginal WTP for attributes (Rands)

Attributes	**Conditional logit**	**RPL**
Physical size of fish stock	154.13	173.87
Congestion	33.04	34.99
Public access	33.16	33.88

The differences in WTP between the two models are not very large, perhaps with the exception of “Physical size of fish stock”. Consequently, there is no clear pattern in the gain of the WTP estimates. The important additional information that the RPL provides is perhaps mainly that there is homogeneity when it comes to the preferences for the attributes.

5. Conclusions

What are the values of an estuary’s recreational attributes and how should an estuary be managed to optimize users’ welfare? Through the use of a choice experiment, we have identified a number of recreational attributes that either increase or decrease the utility derived from an estuary. The results are for the Sundays River Estuary situated in the Eastern Cape, South Africa. Over time, the lower reaches of this estuary have been significantly developed and it experiences high boat use during peak holiday seasons. It is also the victim of recreational over-fishing and public access to the estuary is limited. These circumstances probably affect the results and as such cannot readily be transferred to other estuaries. It is, however, possible to still learn something by analysis of the estimated results. First, the “Physical size of fish stock” has the highest implicit price in this study. Second, “Congestion” decreases social welfare whilst “Public access” increases social welfare. Finally, a comparison of the standard conditional logit model with the random parameter logit model reveals that the less restrictive latter model provides the analyst with information that cannot be got from the standard model. More specifically, 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. In other words, the random variables specified in the random parameter logit elicits general consensus regarding the need to increase the physical size of fish stocks, the desire for less boat congestion, and the need for increased public access.

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