Application of the contingent valuation method to estimate the willingness-to-pay for restoring indigenous vegetation in Underberg, Kwazulu-Natal, South Africa[1]

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Abstract

This study estimates the willingness-to-pay (WTP) for a project (i.e. the Working for Water Programme) aimed at removing alien vegetation and restoring indigenous vegetation in Underberg, KwaZulu-Natal, South Africa. The WTP estimate reflects the benefit of preference for indigenous vegetation over alien vegetation. In a survey, a questionnaire was administered to 260 households in the Underberg region during September 2005. It was deduced that the mean WTP for the project was R21.12 in 2005 (R26.40 in 2008), the total WTP was R25 344.00 (R31 680.00 in 2008) and the WTP per hectare was R21.87 (R27.34 in 2008). A valuation function to predict WTP responses was also estimated. The function showed that knowledge of the local Working for Water Programme and income were important determinants of WTP.

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1 Introduction

The Working for Water Programme is a public works programme designed to clear South Africa of invasive alien vegetation and to restore low-water consuming indigenous vegetation in the areas that have been cleared (Marais, 1998). Funds to clear alien invasive plants were initially secured on the basis that such a programme would increase water runoff in an arid country like South Africa, and provide social benefits through job creation and training. However, Hosking et al. (2002) showed that an increased water runoff does not constitute an economic case for the continuation of the Working for Water Programme and that it was necessary to consider the value of non-water benefits.[2] These include:

- reduced fire protection costs and reduced damage to infrastructure as a result of wildfires;
- conservation of biodiversity and ecosystem resilience;
- a gain in potentially productive land;
- the creation of value-added industries;
- an increase in water quality;
- improved river system services;
- social development and poverty alleviation;
- economic empowerment and training;
- flood control; and
- the containment of erosion and a decrease in the siltation of dams (Marais et al., 2000).

There is, however, a paucity of studies attempting to derive values for most of the abovementioned non-water benefits. This study attempts to value a specific non-water benefit, namely biodiversity conservation at the Underberg Working for Water Programme site. The purpose of this study is to determine households' total WTP for a project that would eradicate alien vegetation and restore indigenous vegetation in order to improve the environmental service flows provided by the indigenous vegetation.

The remainder of the paper is organised as follows. Section 2 provides a background discussion to the study with special reference to the importance of biodiversity in South Africa, the techniques available for valuing biodiversity services, and a description of the study site. Section 3 outlines the methodology used, questionnaire development, and the sample design process. Section 4 provides a review of the results of the study. The fifth section provides a general discussion of these results, and the final section concludes with the summary and policy implications.

2 Background

South Africa's landscapes and biodiversity attract several million tourists annually (*South Africa's Biome Diversity*, 2004). About 70 per cent of foreign tourists to South Africa rated the natural environment and scenic beauty as the most enjoyable aspects of their stay (*South Africa's Biome Diversity*, 2004). A study conducted by Turpie et al. (2003) supports these findings. They found that 80 per cent of the tourists surveyed in the Cape Floristic Region cited natural or semi-natural (rural) attractions as the primary reason for their visit. Despite the high recreational demand for South Africa's natural resources, such as biodiversity, their conservation is not a major concern in the country, considering that it is faced with so many demanding social issues (Turpie et al., 2008). The pursuit of economic development to deal with these social issues sometimes undermines the quest for and achievement of conservation goals. Moreover, this type of development may have a detrimental effect on the state of ecosystems and their ability to produce goods and services, such as biodiversity services (Turpie et al., 2008).

Because biodiversity services benefit people and are scarce, these services supply people with utility and thus have value (Loomis et al., 2000). The services, however, exhibit public good characteristics. More specifically, actual payments are not necessary for entering or using the services provided by indigenous vegetation, so no demand curve can be created from quantity and price information. Furthermore, one user's consumption of the indigenous vegetation's services does not diminish other users' consumption levels, nor does it diminish the utility others derive from consuming its services, as long as the area harbouring the indigenous vegetation is not heavily congested with users. Thus, and in theory, traditional market pricing is inefficient (Hanley & Spash, 1993). Non-market valuation techniques can be applied to monetise the value of services provided by indigenous vegetation.

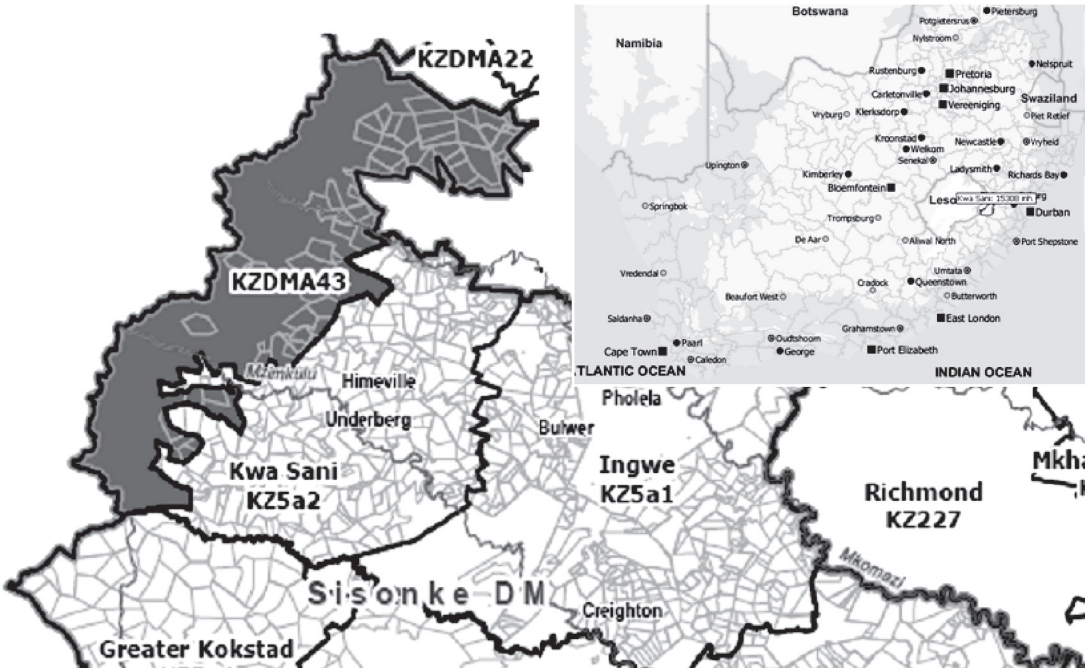
There are two broad categories of non-market valuation techniques whereby the benefit of preference for indigenous vegetation over alien vegetation can be valued: those that use expressed preference and those that use revealed preference. The latter models are built upon the hypothesis that it is possible to infer people's preferences for environmental goods and estimate demand curves by observing their actual behaviour (Hanley & Spash, 1993). Two revealed preference techniques that are often used are the hedonic pricing method and the travel cost method. If the removal of alien vegetation and its replacement with indigenous vegetation happens on a site adjacent to residences in an urban setting, the hedonic pricing method may be used. This pricing method attempts to isolate the specific value of an environmental amenity from the market price of the good (Loomis et al., 2000). In a case where the main benefit of alien vegetation removal and indigenous vegetation restoration at a site is recreational, then the travel cost method may be applied. More specifically, a demand curve for recreation at the site of interest can be derived by using the variation in visitors' travel costs to the site (Loomis et al., 2000). The consumer surplus of recreation at a site where the alien vegetation has been removed and the indigenous vegetation restored can be determined from the derived demand curve.

As opposed to revealed preference models, expressed preference models are capable of measuring a full range of values, including so-called passive use or non-use values, as they do not rely on the observation of actual behaviour that is oriented towards use values (Kahn, 1995). Non-use values can be separated into three key types: option, bequest and existence values (Loomis & White, 1996). Option value relates to the premium individuals are willing to pay to retain future uses or access to a natural resource (Pearce & Moran, 1994). Bequest value is the WTP to preserve an environmental asset or general environmental quality for the potential use and benefit of future generations (Gaston & Spicer, 1998; Loomis et al., 2000). Existence value refers to the satisfaction derived from the preservation of environmental assets so that a habitat for these assets remains, even though these people might never enjoy its consumption (Loomis et al., 2000).

The only expressed preference methods capable of capturing non-use values are the choice modelling (conjoint) method and the contingent valuation method (CVM). The CVM entails creating a hypothetical but realistic market for an environmental good with the aid of a questionnaire in which respondents are asked their WTP for the good in question (Mitchell & Carson, 1989). The survey instruments used for choice modelling analysis are similar to the CVM questionnaires, but for the design of the WTP scenario. The basis of the choice modelling technique is the idea that any good can be described in terms of its attributes, and the levels that these take. This technique thus provides a direct route to the valuation of the attributes of an environmental good and of marginal changes in these characteristics (Louviere & Hensher, 1982). The CVM was used in this study to infer economic values for the services provided by indigenous vegetation in the Underberg area, KwaZulu-Natal.

The study area for this study falls in the Underberg Magisterial District situated in the southern Drakensberg's Kwa Sani Municipality (see Figure 1 below).

Figure 1:
Location of the study area



It was selected as a suitably representative area in which to investigate the Working for Water Programme in KwaZulu-Natal. The site was selected in consultation with the management of the Working for Water Programme. Site selection was based on indigenous and alien vegetation present and the existing or potential tourist value of the site. The Vergelegen Nature

Reserve (29°56'S; 29°45'E), which forms part of the Ukhahlamba Drakensberg National Park, was identified as the site within this magisterial district that would be studied. The Nature Reserve is located north of Himeville and encompasses the top catchment of the Mkomazi River and the Mqatsheni River. The site covers an area of 1 159 hectares. The mean annual rainfall ranges from approximately 804mm to 970mm (Wildy, 2003: 5), with the wet period between October and March and June to July being the driest period (Cawe, 1986).

While the high altitude flora containing most endemics in this area is well protected within the Ukhahlamba Drakensberg National Park (Metroplan, 2001), the distinct, species-rich flora of the foothills (Hilliard & Burtt, 1987) is at risk from changes in land use. Since the arrival of European-style farmers in the area over 150 years ago, the area has been dominated by privately-owned farmland (Johnson et al., 1998). It is mainly used for dairy farming, but a trend towards afforestation in response to the global demand for wood and pulp has been noted since the 1980s (Wildy, 2003: 2).

The most ubiquitous and abundant alien invasive plant species present at the site is the American bramble *(Rubus cuneifolius)* (Turpie, 2003:131). The level of infestation by this plant species ranges from approximately five per cent in conserved grassland areas to 43 per cent in nearby plantation forestry areas (Turpie, 2003: 137). The other major invasive plant species present at the site include *Solanum mauritianum* (Bugweed), and various species of *Eucalyptus* and *Acacia*.

3 Method

3.1 The CVM

As mentioned above, the CVM was applied to estimate the monetary benefit for a preference for indigenous rather than alien vegetation. The value of the biodiversity services provided by indigenous vegetation is modelled through the effects of an increase in its quantity. The premise of this study is that individuals who use the environmental services provided by indigenous vegetation are willing to pay to increase the quantity in order to improve the services. Accordingly, household respondents were asked the maximum amount they would be willing to pay for a project that would eradicate alien invasive vegetation and restore indigenous vegetation. The WTP welfare measure was chosen for the purposes of this study instead of the willingness-to-accept measure, as the former is more appropriate in cases where desired quality or quantity increases would require higher levels of payment (see Mitchell & Carson, 1989). To better understand the determinants of the WTP responses and test these against what could be expected, a WTP function was estimated. A Tobit model was fitted to the data collected to generate a predictive model of WTP (Gujarati, 1995). The Tobit model was preferred to the ordinary least squares (OLS) model for predictive purposes, as it predicts only rational (non-negative) WTP values. The model can be formally expressed as

$$\begin{aligned} Y_i &= \alpha_1 + \alpha_2 X_{2i} + \varepsilon_{2i} \text{ if RHS} > 0 \\ &= 0, \text{ otherwise} \end{aligned} \quad (1)$$

where RHS = right-hand side (Gujarati, 1995). The parameters of a Tobit regression model are estimated using the method of maximum likelihood (ML).

The descriptions of the explanatory variables selected for the purpose of carrying out the regression analysis are listed in Table 1 below. Their expected relationships with household WTP are also shown. The explanatory variables were of both a qualitative and a quantitative nature. Qualitative variables were represented by dummy variables, where a value of 0 indicated the presence of the subject and 1 the absence of the subject. For qualitative variables, the mid-point value was taken from each category assigned, for example, income.

Table 1:
Description of predictive model variables

Variable name	Description		Expected sign
Dependent variable			
WTP (Levy)	Amount household is willing to pay for indigenous vegetation restoration project		
Independent variables			
Race	0= 1=	If respondent is non-white Otherwise	+
Gender	0= 1=	If gender is male Otherwise	–
Resident	0= 1=	If respondent is a tourist Otherwise	+ or –
Local WfWP	0= 1=	If respondent knows about the local Working for Water Programme Otherwise	–
Knowledge	0= 1=	If respondent is well-informed regarding the aims of the Working for Water Programme Otherwise	–
Age	Age of respondent		+ or –
Household size	Household size of respondent		+ or –
Education level	Highest level of educational attainment of respondent		+
Income	Gross annual pre-tax income of respondent		+

3.2 Questionnaire development

In accordance with the guidelines for the application of the CVM, recommended in the Arrow et al. (1993) report, the pre-coded questionnaire to be used as the survey instrument was pre-tested during a pilot survey[3]; a scenario was formulated to make household respondents aware of the positive changes an increase in indigenous vegetation would have on the services it would provide; a WTP welfare measure was employed in the study; and non-responses were zero (upon data validation, unusable responses were discovered and discarded). Household respondents were reminded of the available substitute sites nurturing similar indigenous vegetation, as well as of the fact that they would have to make a monetary sacrifice if they were to make a payment (i.e. household respondents face a budget constraint).[4]

The WTP question asked what the respondent was willing to pay for a project that would eradicate alien vegetation and restore the indigenous vegetation in question, based solely on his/her preference for the indigenous rather than the alien vegetation. This question corresponded to a prospective future occurrence, not one that had already taken place.

The payment question, phrased as a referendum on a ballot (i.e. a double-bounded dichotomous choice question), was used to elicit the household's WTP. With a double-bounded choice question, individuals were presented with a two-sequence WTP offer. First, household respondents were asked to vote yes or no to the initial WTP amount offered. Following this, a second WTP amount was offered. The second amount could be higher or lower than the first amount depending on the individual's reaction to the first offer. Four possible outcomes could thus emerge: both answers are yes; yes followed by no; no followed by yes; and both answers are no. The starting bid amount was varied according to the household respondents. There were 12 bid sets in total. Initial bid levels ranged from R2 to R90. If the referendum resulted in a majority of 'yes' votes, the project would be funded by means of an annual tourist or municipal levy (i.e. the payment or bid vehicle). Household respondents were told that residents and tourists alike would be charged the same levy. A follow-up question on zero responses to the WTP question was also included in the questionnaire. The respondent was asked his/her reasons for providing a zero response.

The questionnaire was also prepared to obtain information on: whether the respondent was a visitor or resident; the respondent's knowledge about alien vegetation, indigenous vegetation and the Working for Water Programme; the respondent's preference for various vegetation types; the frequency of site use; and the respondents' personal information, including age, race, level of education, level of income and gender.

3.3 Sample design

The first step in the sample design process was to determine the target population. This comprised everyone with a demand for the indigenous vegetation present at the Underberg site. Identifying these people proved a complex task and could not be performed beforehand, as visitors to the area also formed part of the target population. For this reason, statistically-preferred respondent selection procedures could not be applied. As an alternative to these procedures, it was assumed that demand was inversely related to distance of residence from the sites, and that at some distance the demand for indigenous vegetation became superfluous. The following institutions were used to identify the target population: municipalities, tourism authorities, National Parks Boards and any other authorities who could help in determining how many users utilised the site and for what purpose. In addition, census data on the Kwa Sani Municipality was obtained. It was also decided to focus on individuals falling within the 15–64 year old age bracket.

Based on this information, the target population groups were sub-divided into tourists and local residents. The sub-category of 'tourists' was further sub-divided into: those from KwaZulu-Natal, those from elsewhere in South Africa, those from Africa, and those from other continents. The target population figure gauged to be using the abovementioned sources and designations amounted to 1 200 households (N). The sample size (n) was determined according to statistical theory on random sampling with continuous data (Cochran, 1977). It is a two-stage theory – see Equations 2 and 3 below.

$$n_0 = \left(\frac{(z_\alpha/2^{\,s})}{r\bar{Y}} \right)^2 \qquad (2)$$

where:

n_0 = first approximation of n.

$z_\alpha/2$ = area under the normal distribution between –1.96 and 1.96.

s = the estimation of the standard error in the population. To estimate the standard error, Cochran (1977) used the result of a pilot study.

r = the acceptable margin of error for the mean being estimated (0.1).

$\bar{Y}$ = sample mean (Cochran, 1977).

In order to populate Equation 2, the relevant mean and standard deviation statistics were required. Estimates of these values were obtained from a pilot study carried out on the Albany Working for Water Programme site in 2003 (Du Plessis, 2003). The mean from the Du Plessis (2003) study was R75.76 and the standard deviation R68.35. It was assumed that the sample mean WTP for the Underberg site would vary within 10 per cent of the real mean and with a 95 per cent confidence level. Populating Equation 2 with the relevant data produces a required sample size of 313. However, since this sample size exceeds five per cent of the Underberg population (i.e. 1 200 households), Cochran's (1977) finite population correction formula was used to calculate the final sample size (see Equation 3 below).

$$n = \frac{n_0}{1 + \left(\frac{n_0}{N}\right)} \qquad (3)$$

The minimum required sample size for the Underberg site in terms of Cochran's (1977) method is 248. This sample size was exceeded in this study, and 260 household respondents were interviewed. The questionnaire was administered during September 2005. Personal interviews were used to conduct the survey in line with recommendations of the NOAA panel's report (Arrow et al., 1993). Non-response rates of from 20 to 30 per cent are common in CVM research, and a small number of non-responses are welcome because the researcher wishes to avoid including thoughtless responses in his/her analysis (Mitchell & Carson, 1989). Of the 260 questionnaires completed, 259 were considered valid responses. The non-response rate of this study thus falls well within the norm. Moreover, of the 260 households interviewed, 81.85 per cent were residents, while 18.15 per cent were tourists.

4 Results

This section presents the results of the survey undertaken. The socio-economic profiles and Working for Water Programme knowledge levels of the household respondents are reported, as are their WTP bids at the Underberg site. The results of fitting the data collected to a Tobit model are also presented. This is followed by an analysis of differences between resident and tourist responses to the WTP question. Finally, there is a short discussion on the levels of confidence attached to the results obtained.

4.1 Socio-economic characteristics

Table 2 below provides a summary of the socio-economic profiles of the sample of households surveyed at the site in question.

Table 2:
Socio-economic profile of household respondents – Underberg site

Statistic	Mean	Std. dev.	Min	Max	Median
Household size (No. of people)	4.17	2.51	1	15	4
Age (in years)	37	13.94	16	82	34
Education level of household respondents (No. of years)	10.5	3.8	5	18	12
Annual pre-tax income (in Rands)	53 527.13	94 241.41	0	750 000	8 750
Worth of fixed property (in Rands)	336 337.20	625 678.50	0	3 000 000	25 000

The mean household size was four and is consistent with information obtained from the 2001 Census (Tessendorf, 2007). The age of the household respondents ranged from 16 to 82 and the average household respondent was 37 years old. The mean number of years of education completed by the household respondents ranged from 5 to 18 years and the average number of years was 10.5. The mean income level was found to be R53 527. The median income was substantially lower at R8 750. It provided a better reflection of the central tendency in income levels at the study site, and was more in line with the average income level in KwaZulu-Natal, as determined in the 2001 Census. The worth of fixed property varied dramatically among different household respondents, the minimum worth reported being R0 and the maximum worth R3 000 000.

4.2 How informed the households were about the Working for Water Programme

Table 3 below shows the proportions of household respondents knowledgeable about the Working for Water Programme.

Table 3:
Proportions of household respondents knowledgeable of the Working for Water Programme

Variable	Classes	Underberg site
Familiarity with Working for Water Programme in South Africa	Yes	40%
	No	60%
	Total	100%
Familiarity with Working for Water Programme at Underberg	Yes	23%
	No	77%
	Total	100%
Main objectives	Person knows 2 or more aims	10%
	Person knows 0 to 2 aims	90%
	Total	100%
Understanding	Excellent	7%
	Good	25%
	Average	31%
	Poor	21%
	Very poor	16%
	Total	100%

More than half the household respondents (60 per cent) reported that they were unfamiliar with the Working for Water Programme in South Africa. Only 23 per cent of household respondents were familiar with the Working for Water Programme in the Underberg area, while 77 per cent were unfamiliar with it. Combining the responses to the questions on familiarity with the Programme in South Africa and the specific site respectively reveals that the percentage of household respondents who replied affirmatively to both questions was only 30 per cent. This indicates that a minority of household respondents were well-informed about the Working for Water Programme.

Further indication that household respondents were generally poorly informed about the Working for Water Programme is highlighted by the fact that only 10 per cent could name more than two of the Programme's objectives. However, the majority of household respondents were rated as having an average or above average understanding of the research question after completing the survey.

4.3 Sample WTP bids

Table 4 below summarises the sample WTP bids for the project that will eradicate alien invasive vegetation and restore indigenous vegetation.

Table 4:
The average WTP (in Rands)

Site	Sample size	Mean WTP (Rands)	Standard deviation (Rands)	Minimum WTP (Rands)	Median WTP (Rands)	Maximum WTP (Rands)
Underberg	259	21.03	37.06	0	7.5	200

Analysis of the WTP statistics reveals that, on average, each of the households at the Underberg site was willing to pay R21.03 in 2005 (R26.40 in 2008) for the indigenous vegetation restoration project. None of the households provided excessively large bids.

Zero WTP responses were submitted by 29.73 per cent of the households interviewed and t were deemed to be either protest bids or genuine zero bids. Protest bidders were identified in this survey as households who indicated that they lacked confidence in the government or municipality to collect and use the levies for the project and/or who stated that they were already paying enough to the government or municipality. Protest bids were omitted from the analysis, and the genuine zero bids were retained.

4.4 Estimation of the WTP function

The results of fitting a Tobit model to the data for the Underberg site are documented below in Table 5. Predictors that did not offer sufficient statistical guarantee were omitted from the valuation function. The fit of the overall bid function is within acceptable norms.

Table 5:
The fit of the WTP function for the Underberg site using a Tobit model

Variable	Coefficient	Std. error	z-statistic	p-value
CONSTANT	33.539	9.794	3.424	0.001
RESIDENT	11.338	7.921	1.431	0.152
KNOWLEDGE	–37.571	6.741	–5.573	0.000
INCOME	–0.025	0.015	–1.664	0.096
R^2	0.133921			
Adjusted R^2	0.120282			
Log likelihood	–1003.42			

It was expected that the residential variable (i.e. resident) would be significant in explaining WTP bids because it was significant in the complete Tobit model, but fitting the data to the reduced Tobit model did not prove this to be the case. The knowledge variable has a significance level of 0 per cent and the coefficient is negative. This result accords with the *a priori* expectation. Thus, households who are knowledgeable about the local Working for Water Programme have a WTP R37.57 higher than that of households who are unaware of the Programme's activities. The income variable has a significance level of 9.6 per cent and a negative coefficient; the model suggests that for every additional R100 a household earns per annum his/her WTP will decrease by R2.50. As a number of the wealthier households had indicated that they owned farms which had been planted with pine and gum trees, this result was not as surprising as initially thought.

4.5 An analysis of tourist and resident WTP responses

As mentioned above, it had been expected that the residential variable (i.e. resident) would be significant in explaining WTP bids. However, fitting the data to the reduced Tobit model did not prove this to be the case. A decision was thus made to test for differences between the two groups contained in the residential variable. The results of a comparison of means of variables for tourists and local residents regarding the valuation question are shown in Tables 6 and 7 below.

Table 6:
Group statistics

Resident variable	N	Mean	Std. deviation	Std. error mean
Resident	212	22.9458	39.5786	2.7183
Tourist	47	12.3723	20.6080	3.0060

Table 7:
Independent samples test of the residential variable

	Levene's test for equality of variances		t-test for equality of means						
	F	Sig.	T	df	Sig. (2-tailed)	Mean difference	Std. error difference	95% Confidence interval of the difference	
								Lower	Upper
Equal variances assumed	6.121	0.014	1.777	257	0.077	10.5734	5.9503	–1.1441	22.2909
Equal variances not assumed			2.609	132.653	0.010	10.5734	4.0528	2.5570	18.5898

The F test is significant at $p<.05$. The null hypothesis that the two groups (residents and tourists) come from populations with equal variances must therefore be rejected. The results indicated that there was a significant difference in WTP between the two groups t (132.653) = 2.609, p=0.010. Residents of the Underberg area had a significantly higher WTP (M = 22.9458, SD = 39.5786) than the tourist group (M = 12.3723, SD = 20.6080).

Two-way chi-square tests were also conducted on the residential variable (i.e. resident) to investigate the significance of association between variables. This test determined whether the observed frequencies differed markedly from the frequencies that would be expected by chance (Sprent, 1993). Observed frequencies are laid out in a contingency table (see Table 8), and the observed frequencies in each cell in the table are compared with the frequencies expected if there were no relationship between the two variables in the populations from which the sample had been drawn. The chi-square test (see Table 9) compares what actually happened to what hypothetically would have happened *ceteris paribus,* which is the null hypothesis (Sprent, 1993).

Table 8:
WTP as measured by residential variable

Levy WTP	Resident variable		Total
	Resident	Tourist	
0.00	56	21	77
1.00	11	0	11
3.50	21	4	25
7.50	32	6	38
15.00	29	7	36
22.50	11	1	12
27.50	13	2	15
35.00	6	2	8
45.00	6	2	8
55.00	7	0	7
65.00	2	0	2
85.00	2	1	3
95.00	3	1	4
150.00	11	0	11
200.00	2	0	2
Total	212	47	259

Table 9:
Chi-square Test

	Value	Df	Asymp. sig. (2-sided)
Pearson Chi-square	14.004[a]	14	0.449
Likelihood ratio	19.518	14	0.146
N of valid cases	259		

a. 16 cells (53.3%) have expected count less than 5. The minimum expected count is.36.

If the actual results obtained from the chi-square test differ significantly from the predicted null hypothesis results, the null hypothesis is rejected and a statistically significant relationship can be assumed between the variables (Sprent, 1993). However, the results presented in Table 9 indicated that we could not be confident that residents and tourists differed as far as their WTP (p=.449) was concerned.

4.6 Confidence in results

Contingent valuation studies are subject to many biases, and have to be tested for validity and reliability. Construct validity refers to how well a valuation method explains the values generated (Hanley & Spash, 1993). The aim is to assess the overall acceptability of the models. Three criteria were used to test for construct validity:

- The model is well fitted based on the statistical significance of the model; that is, the fitted model had an adjusted R^2 value greater than 15 per cent (Hanley & Spash, 1993);
- The reduced model contains the expected significant variables;
- The signs of the coefficients in the reduced model accord with expectations (see Table 5).

Four ratings were constructed in terms of these criteria:

- Strong support: if all of the above criteria are met;
- Moderate support: if any two of the above criteria are met;
- Weak support: if only one of the above criteria is met;
- No support: none of above criteria is met.

Based on the above criteria it was concluded that there was moderate support for the local Working for Water scenario. The repeatability test of a CVM model is that when it is repeatedly applied in the same or very similar situations, the difference in results should be statistically insignificant between these applications (Hanley & Spash, 1993). This test could, unfortunately, not be carried out because only one survey was conducted.

5 Discussion

The total WTP for an indigenous vegetation restoration project is shown in Table 10 below. This estimate is the predicted value using Tobit models and the data collected during the contingent valuation survey, and is calculated as the product of the predicted median willingness-to-pay per annum and the estimated number of households. The median WTP figure is used instead of the mean, since it is a more conservative measure. The influence of statistical outliers is removed.

Table 10:
Total WTP (2005 price levels)

Site	Estimates of number of households	Predicted mean of WTP (Rands)	Predicted median of WTP (Rands)	WTP/ha (Rands)	TWTP (Rands)
Underberg	1200	24.87	21.12	21.87	25 344.00

The total WTP to preserve indigenous vegetation in the Underberg area is estimated to be R25 344.00 (R31 680.00 in 2008) per annum, and the WTP per hectare (ha) per annum is R21.87 (R27.34 in 2008). This marginal per hectare value should be added to those associated with other Working for Water Programme benefits and compared with the marginal cost per hectare information pertaining to alien vegetation clearing operations in order to guide the allocation of funds to the respective Working for Water Programme sites. Unfortunately, monetary values for other benefits of the Working for Water Programme for the Underberg site were not available, so the discussion below is limited to placing the biodiversity benefit in the context of the cost of indigenous vegetation restoration and the further development of a payment for ecosystem services (PES) mechanism.

The level of infestation by invasive alien plant species, mostly bramble, is approximately five per cent in the conserved grassland area comprising the Vergelegen Nature Reserve (Turpie, 2003:137). A total area of 1 159 ha has been invaded. This translates into a condensed invaded area (i.e. percentage density of invasion x area) of 58 ha (Turpie et al., 2008). Assuming an incremental water use of 2 713m^3/ha/a for (condensed) invaded areas in Southern KwaZulu-Natal (Turpie et al., 2008), it is estimated that 157 354m^3/a (i.e. 58ha × 2713m^3/ha/a) of water is lost in t.he Vergelegen Nature Reserve owing to alien vegetation infestations. If the area is not condensed then the water loss per hectare per annum translates into 135.77m^3/ha/a (i.e. (157 354m^3/a)/1 159ha).

A recent study by Blignaut et al. (2007) determined the charges for clearing invasive alien plant species to increase water supply in South Africa. Charges were calculated for each of South Africa's 19 Water Management Areas (WMAs). The Vergelegen Nature Reserve falls under the Mvoti to Umzimkulu WMA. Since no invasive alien control charges are available for Nature Reserve areas, it was decided to use the most conservative charge per water-user group available in the area of interest. In the case of the Vergelegen Nature Reserve, this group is the agricultural sector (Blignaut et al., 2007). The Extended Public Works Programme (EPWP) portion (for agriculture) of the total charge for invasive alien plant control in the area of interest was estimated to be R3.17/m^3 (R3.49/m^3 in 2008) and the water-user group portion (for agriculture) was estimated to be R0.54/m^3 (R0.59/m^3 in 2008) (Blignaut et al., 2007). The total charge is thus R3.71/m^3 (R4.09/m^3 in 2008). Based on an annual water loss of 157 354m^3 and a total charge of R3.71/m^3, it was estimated that it would cost approximately R583 783/a (R643 913/a in 2008) (or R504/ha/a (R556/ha/a in 2008), assuming an uncondensed area of 1 159ha) to control alien invasive species in the Vergelegen Nature Reserve. The WTP amount of R21/ha/a (R26.40 in 2008) estimated in this study could thus contribute 4.7 per cent (at 2008 price levels) toward the cost to remove alien vegetation and restore indigenous vegetation in the Vergelegen Nature Reserve. Furthermore, the WTP amount makes up 33 per cent[5] of the agriculture user-group's current charge per cubic metre of water at 2008 price levels.

The fact that the majority (approximately 70 per cent) of household respondents were willing to pay to secure the preservation of indigenous vegetation provides a compelling case for expanding the payment for the ecosystem services (PES) financing system in South Africa. The system entails voluntary disbursements for clearly-delineated ecosystem services that are qualified, based on service delivery (Turpie et al., 2008). One merit of this system as a conservation instrument is that it acts as both a financing tool and an incentive (Turpie et al., 2008). The PES system originated as a result of the creation of the Working for Water Programme in South Africa. Although the main motivation behind the Working for Water Programme is the improved provision of water, Turpie et al. (2008) maintain that it should be viewed as an 'umbrella service'. The actions taken by the Programme to increase water supplies also advance, inter alia, biodiversity conservation. This Programme is funded mainly by the government, and voluntary disbursements account for only a small proportion of the Programme's total funding. The results of this study, however, show that more and higher voluntary payments to help finance the Working for Water Programme could be obtained if water users were made more aware that the 'umbrella service' encompassed a biodiversity conservation component.

6
Summary

In this study, the contingent valuation method was used to estimate households' WTP for a project (i.e. the Working for Water Programme) aimed at removing alien vegetation and restoring indigenous vegetation in Underberg, KwaZulu-Natal, South Africa. The WTP estimate reflects the benefit of preferring indigenous vegetation to alien vegetation. The premise of this study is that individuals who use the environmental services provided by the indigenous vegetation are willing to pay for increasing their relative abundance in order to improve the services. The survey conducted conforms largely to the guidelines suggested by Arrow et al. (1993), and the more conservative WTP approach was adopted. In a survey, a questionnaire was administered to 260 households in the Underberg region during September 2005. It was deduced that the mean WTP for the project was R21.12 (R26.40 at 2008 price levels), the total WTP was R25 344.00 (R31 680.00 at 2008 price levels) and the WTP per hectare was R21.87 (R27.34 at 2008 price levels). This marginal per hectare value should be added to those associated with other Working for Water Programme benefits and compared with the marginal cost per hectare information pertaining to alien vegetation clearing operations in order to guide the allocation of funds to the respective Working for Water Programme sites.

A valuation function to predict WTP responses was also estimated. The function showed that knowledge of the local Working for Water Programme and income to be important determinants of WTP. These results suggest that the stated WTP bids do not display a random character but instead depend on objective variables, and that those individuals who were questioned as part of the survey were capable of linking their preference for indigenous vegetation to a WTP amount.

Endnotes

1 The helpful comments made by two anonymous referees are gratefully acknowledged.
2 An anonymous referee felt that this was a controversial point to make.
3 After the pilot study the questionnaire was simplified and improved.
4 This was done in an attempt to reduce mental account bias.
5 R26.40 expressed as a percentage of (157 354m^3 × R0.59/m^3)/1159ha or R80.10/ha/a.

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Appendix

CONTINGENT VALUATION QUESTIONNAIRE ON THE BIODIVERSITY BENEFIT PROVIDED BY THE WORKING FOR WATER PROGRAMME

UNDERBERG AREA

Date	

Instructions to person administering the survey:

a) Name of person administering the questionnaire (not the respondent): ____________

b) NO respondent's name is to be recorded and the information given by the respondent is to be treated as confidential.

c) Please tick the appropriate blocks. If the answer is other, please provide the correct answer in the space provided alongside 'other'.

d) If the person is reluctant to answer a question, e.g. on age or income, move on to the next question, but encourage the person to answer all questions, as we need this for statistical analysis.

e) Question 10 and 15 must be answered or the questionnaire will be of no use.

INTRODUCTION

(The person administering the survey must read this paragraph to the respondent before proceeding with the survey.)

I am ____________________________. Would you mind being interviewed? There are between 13 and 17 questions to answer. It will take about 10 minutes of your time. It is about public willingness to pay for alien plant clearing and indigenous vegetation rehabilitation projects, like the Working for Water Programme.

SECTION A: DEMOGRAPHIC INFORMATION OF RESPONDENT

1 ARE YOU A:

1.1	Resident
1.2	Tourist

(INSTRUCTION: If the answer to question 1 is Tourist – go to Question 1.1)

1.1 If a tourist, are you a/an:

1.1.1	Tourist from within KwaZulu-Natal
1.1.2	Tourist from one of the other provinces of South Africa
1.1.3	International tourist from within Africa
1.1.4	International tourist from elsewhere

2 HOW OLD ARE YOU?

---

3 HOW MANY PEOPLE MAKE UP THE HOUSEHOLD TO WHICH YOU BELONG?

---

4 WHAT IS THE HIGHEST LEVEL OF EDUCATION THAT YOU HAVE ATTAINED?

4.1	Less than Std 8/Grade 10
4.2	Std 8/Grade 10
4.3	Matric/Grade 12
4.4	Diploma
4.5	Degree
4.6	Postgraduate degree

5 WHAT IS YOUR ANNUAL INCOME BEFORE TAXES? Please note: This income includes income received from Government in the form of social grants.

	R		
5.1			0
5.2	1	–	17 500
5.3	17501	–	35 000
5.4	35 001	–	60 000
5.5	60 001	–	90 000
5.6	90 001	–	120 000
5.7	120 001	–	150 000
5.8	150 001	–	180 000
5.9	180 001	–	210 000
5.10	210 001	–	240 000
5.11	240 001	–	300 000
5.12	300 001	–	350 000
5.13	350 001	–	500 000
5.14	500 001	+	

6 WHAT IS THE APPROXIMATE WORTH OF HOUSES AND LAND OWNED BY THE HOUSEHOLD TO WHICH YOU BELONG (anywhere in the world, at current prices in Rand equivalents)?

R			
6.1			0
6.2	1	–	50 000
6.3	50 001	–	100 000
6.4	100 001	–	200 000
6.5	200 001	–	500 000
6.6	500 001	–	1 000 000
6.7	1 000 001	–	1 500 000
6.8	1 500 001	–	2 000 000
6.9	2 000 001	+	

SECTION B: BIODIVERSITY BENEFIT INFORMATION

7 RANK YOUR ORDER OF PREFERENCE FOR THE FOLLOWING VEGETATION by circling the relevant number. (1 would be the most preferred vegetation type and 3 the least preferred)

	Most Preferred		Least Preferred
Commercial plantations of Wattle or Pine or Gum	1	2	3
Plants and trees that were brought to South Africa from elsewhere e.g. Australia that grow in the wild, such as Wattle, Pine, Gum and Hakea	1	2	3
Moist Upland Grassland	1	2	3

(INSTRUCTION: At this point, show the respondent the pictures of both the alien invasive plants as well as the indigenous plant and explain the different types of vegetation.)

- Moist Upland Grassland is dense sour grassland. This means that most grasses are unpalatable outside of the growing season. Red Grass, Spear Grass, Weeping Love Grass and Wire Grass are some of the most common species present. The tall-growing Common Thatch grass is common in the north. Other plant species that are common in Moist Upland Grassland include Spiky Cucumber, Wild Cucumber and Baker's Wild Aster. Trees and shrubs that occur on sheltered sites, rocky hills and ridges, include Common Spike Thorn and Buffalo Thorn. In fire-protected areas the incidence of other species increases, including forest pioneers such as Cape Beech and Fynbos species, such as Blombos and Jakkalsstert.

8 HAVE YOU HEARD ABOUT THE NATIONAL WORKING FOR WATER PROGRAMME?

8.1	Yes
8.2	No

9 WHAT WOULD YOU SAY ARE THE MAIN OBJECTIVES OF THE WORKING FOR WATER PROGRAMME?

9.1	Person knows more than 3 or more of the aims listed below
9.2	Person knows 2 of the aims listed below
9.3	Person knows 1 of the aims listed below
9.4	Person knows 0 of the aims listed below

Working for Water's objectives are stated below:

- To **increase** the **water yield** from river catchments;
- To **increase agricultural capacity** by creating more space for crops;
- To **preserve biodiversity** (all the species of animals, plants, fungi and micro-organisms occurring in the area) and the area covered by indigenous vegetation;
- To **generate employment** for the poor;
- To **generate income** by using the wood of the alien plants cleared; and
- To **reduce the intensity of floods, fires,** and the **damage caused by this increased intensity**, like soil erosion.

(INSTRUCTION: Fill in the person's knowledge and then say: **This survey is not about the impact of clearing aliens on water yields, fire, agriculture, and so on. Some have challenged the extent of some of these benefits. This survey is about one thing and one thing only – your preference for indigenous vegetation over alien vegetation and how much you would be prepared to pay to remove the alien vegetation and rehabilitate the indigenous.**)

10 Currently, the National Working for Water Programme is active at about 300 sites. WOULD YOU BE WILLING TO PAY **R _______ EVERY YEAR** – IN TOURIST LEVIES (if you are a tourist) OR IN INCOME TAXES (if you are a resident) TO FINANCE THE **NATIONAL WORKING FOR WATER PROGRAMME** purely because of your preference for indigenous vegetation over the alien vegetation?

Remember that your income is limited and has several alternative uses and that this Programme is but one of many natural resource conservation projects in South Africa and the world.

Yes / No

[ ] YES	→	If YES: Would you be willing to pay R _______ every year?	(check one)	[ ] YES
				[ ] NO
[ ] NO	→	If NO: Would you be willing to pay R _______ every year?	(check one)	[ ] YES
				[ ] NO

(INSTRUCTION: Visual aid for the person administering the survey. In the follow-up questions refer to the amounts indicated in bold in the table below. Please circle the final willingness to pay amount.)

R		
		0
0	–	**2**
3	–	**5**
6	–	**10**
11	–	**20**
21	–	**25**
26	–	**30**
31	–	**40**
41	–	**50**
51	–	**60**
61	–	**70**
71	–	**80**
81	–	**90**
91	–	**100**
101	–	**200**

11 IF YOUR ANSWER TO THE ABOVE QUESTION (QUESTION 10) IS ZERO (0), WHAT ARE YOUR REASONS (You may have more that one)?

11.1	Cannot afford the tax
11.2	Get no or negligible value out of the WfW Programme
11.3	Lack of confidence in Government to collect and use the taxes collected for the use mentioned
11.4	Already pay enough to the Government
11.5	I do not feel responsible for the vegetation of the area. This is the farmer's responsibility or the Government's responsibility (if it is state land)
11.6	I prefer alien vegetation over natural vegetation
11.7	Other (Please specify)

12 If you prefer alien vegetation over indigenous vegetation (Answer 11.6) WHAT WOULD YOU BE WILLING TO PAY TO INCREASE ALIEN VEGETATION COVERAGE IN SOUTH AFRICA?

	R		
12.1			0
12.2	1	–	20
12.3	21	–	50
12.4	51	–	100
12.5	101	–	200
12.6	201	–	500
12.7	501	–	1000
12.8	1001	–	5000
12.9	5001	+	

13 DO YOU KNOW THAT THE WORKING FOR WATER PROGRAMME IS CLEARING ALIEN VEGETATION IN THIS AREA? (The respondent is then shown a map indicating the location of the Cobham site.)

13.1	Yes
13.2	No

(INSTRUCTION: Fill in the respondent's knowledge.)

At this site, the Working for Water Programme clears alien vegetation such as Gum, Bugweed, Bramble and Wattle species to restore Moist Upland Grassland, the indigenous vegetation of this area.

- Moist Upland Grassland occupies 3.6% of South Africa, with 30.2% of it growing in KwaZulu-Natal. This vegetation is used for grazing. It is also attractive to look at.

14 HOW MANY TIMES PER YEAR DO YOU GO HIKING/VISITING THE SITE WHERE THE WORKING FOR WATER PROGRAMME IS CLEARING ALIEN VEGETATION?

____

15 WOULD YOU BE WILLING TO PAY **R ________ EVERY YEAR** – IN LOCAL TOURIST LEVIES (if you are a tourist) OR IN LOCAL MUNICIPAL SERVICE LEVIES (e.g. like a refuse removal charge for a resident in the area) TO FINANCE THE **COBHAM WORKING FOR WATER PROGRAMME** purely because of your preference for Moist Upland Grassland over the alien vegetation?

Yes / No

[ ] YES	→	If YES: Would you be willing to pay R ________ every year?	(check one)	[ ] YES
				[ ] NO
[ ] NO	→	If NO: Would you be willing to pay R ________ every year?	(check one)	[ ] YES
				[ ] NO

(INSTRUCTION: Visual aid for the person administering the survey. In the follow-up questions refer to the amounts indicated in bold in the table below. Please circle the final willingness to pay amount.)

R		
		0
0	–	**2**
3	–	**5**
6	–	**10**
11	–	**20**
21	–	**25**
26	–	**30**
31	–	**40**
41	–	**50**
51	–	**60**
61	–	**70**
71	–	**80**
81	–	**90**
91	–	**100**
101	–	**200**

16 IF YOUR ANSWER TO THE ABOVE QUESTION (QUESTION 15) IS ZERO (0), WHAT ARE YOUR REASONS (You may have more that one)?

16.1	Cannot afford the levy
16.2	Get no or negligible value out of the WfW Programme
16.3	Lack of confidence in local government to collect and use levies collected for the use mentioned
16.4	Already pay enough to the municipality
16.5	I do not feel responsible for the vegetation of the area. This is the farmer's responsibility or the government's responsibility (if it is state land)
16.6	I prefer alien vegetation over natural vegetation
16.7	Other (please specify)

17 DO YOU HAVE ANY OTHER COMMENTS YOU WOULD LIKE TO CONTRIBUTE ON THIS PUBLIC ISSUE?

CONCLUSION

(The person administering the survey must read this paragraph to the respondent after completing the survey.)
Thank you for assisting us by taking the time to complete this survey.

SECTION C: INFORMATION ABOUT THE RESPONDENT

PLEASE NOTE: THIS SECTION IS TO BE COMPLETED BY THE PERSON ADMINISTERING THE SURVEY.

18 RANK YOUR VIEW OF THE RESPONDENT'S UNDERSTANDING OF THE RESEARCH QUESTION AFTER THE COMPLETION OF THE SURVEY by circling the relevant number. (1 would indicate that the respondent had an excellent understanding of the research question, while 5 would indicate that the respondent had a very poor understanding of the research question.)

Excellent				Very poor
←				→
1	2	3	4	5

19 RACE OF RESPONDENT

19.1	African
19.2	White
19.3	Coloured
19.4	Indian/Asian

20 GENDER OF RESPONDENT

20.1	Male
20.2	Female