ESTIMATING THE WILLINGNESS-TO-PAY FOR RESTORING INDIGENOUS VEGETATION AT SELECTED SITES IN SOUTH AFRICA

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EXECUTIVE SUMMARY

The Working for Water (WfW) 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. Funds to clear alien invasives were initially secured on the basis that such a programme would increase water runoff, facilitate biodiversity and ecosystem functioning, and provide social benefits through job creation.

The economic merits of the Programme, in terms of increased water yields, has been established in the Western Cape and KwaZulu-Natal, but questioned in the Eastern and Southern Cape. However, there are economic aspects of the studies carried out in the Eastern and Southern Cape that merit more attention than was given them; one of these being the issue of non-water benefits.

Preliminary figures emanating from contingent valuation pilot studies conducted at six WfW projects sites indicated that one of these non-water benefits, namely the biodiversity and ecosystem resilience benefit, could be substantial. As such, the primary objective of the present study was to apply the contingent valuation method (CVM) to value people's preference for indigenous vegetation. This value was intended to serve as a proxy for increased biodiversity and ecosystem resilience at three WfW sites.

Despite the controversy surrounding the CVM, it has been found that it is a credible valuation tool. The CVM's merits lie in its versatility and in the fact that it is the only method available which is capable of obtaining estimates of both non-use and use values, thus making it applicable for valuing biodiversity.

The primary aim of a CVM study is to determine an estimate of the total willingness-to-pay (WTP).

Table 1: Estimated total willingness-to-pay per site

Site	Local municipality	Estimate of number of households benefiting	Median of predicted WTP (R)*	Total WTP (R / annum)
Port Elizabeth: National WfW Programme	Nelson Mandela Metropolitan Municipality	17 287	43.24	747 489.88
Underberg: National WfW Programme	Kwa Sani Municipality	1 200	29.22	35 064.00
Worcester: National WfW Programme	Breede Valley Municipality	10 441	44.99	469 740.59
Port Elizabeth: Local WfW Programme	Nelson Mandela Metropolitan Municipality	17 287	32.82	567 359.34
Underberg: Local WfW Programme	Kwa Sani Municipality	1 200	21.12	25 344.00
Worcester: Local WfW Programme	Breede Valley Municipality	10 441	52.79	551 180.39

* Values are estimated on the basis of Table 8.27. The values relate to the period July 2005 to October 2005.

In this study, the total WTP figure was calculated by multiplying the median WTP for the local WfW Programme by the total number of user households. The respective total WTP amounts are shown in Table 1. It was anticipated that respondents would be willing to pay more for the national WfW Programme, than for the less inclusive good (i.e. the local WfW Programme). The results correspond with this expectation at the Port Elizabeth and Underberg sites. However, due to strategic factors Worcester respondents were willing to pay more for the local WfW Programme than for the national Programme.

The per hectare biodiversity benefit was calculated by dividing the total WTP per annum by the size of the local WfW Programme. These values are shown in Table 2.

Table 2: Biodiversity benefit per hectare – selected WfW sites

Site	Total WTP (R / annum)	Size of the local WfW Programme in ha	WTP per hectare (R / ha)
Port Elizabeth: Local WfW Programme	567 359.34	8 700	65.21
Underberg: Local WfW Programme	25 344.00	1 159	21.87
Worcester: Local WfW Programme	551 180.39	6 245	88.26

* The values relate to the period July 2005 to October 2005.

It was found that sites nearer large urban populations attract higher WTP bids than sites in rural areas (see Table 2). The per hectare biodiversity benefit calculated in the present study lends support to the findings of the pilot study which suggested that the biodiversity and ecosystem resilience benefit could be the biggest benefit of the WfW Programme.

This study concludes that the correct application of the CVM provides an effective tool in providing economic value estimates of the biodiversity benefit associated with the WfW Programme. However, inconsistencies in the data suggest that more attention must be given to the wording of the questionnaire and the sampling process.

KEY WORDS

WORKING FOR WATER PROGRAMME, BIODIVERSITY, PREFERENCE FOR INDIGENOUS VEGETATION, CONTINGENT VALUATION METHOD, CONTINGENT VALUATION BIASES, SAMPLE DESIGN, VALIDITY TESTS, OLS MODEL, TOBIT MODEL, WILLINGNESS-TO-PAY

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LIST OF ABBREVIATIONS

CBA	Cost Benefit Analysis
CM	Choice Modelling
CVM	Contingent Valuation Method
DWAF	Department of Water Affairs and Forestry
ECSECC	Eastern Cape Socio-Economic Consultative Council
ha	hectares
HPM	Hedonic Pricing Method
HSRC	Human Sciences Research Council of South Africa
NOAA	National Oceanographic and Atmospheric Administration
OLS	Ordinary Least Square
spp.	Species
SRS	Simple random sampling
SSR	Sum of squares of the residuals
Stats SA	Statistics South Africa
TCM	Travel Cost Method
VFR	Visiting friends and relatives
WTA	Willingness-to-accept
WTP	Willingness-to-pay
WfW	Working for Water

CHAPTER ONE
INTRODUCTION

1.1 BACKGROUND

Ecosystems provide vital services, such as fresh water, conservation of biodiversity, soil generation and aesthetic and cultural benefits (Chapman, le Maitre and Richardson, 2001:1). South Africa has a rich variety of ecosystems and is ranked as the third most biologically diverse country in the world, containing between 250 000 and 1 000 000 species (Wynberg, 2002), many of which occur nowhere else. For plants alone, some 18 000 vascular plant species occur in the country, of which 80 per cent are endemic (Cowling and Hilton-Taylor, 1997). Animal life is equally varied, both in terms of numbers and in terms of variety. In terms of the number of endemic mammal, bird, reptile and amphibian species, South Africa is the 24th richest country in the world, and the fifth richest in Africa (World Conservation Monitoring Centre, 1992). South Africa is also the only country in the world to have within its boarders an entire plant kingdom – the Cape Floral Kingdom (Low and Rebelo, 1996). Approximately 40 to 50 per cent of the Earth's landscape has, however, been transformed and irreversibly degraded by human activity (Vitousek, Mooney, Lubchenco and Mellilo, 1997). An example of transformation and degradation caused by human activity is the introduction of alien vegetation.

Invading alien plants[1] cover some 10 million hectares in South Africa, which represents about 8 per cent of the surface area of the country (Versfeld, le Maitre and Chapman, 1998). The equivalent condensed area is 1.7 million hectares, an area larger than the province of Gauteng. The Western Cape is the most heavily

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[1] "Invading alien plants", "invasive plants" or "plant invaders" are terms generally used to refer to alien plants that are capable of reproducing and spreading without the direct assistance of humans.

invaded at about a third of the total area, followed by Mpumalanga, KwaZulu-Natal and Limpopo (see Table 1.1 below).

Table 1.1: Areas invaded by alien plants in the different provinces both as hectares and as a percentage of the area of the province

Province	Area (ha)	Total area invaded		Condensed invaded area[2]	
		(ha)	(%)	(ha)	(%)
Eastern Cape	16 739 817	671 958	4.01	151 258	0.9
Free State	12 993 575	166 129	1.28	24 190	0.19
Gauteng	1 651 903	22 254	1.35	13 031	0.79
KwaZulu – Natal	9 459 590	922 012	9.75	250 862	2.65
Lesotho	3 056 978	2 457	0.08	502	0.02
Mpumalanga	7 957 056	1 277 814	16.06	185 149	2.23
Northern Cape	36 198 060	1 178 373	3.26	166 097	0.46
Limpopo	12 214 307	1 702 816	13.94	263 017	2.15
North West	11 601 008	405 160	3.49	56 232	0.48
Western Cape	12 931 413	3 727 392	28.82	626 100	4.84
RSA + Lesotho	124 803 707	10 076 365	8.07	1 736 438	1.39

Source: Le Maitre, Versfeld and Chapman (2000:401)

How much these alien plant invasions cost the country has not been determined. A partial estimate has, however, been generated in terms of water losses due to alien plant invaders. Not only do alien plant invaders result in a loss of an estimated 7 per cent of South Africa's mean runoff (3.3 billion m^3) through transpiration annually (Versfeld *et al*., 1998), they also threaten the biodiversity of the sub-continent (van Wilgen, Cowling and Burgers, 1996).

In the Cape Floral Kingdom alone, approximately 750 plant species face extinction due to this threat. Richardson and van Wilgen (1986) found that afforestation with Pine species at Biesievlei, Jonkershoek, had decreased the indigenous vegetation cover (i.e. Fynbos) from 75 to 20 per cent and decreased the aggregate number of species by 58 per cent from 298 to 126 in just 39 years.

[2] The condensed area is the total area adjusted to bring the cover to the equivalent of 100 per cent.

South Africa's landscapes and biodiversity have enormous recreational and aesthetic value and attract several million tourists annually (South Africa's biome diversity, 2004). In 1992, the total income generated by tourism in South Africa was R7 billion of which R3.4 billion was foreign exchange (South Africa's biome diversity, 2004). About 70 per cent of foreign tourists to South Africa rated the natural environment and scenic beauty provided as the most enjoyable aspects of their stay (South Africa's biome diversity, 2004). It is deduced that "ecotourism[3]" accounted for the generation of about R2.4 billion in foreign exchange in 1992 (South Africa's biome diversity, 2004). A more recent study conducted by Turpie, Heydenrych and Lamberth (2003) support 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. On this basis they estimate that these attractions were the cause of a R7 443 million injection into the Western Cape economy (Turpie *et al*., 2003:241). A total of R9 304 million was spent in 1997 by holiday visitors to the Western Cape (Wesgro and KPMG, 1998). Of this, overseas tourists were responsible for 48 per cent (Wesgro and KPMG, 1998). Furthermore, South Africa's indigenous vegetation has a consumptive use value. For example, in 1999, the cut-flower industry in the Western Cape generated a gross income of R149.3 million (1999 Rands; Turpie *et al*., 2003:237) up from US$ 18 – 19.5 million in 1993 (van Wilgen, Little, Chapman, Görgens, Willems and Marais, 1997:409).

The effects that alien plant invaders have on biodiversity has been a concern for some time (van Wilgen, Richardson, le Maitre, Marais and Magadlela, 2001), but

[3]Ecotourism is defined as an "enlightening, participatory travel experience to environments, both natural and cultural, that ensures the sustainable use, at an appropriate level, of environmental resources" (Dalgliesh, Steytler and Breetzke, 2004). By respecting the integrity of the host communities, ecotourism produces economic opportunities that contribute to the long-term conservation of the resource base and reinforces the perception that conservation can bring meaningful benefits to all tourism role players (Dalgliesh *et al*., 2004).

only after it was recognised that they reduced catchment yields was the problem properly addressed (Turpie, 2004:87). It was this recognition that led to the establishment of the Working for Water (WfW) Programme in 1995. The WfW Programme is a multi-departmental initiative led by the Departments of Water Affairs and Forestry, Environmental Affairs and Tourism, and Agriculture. It entails removing invasive alien vegetation and restoring low-water consuming indigenous vegetation in the areas that have been cleared. With approximately 300 projects throughout the country, the WfW Programme aims to enhance water security, improve ecological integrity, restore the productive potential of land and promote sustainable use of natural resources and invest in the most marginalised sectors of South African society (DWAF, 2001a:2).

The WfW Programme's economic viability in terms of improved water yield has been repeatedly demonstrated in selected mountain catchments. For instance, in the Western Cape the Programme's viability has been demonstrated by van Wilgen *et al*. (1997). Modelling exercises carried out by van Wilgen *et al*. (1997) have shown that this type of management strategy has the potential to prevent large decreases in water supply and is efficient (le Maitre, van Wilgen, Chapman and McKelly, 1996; van Wilgen *et al*., 1997). Gilham and Haynes (2001) showed in a cost-benefit analysis (CBA) that the WfW Programme is economically viable in selected sites in KwaZulu-Natal. In the Eastern Cape most of the work on the Programme was initially conducted in the Tsitsikamma Mountains, but more recently increasing attention has been directed towards the coastal region, mainly in the Port Elizabeth and Port Alfred areas. Hosking, du Preez, Campbell, Wooldridge and du Plessis (2002) investigated the economic case for the Programme on selected sites in the Eastern and Southern Cape, by performing a CBA, based on increased water yield and livestock potential. This study concluded that the catchment management carried out under the WfW Programme at the selected sites was inefficient in terms of the benefits that could be valued, but noted a number of omissions in these analyses (Hosking *et al*., 2002:195-197). The most important omissions were the non-water benefits associated with the WfW Programme. Non-water benefits include, reduced fire protection costs and reduced damage to infrastructure as a result of wildfires, conservation of biodiversity and ecosystem resilience, gain in potentially productive land (grazing potential, livestock production and other agricultural practices), value added industries, increase in water quality, improved river system services, social development and poverty alleviation, job creation, economic empowerment and training, flood control, and the containment of erosion and a decrease in the siltation of dams (Marais, Eckert and Green, 2000).

The important contribution of the Hosking *et al*. (2002) study was to draw attention to the fact that the water benefits on their own did not constitute an economic case for the continuation of the WfW Programme at the selected sites – that some projects may be inefficient and that it was necessary to value the non-water benefits.

Du Plessis (2003) hypothesised that the most important omission, as far as the non-water benefits are concerned, was the biodiversity benefit. In a study conducted by du Plessis (2003), it was found that when this non-water benefit was added to the cost-benefit profile of the Hosking *et al*. (2002) study, the results changed significantly. With the inclusion of this benefit, some of the sites valued by Hosking *et al*. (2002) became efficient.

The du Plessis (2003) study valued the biodiversity benefits of alien control by means of a contingent valuation study. The study indicated that the biodiversity benefit attributable to the WfW Programme was substantial. The du Plessis (2003) study, although insightful, however, was a pilot one and suffered from a number of deficiencies. The most serious deficiency was the sample design utilised in the contingent valuation study. Furthermore, the valuations were conducted on WfW Programme sites in the Eastern Cape Province only.

1.2 OBJECTIVES OF THE STUDY

The purpose of this study was to value the biodiversity benefit generated by the WfW Programme at three sites, one of which is situated in the Western Cape Province (Worcester), one of which is situated in the Eastern Cape Province (Port Elizabeth Driftsands) and one situated in KwaZulu-Natal (Underberg area). These sites were chosen, in consultation with advisors from the WfW Programme, on the basis of their geographical location, the vegetation types present and their value as tourist attractions. The study aimed to provide policymakers with information regarding the value of the WfW Programme on the basis of what people are prepared to pay towards the Programme in order for the Programme's project teams to continue clearing operations.

The objectives of this study were addressed in the following way:

- A brief discussion of the impact that invasive alien plants have on runoff and South Africa's flora, together with a synopsis of some studies that have been performed to investigate the economic viability of the WfW Programme, was provided (Chapter One).
- Relevant background information and a discussion concerning the characteristics of the study sites was provided (Chapter Two).
- A description of the WfW Programme, and its link to preserving biodiversity was provided (Chapter Three).
- The valuation techniques used to value environmental service flows were overviewed. (Chapter Four).
- The pilot study conducted by du Plessis (2003) to value the biodiversity benefit of the WfW Programme was reviewed (Chapter Five).
- The sample selection process was described (Chapter Six).
- A discussion of selected issues relating to the administration of the contingent valuation surveys was provided (Chapter Seven).

- People's willingness-to-pay for indigenous vegetation (i.e. value the biodiversity benefit) through the application of the contingent valuation method was determined (Chapter Eight).
- Conclusions and recommendations were drawn based on the results of the aforementioned analyses (Chapter Nine).

1.3 CONCLUSION

There are ecological, economic and philosophical justifications for conserving biodiversity (Gowdy and Carbonell, 1999). However, promoting biodiversity is subject to budget constraints, and the costs associated with promoting it need to be weighed up against the benefits.

The clearing of invasive alien plants, using labour-intensive methods, will lead to many benefits other than those associated with increased water yield alone. The conservation of biodiversity is one of these. It entails the preservation of areas for indigenous vegetation growth. It has been highlighted as a major economic benefit of the WfW Programme by du Plessis (2003), but evidence in support of this proposition is thin. This dissertation aims to extend du Plessis' (2003) analysis by conducting an in-depth and comprehensive contingent valuation study to value the biodiversity benefit generated by the WfW Programme at three representative sites.

CHAPTER TWO
THE STUDY SITES

2.1 INTRODUCTION

Three different sites where the WfW Programme is currently operating were selected for analysis. The sites were chosen in consultation with the management of the WfW Programme. As mentioned previously, the site selection was based on indigenous and alien vegetation present and the existing or potential tourist value of each site. The three sites selected were Port Elizabeth Driftsands (Eastern Cape), Worcester (Western Cape) and Underberg (KwaZulu-Natal).

2.2 PHYSICAL FEATURES

2.2.1 GEOGRAPHICAL LOCATION

(a) Port Elizabeth Driftsands site

The Port Elizabeth Driftsands Project (33˚55'S; 25˚35'E) falls within the Nelson Mandela Metropolitan Municipality and covers an area of 8 700 hectares (see Figures 2.1 and 2.2). The Project (33˚55'S; 25˚35'E) is centred within the city of Port Elizabeth (the main economic hub in the Eastern Cape Province), which is fast becoming a popular tourist destination (Conservation Support Services, 2003). It is made up of coastal dunes and includes the Baakens and Papenkuils Rivers.

Figure 2.1: WfW project sites in and around Port Elizabeth

Source: Conservation Support Services (2003)

The Port Elizabeth Driftsands Project is located approximately 10 kilometres south-west of the Port Elizabeth central business district and harbour (McGwynne, Kerley and Campbell, 1996). The site is south of the Port Elizabeth airport and approximately 1 – 2 kilometres south of the coastline. The suburbs of Walmer Heights, Summerstrand and Humewood border the site. Gqebera Township adjoins the northern edge of the project site (see Figure 2.2).

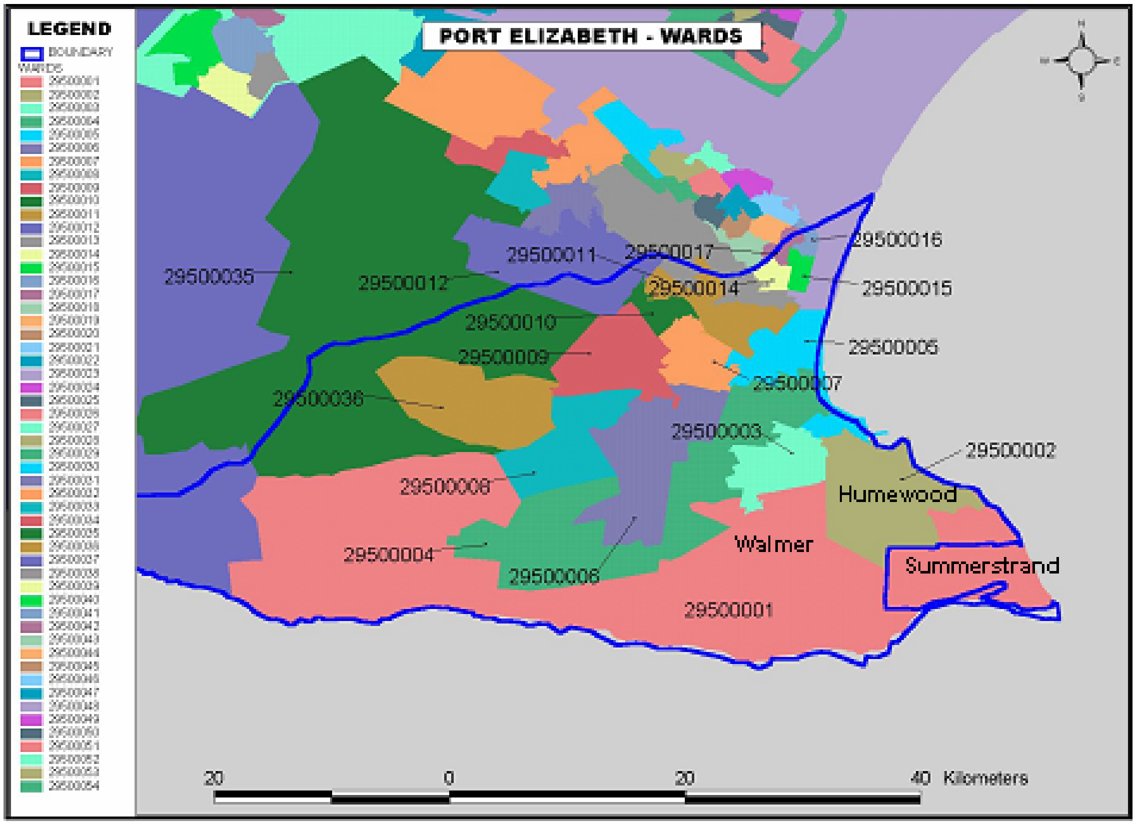

Figure 2.2: Wards bordering the Port Elizabeth Driftsands site

Source: Conservation Support Services (2003)

Of relevance to this study is that the downwind section of the Driftsands dunefield was stabilised by Joseph Lister of the Cape Forestry Department in the late 1800's. Lister constructed a railway line in 1883 from the growing city of Port Elizabeth into the dunes (McGwynne *et al*., 1996). Mule wagons brought over 80 tonnes of domestic refuse a day along this line, which was then spread over the dunes. In addition, Australian Acacias, mainly *Acacia cyclops* and *Acacia saligna*, as well as rye grass and pipe grass, were planted and by 1909 the whole dunefield had been stabilised (McGwynne *et al*., 1996).

(b) Worcester site

Worcester (33˚39'S; 19˚26'E) lies in the Breede River Valley, between the rugged Du Toits and Hex River mountains, east-northeast of Cape Town.

The Worcester Project (see Figures 2.3 and 2.4) stretches from De Doorns, along the Hex River to the Breede River and from around Slanghoek near Goudini to Aan De Doorns in the east (Marais, pers. comm., 2004). For the purpose of this study, only the sites within the town of Worcester were considered. These sites cover an area of approximately 6 245 hectares.

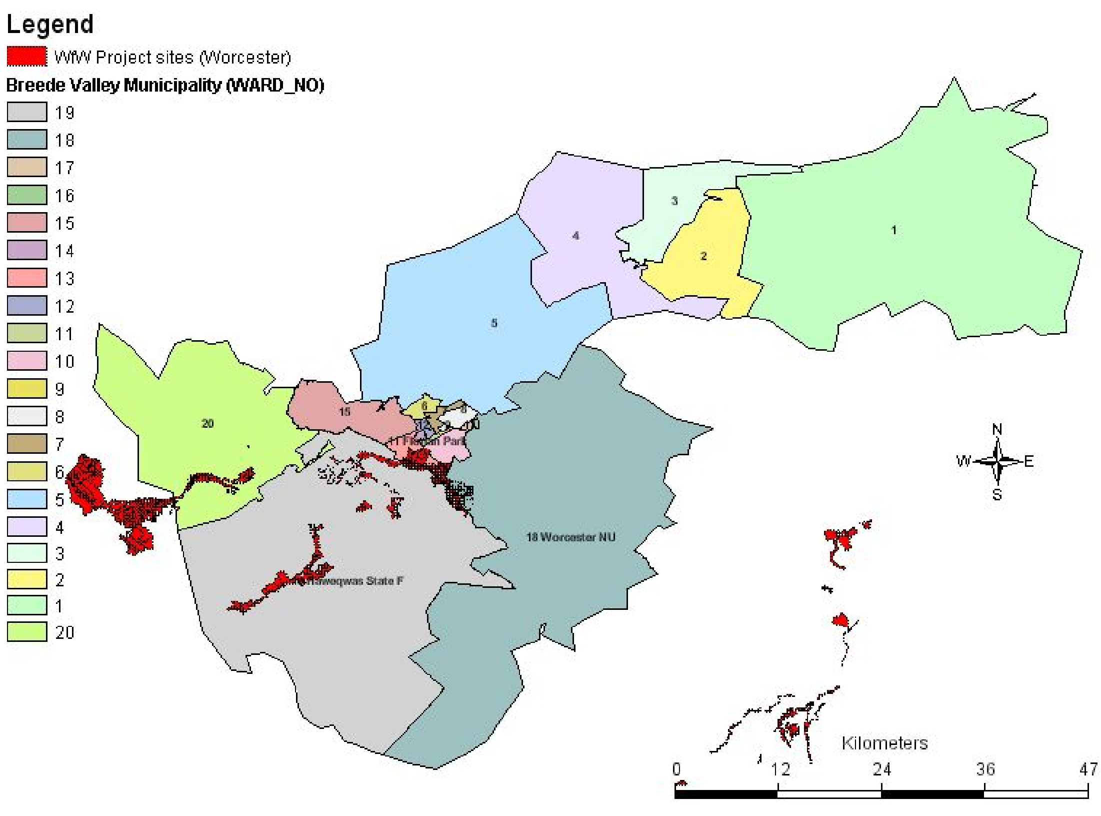

Figure 2.3: WfW project sites in and around Worcester

Source: Wannenburgh, pers. comm. (2005)

The suburbs of Johnsons Park, Florian Park, Avian Park, Noble Park and Worcester NU border the site. Haweqwas State Forest forms the western boundary of the project site (see Figure 2.4).

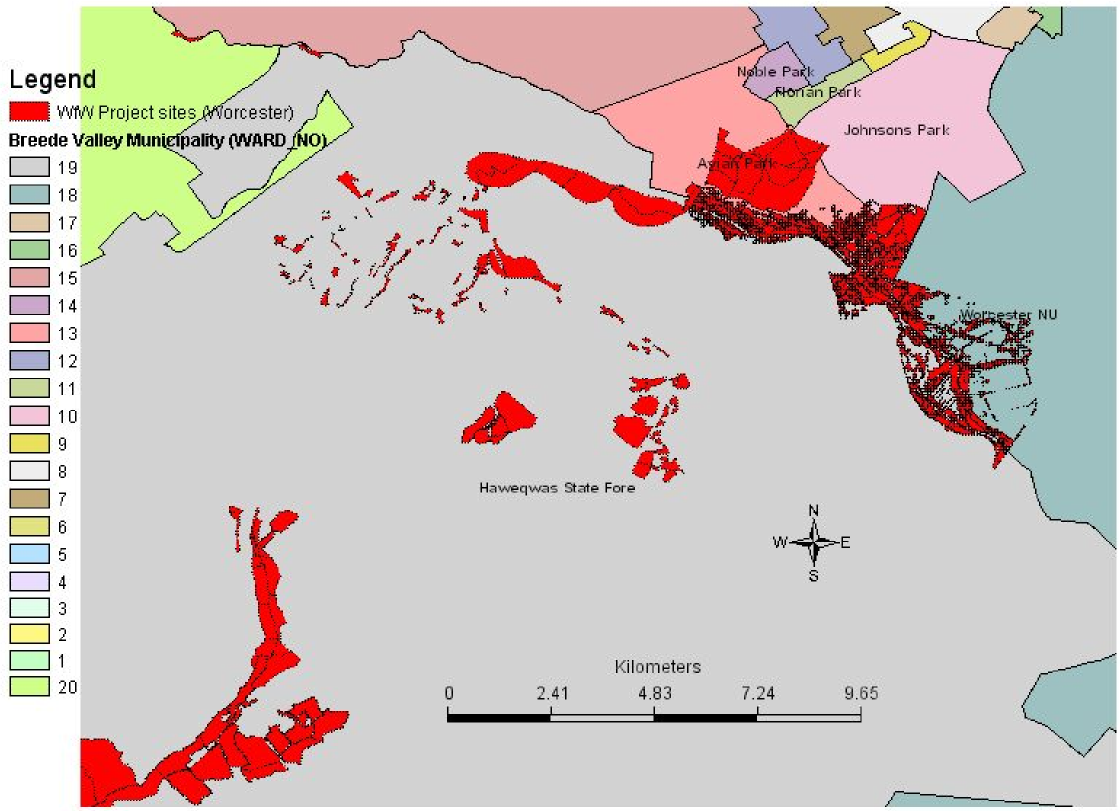

Figure 2.4: Wards bordering the Worcester site

Source: Wannenburgh, pers. comm. (2005)

The first exotic timber plantation (mainly *Eucalyptus globulus*) was established at Worcester in 1876 by Joseph Lister to produce wood to meet the early steam locomotives' fuel requirements (Steyn, 1982).

(c) Underberg site

The Underberg Magisterial District (29˚49' - 29˚98'S; 29˚09' - 29˚70'E), situated in the southern Drakensberg's Kwa Sani Municipality, was selected as a suitably representative area in which to investigate the WfW Programme in KwaZulu-

Natal. The Vergelegen Nature Reserve (29˚56'S; 29˚45'E), which forms part of the Ukhahlamba Drakensberg National Park (indicated by the dark red boundary), was identified as the site within this magisterial district that would be studied (see Figure 2.5). The Vergelegen Nature Reserve is situated north of Himeville and encompasses the top catchment of the Mkomazi River and the Mqatsheni River (Whitley, pers. comm., 2005). This site covers an area of 1 159 hectares.

Figure 2.5: WfW project sites in and around Underberg
Source: Whitley, pers. comm. (2005)

The farm Dieu Donne in the Polela Valley was the first farm used for the planting of *Pinus patula* in the Underberg area (Clark, pers. comm., 2006).

2.2.2 CLIMATE AND RAINFALL CONDITIONS

Precipitation varies significantly across the different project sites. This can be attributed partly to the topography.

(a) Port Elizabeth Driftsands site

The climate in this area is regarded as sub-tropical in the Köppen system of classifications (Lubke, 1988) and the proximity to the coast ensures moderate temperatures. Daily temperatures range from an average minimum of 8.8º C to an average maximum of 25.4º C (see Table 2.1).

Table 2.1: Long term minimum, maximum and mean temperature for Port Elizabeth for the period 1961 to 1990

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
MAX	25.4	25.4	24.6	23.0	21.7	20.3	19.7	19.6	20.0	20.8	22.3	24.3	22.3
MIN	17.9	17.9	16.9	14.3	11.5	9.2	8.8	9.8	11.4	13.1	14.6	16.4	13.5
MEAN	21.7	21.6	20.7	18.7	16.6	14.7	14.3	14.7	15.7	17.0	18.5	20.3	17.9

Source: Weather SA (2006)

Wind data for Port Elizabeth indicates that the wind pattern is dominated by westerly and south-westerly winds during both winter and summer months, respectively (Stone, Weaver and West, 1998). Gales (winds of over 18 m sec^{-1}) are reasonably common along the coast and occur on average 20 times a year at Port Elizabeth (Tinley, 1985).

Port Elizabeth has an average annual rainfall of 624 mm (Weather SA, 2006), while the Port Elizabeth Driftsands site has an average annual rainfall of 500mm (du Plessis, 2003:11; Hosking *et al*., 2002:23). During the 29 year period reported in Table 2.2, over 50 per cent of the precipitation in the Port Elizabeth area fell between April and September.

Table 2.2: Long term minimum, maximum and mean rainfall for Port Elizabeth for the period 1961 to 1990

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
MAX	122	138	309	148	154	210	215	183	468	147	112	137	1068
MIN	6	6	5	12	6	4	3	5	3	18	10	7	406
MEAN	36	40	54	58	59	62	47	64	62	59	49	34	624

Source: Weather SA (2006)

A feature of the Port Elizabeth area is flooding during so-called three-day rain events (Stone *et al*., 1998). These high rainfall events are associated with a high-pressure system to the south feeding in cool moist air into the area. If this coincides with a cut-off low-pressure area over the interior, devastating floods can transpire (Kopke, 1988). Episodic flooding, which can cause extensive damage to disturbed or modified natural systems, is a feature of the Port Elizabeth area (Bok, 2001).

(b) Worcester site

Worcester experiences a Mediterranean climate characterised by warm, dry summers and cool, wet winters. While most of the Breede River Valley receives relatively abundant rainfall (from 500 mm to over 1000 mm per annum), the town of Worcester remains relatively dry due to a rain-shadow phenomenon caused by the surrounding high mountains (Wikipedia, 2006). Rainfall, which occurs mainly in the winter months, ranges from 250 mm to 350 mm annually (Cowling, 2001). Long term minimum, maximum and mean temperature values, based on monthly averages for the 12-year period, 1974 – 1986, are shown in Table 2.3. Daily temperatures range from an average minimum of 6.2º C, experienced during July, to an average maximum of 25.5º C (Weather SA, 2006).

Table 2.3: Long term minimum, maximum and mean temperature for Worcester for the period 1974 to 1986

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
MAX	25.3	25.5	23.9	21.4	17.8	16.2	15.5	15.6	17.1	19.3	21.9	23.8	20.3
MIN	12.4	12.7	11.4	10.0	7.8	6.9	6.2	6.3	7.1	8.2	10.1	11.5	9.3
MEAN	18.9	19.0	17.6	15.7	12.8	11.6	10.9	10.9	12.1	13.8	16.0	17.6	14.8

Source: Weather SA (2006)

Wind data indicates that the wind pattern is dominated by west-north-westerly and north-westerly winds during the autumn and winter months. South-easterly winds dominate during the summer months (Weather SA, 2006).

(c) Underberg site

In the Underberg area temperature and rainfall are seasonal. Heavy mists are typical in spring and summer, while snow may fall in winter (DWAF, 2001b). The mean annual rainfall for Underberg ranges from approximately 804 mm to 970 mm (Wildy, 2003:5), with the wet period between October and March and June – July being the driest period (Cawe, 1986). The mean average rainfall at the site is 409 mm per annum (Whitley, pers. comm., 2005).

Minimum daily temperatures range from an average minimum of –3.5º C, during June, to an average maximum of 25.3º C in January (see Table 2.4).

Table 2.4: Long term minimum, maximum and mean temperature for Underberg for the period 1981 to 1990

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
MAX	25.3	24.8	24.0	22.1	20.6	17.7	18.2	19.7	21.7	21.6	22.9	24.6	21.9
MIN	11.9	11.1	9.4	6.0	1.1	-3.5	-3.3	-0.1	4.2	6.8	9.2	10.8	5.3
MEAN	18.6	18.1	16.9	14.0	10.9	7.1	7.5	9.8	13.0	14.2	16.0	17.7	13.6

Source: Weather SA (2006)

Wind data provided by Weather SA (2006) indicates that the wind pattern in Underberg is dominated by north-westerly and south-westerly winds during the autumn and winter months. Easterly winds prevail during the spring and summer months.

2.2.3 TOPOGRAPHY AND GEOLOGY

The topography and geology of the three WfW Programme project sites have an effect on the quality of ecosystem services provided in these areas.

(a) Port Elizabeth Driftsands site

The Driftsands site is characterised by quaternary aeolian sands of marine origin with calcretised layers overlying Table Mountain Quartzite bedrock (Rust, 1998) while alluvial clays are found in the valleys (du Plessis, 2003:11).

(b) Worcester site

The topography of the Worcester area is dominated by the prominent mountain ranges of the Cape Fold Belt, separated by cultivated, wide intermontane valleys. The geology of the area is underlain largely by sandstones and shales of the Cape Supergroup and Malmesbury Group, Cape Granites, and younger sand and alluvial deposits of Tertiary and Quaternary Formations (Crowther, Campbell and Associates, 2002).

(c) Underberg site

The geology of the area consists of the Molteno Formation. The dominant soils are deep, leached, acid, ferralitic soils derived from dolerite and Beaufort series sandstones in an undulating terrain bisected by dolerite dykes and sills (Metroplan 2001).

2.2.4 INDIGENOUS AND EXOTIC FLORA FOUND AT THE SELECTED SITES

The indigenous and exotic vegetation varies across the different project sites.

(a) Port Elizabeth Driftsands site

According to Low and Rebelo's (1996) classification system, Grassy Fynbos, Dune Thicket and Renosterveld are the principal indigenous vegetation types present at the Driftsands site. Five species of plants found on the precinct are endemic to the Eastern Cape. These are *Zygophyllum uitengagense* Scnd.; *Muraltia squarrosa* (L. f.) DC.; *Erica glumiflora* Klotzsch ex Benth.; *Rapanea gilliana* (Sond.) Mez; *Felicia echinata* (Thunb.) Nees; and *Haplocarpha lyrata* (Harv.). A further eight species recorded in the Dune Fynbos are protected by law. These are: *Chondropetalum microcarpum* (Kunth) Pillans; *Boophane disticha* Herb.; *Brunsvigia litoralis* R.A. Dyer; *Tritonia* sp.; *Gladiolus* sp.; *Erica glumiflora* Klotzsch ex Benth.; *Sideroxylon inerme* subsp. *Inerme* and *Harveya* sp. (McGwynne *et al*., 1996).

However, the greater part of the Driftsands site is infested with aliens. The principal invasive alien species present comprise *Acacia saligna*, *Acacia cyclops*, *Acacia longifolius* (Long-leaved wattle) and *Eucalyptus* spp. (Gums) (Conservation Support Services, 2003; du Preez, 2002:58). The relative alien infestation rate varies between 5.1 and 10.0 per cent (Hosking *et al*., 2002:16). These alien plant species constitute a threat to the biodiversity of the area and increase the fire risks (du Plessis, 2003).

(b) Worcester site

The Worcester Valley has been transformed by agriculture. However, remnants of the original Alluvial Fynbos and Central Mountain Renosterveld still occur (Crowther, Campbell and Associates, 2002). The most western boundary of the

Little Succulent Karoo vegetation is found between Rawsonville and Worcester, giving the area bio-geographical importance (Crowther, Campbell and Associates, 2002). This vegetation type is described as very rare due to its limited geographical coverage and because a great deal has been lost to agriculture.

The principal invasive alien species in this vegetation type are woody alien plants. The relative alien infestation rate is approximately 15 per cent (Wannenburgh, pers. comm., 2005). *Pinus* species, *Hakea* species and *Acacia* species are the most abundant, impacting not only on the flora, but also on tourism and water yields (Marais, pers. comm., 2004).

(c) Underberg site

The Underberg district of the southern Drakensberg forms part of the Eastern Mountain centre of endemism (Cowling and Hilton-Taylor, 1997). While the high altitude flora containing most endemics is well protected within the Ukhahlamba Drakensberg National Park (Metroplan 2001), the distinct, species-rich flora of the foothills (Hilliard and Burtt, 1987) is at risk from changes in land use. Both wetland and dryland areas have been subjected to extensive transformation.

Rubus cuneifolius (American bramble) is the most ubiquitous and abundant alien invasive plant species present at the site (Whitley, pers. comm., 2005; Turpie, 2003:131). The level of infestation by this plant species ranges from approximately 5 per cent (Whitley, pers. comm., 2005; Turpie, 2003:137) in conserved grassland areas (such as the Vergelegen Nature Reserve) to 43 per cent in nearby plantation forestry areas (Turpie, 2003:137). The other main invasive alien plant species present at the site include *Solanum mauritianum* (Bugweed), and various species of *Eucalyptus* and *Acacia* (Whitley, pers. comm., 2005).

2.3 ECONOMIC FEATURES

2.3.1 LAND USE

(a) Port Elizabeth Driftsands site

The land containing the Port Elizabeth Driftsands site is situated in the urban areas of the Nelson Mandela Metropolitan Municipality. The site is owned and managed by the Nelson Mandela Metropolitan authority and once constituted the Driftsands Forest Reserve, which was later de-proclaimed. It is largely unused except for game poaching and wood collecting by people from the nearby Gqebera (Walmer) Township (McGwynne *et al*., 1996). The Driftsands area was intended for future residential purposes to accommodate human population growth in Port Elizabeth and to allow for the development of low-cost housing in areas alongside those that were historically for white people (McGwynne *et al*., 1996). However, the extension of a residential component into the Driftsands area came under review, and the proposed area was set aside for the Madiba Bay Leisure Park development (Coastal and Environmental Services, 2005). The Madiba Bay Leisure Park development is designed as a coastal tourist attraction. Its mission is to enhance domestic and international tourism, empower disadvantaged communities and to promote sustainable development and tourism in the Port Elizabeth area (Coastal and Environmental Services, 2005). This city-based “Leisure Park” will incorporate a range of attractions (e.g. wildlife, culture and crafts) that visitors can expect to experience in the Eastern Cape Province as a whole and is marketed on the back of the Eastern Cape’s rich biodiversity (Coastal and Environmental Services, 2005).

(b) Worcester site

Worcester functions as the economic, medical, judicial, sports, shopping, and administrative capital of the Breede Valley Municipality (Schroeder, 2002:30).

The Worcester area is the centre of a wine-producing district and produces approximately 25 per cent of South Africa's winegrapes and 45 per cent of these are used for the distilling of brandy ('Tourism', 2002). The area is also known for its table grapes. In addition, the Worcester area is well known for olive farming and the production of olive oil. Fruit processing and canning are its other economic mainstays (Encyclopædia Britannica Online, 2005).

(c) Underberg site

Since the arrival of European-style farmers in the area over 150 years ago, the Underberg area has been dominated by privately owned farmland (Johnson, Barnes and Taylor, 1998). Dairy farming is the most prominent use of land in the Underberg district (Wildy, 2003:2). However, a trend towards afforestation has been noted since the 1980s in response to the global demand for wood and pulp (Wildy, 2003:2). Tourism is another important contributor to the economy of the area (McAlister, 2004:4).

2.4 CONCLUSION

There are significant differences in the features between the three sites (Port Elizabeth, Worcester and Underberg) that were researched in this study. The differences noted between the sites indicate that contingent valuation studies are justified for each unique site and that study results should not be used to make generalisations about WfW project sites in order to prevent inference biases (see Section 4.5.2 (a)) from occurring that may render the valuation invalid.

Chapter Three will discuss the WfW Programme.

CHAPTER THREE
THE WFW PROGRAMME

3.1 INTRODUCTION

The WfW Programme is an integrated multi-agency intervention to address the alien plant problem, and has grown into one of the world's most extensive programmes dealing with invasive aliens (Richardson and van Wilgen, 2004:45). This Programme entails the clearing and control of invasive alien vegetation whilst restoring low water-consuming indigenous vegetation to the cleared areas (Hosking and du Preez, 2004b:385). By hiring previously unemployed individuals to clear invasive alien plants, the WfW Programme addresses the multiple aims of ecosystem rehabilitation, water conservation, and poverty relief through job creation, as well as environmental education and awareness-raising about alien plants and water conservation (Bohensky, Lynam and Biggs, 2004). Over 300 projects have been implemented in South Africa since its inception in October 1995 (DWAF, 2006).

Alien plant clearing programmes were first initiated in South Africa in the early 1970s (van Wilgen, le Maitre and Cowling, 1998). These programmes, despite being small in scale, yielded positive results. Not only were ecosystem services preserved, cost-benefit analysis demonstrated that the clearing was efficient. Jobs were also created (van Wilgen *et al*., 1998).

The WfW Programme was formally initiated in September 1995, with a grant of R25 million from the Government's Reconstruction and Development Programme. Professor Kader Asmal's motivation to release funding to clear alien invasive plants was based on three principal benefits: increased water runoff, the conservation of South Africa's rich biological diversity as well as the benefits obtained from properly functioning ecological systems, and the social benefits of a labour intensive clearing programme (Hosking *et al*., 2002:4).

3.2 THE OBJECTIVES OF THE WFW PROGRAMME

The goal of the national WfW Programme is to “contribute to the sustainable prevention and control of invasive alien plants, and thereby the optimising of the conservation and use of natural resources. In doing so, it will address poverty relief and promote economic empowerment and transformation within a public works' framework” (DWAF, 2004:i).

The specific objectives that flow from this goal are outlined below:

- Ecological: To improve the ecological integrity of South Africa’s natural systems through the removal and control of alien invasive plants, and to protect and restore biodiversity, thereby countering abnormal fires, soil erosion, flooding, scouring of rivers, and the siltation of rivers, dams and estuaries.
- Hydrological: To improve water security in South Africa by regaining control over alien plant invasions and to promote the quest for equity, efficiency and sustainability in the supply and use of water.
- Agricultural: To restore the productive potential of land, in partnership with the Land Care initiative of the Department of Agriculture, through the control of invasive alien vegetation and to promote the sustainable use of natural resources.
- Socio-economic empowerment: To optimise and develop the social benefits of this community-based public works programme by investing in the most marginalised sectors of the South African economy.
- Economic: To develop the economic benefits (drawn from land, water, wood and people) of clearing these invasive plants, by facilitating economic empowerment and the development of secondary industries, and to play its part in protecting the economic integrity of the productive potential of South Africa.
- Institutional development: To build an effective and efficient organisation that optimises co-operative government, partnerships, transformation, staff

development and learning (DWAF, 2004; du Plessis, 2003:3; Conservation Support Services, 2003).

3.3 INVASIVE ALIEN PLANTS IN THE EASTERN CAPE, WESTERN CAPE AND KWAZULU-NATAL

Approximately 8 750 alien plant species have been introduced into South Africa. Only 193 have become seriously invasive (DWAF, 2006), mainly trees and shrubs that mature quickly, multiply prolifically, spread easily, and fare well in disturbed conditions (van Wilgen and van Wyk, 1999:566).

The WfW Programme identified the Black Wattle (*Acacia mearnsii*), Silver Wattle (*Acacia dealbata*), *Pinus* spp., Port Jackson (*Acacia saligna)* and Eucalyptus trees as the worst invaders in the Eastern Cape (DWAF, 2006). Of these alien invasives, Wattle is the fastest growing invader, covering new areas in 5 – 10 years. Other projected rates of spread are given as 1 – 2 per cent per year doubling in the following 10 – 20 years (DWAF, 2006). In high rainfall areas, the potential for spread is, however, greater (DWAF, 2006) (see Figure 3.1).

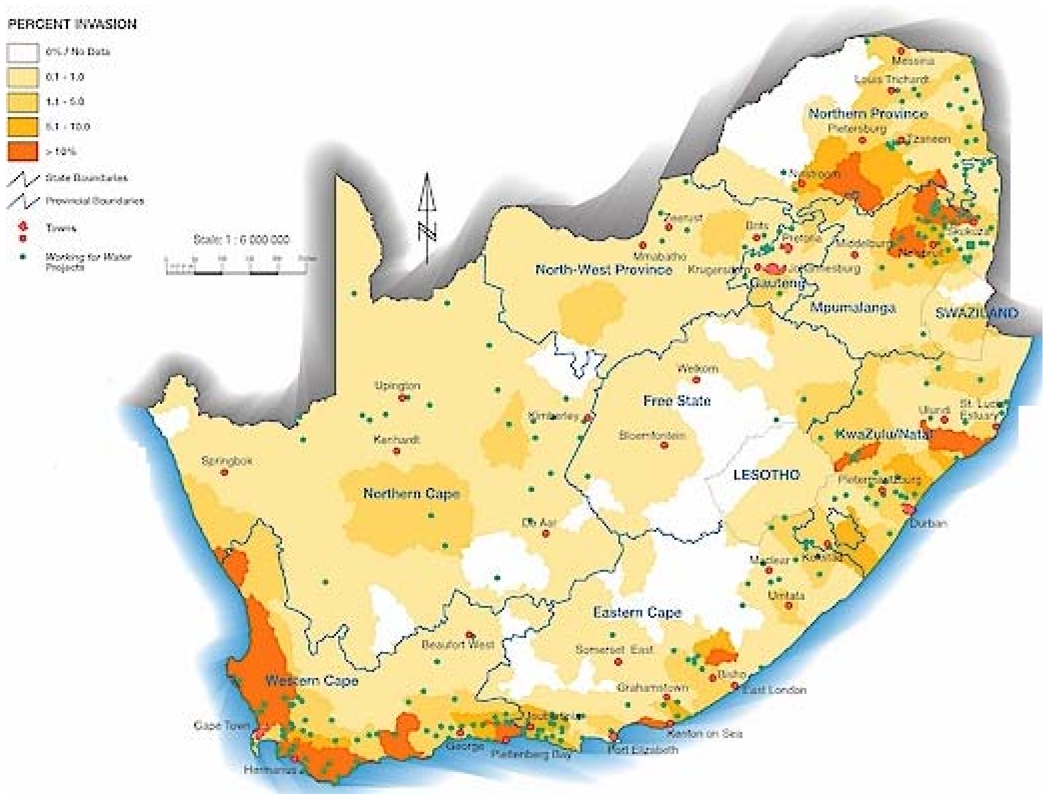

Figure 3.1: Estimated percentages of invading alien cover per quaternary water catchment and the location of WfW project sites

Source: DWAF (2001a:12)

Note: The Northern Province has been renamed. It is now known as the Limpopo Province.

Hakea spp., Rooikrans (*Acacia cyclops*), *Acacia saligna*, *Pinus* spp. and Sesbania were identified as the worst invaders in the Western Cape (DWAF, 2006). The WfW Programme (DWAF, 2006) notes that the Western Cape's rivers are largely invaded and has warned that there is scope for further spread into the mountain catchment areas and remaining uninvaded streams (see Figure 3.1).

Acacia mearnsii, *Acacia dealbata*, Lantana, Brambles and Chromolaena have been identified as the worst invaders in KwaZulu-Natal (DWAF, 2006). The WfW Programme (DWAF, 2006) states that rivers are high-risk areas. Riverbanks, floodplains, road verges and drainage lines are being overrun by alien vegetation. Coastal and inland forests are also at risk of being transformed to alien vegetation (see Figure 3.1).

3.4 THE WFW CONTROL OPERATIONS

Control of invasive alien plants entails their removal both from areas where they have established themselves as well as from those areas where infestation is in its initial stages (Hosking *et al*., 2002:28). The areas are divided into management units, ranging in size from approximately 50 – 2 000 hectares. Controlling the spread of invasive alien vegetation is accomplished through intensive initial clearing of management units and repeated follow-up procedures (Hosking *et al*., 2002:28). Initial control entails the removal of invasive alien plants and is associated with a drastic reduction in the existing alien population. Follow-up control entails controlling seedlings, root suckers and coppice growth in a previously cleared area. Maintenance control focuses on minimising invasive alien plant numbers (DWAF, 2006).

The WfW Programme teams have undertaken a considerable amount of follow-up clearing since 1998 / 1999 (see Figure 3.2). During the 2003 / 2004 financial year initial clearing only accounted for 24.5 per cent (194 439 hectares) of the area cleared of alien invasive plants. Follow-up operations in areas that have already been cleared take priority in field operations because if this phase is neglected, the cleared area will soon become re-infested with dense alien vegetation, arising either from re-invasion by the original alien species or from invasion by another alien species (Hosking *et al*., 2002:28; Hobbs and Mooney, 1993). Should re-growth be allowed to occur, the initial investment would, in effect, have been wasted (Hosking *et al*., 2002:28; Hosking and du Preez, 2004a:144).

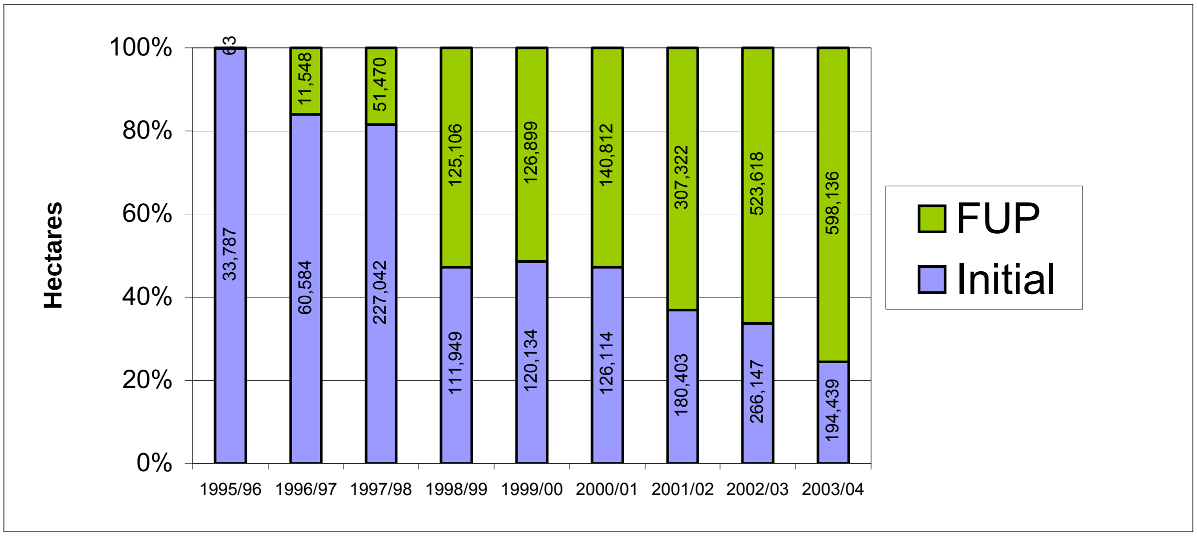

Figure 3.2: Initial / follow-up ratio per year for the national WfW Programme

Source: Wannenburgh, pers. comm. (2005)

In Fynbos areas four to five treatments are required over a ten-year period before a 75 – 100 per cent infestation is brought to a state where it only requires maintenance (Marais, Willems and Hanks, 1999). The initial follow-up treatment generally takes place within the first year after the initial clearing for resprouting species (Marais *et al*., 1999). The choice of control programme will be influenced by a range of factors including the species present, the density of the stands and the accessibility of the management units (Hosking and du Preez, 1999:444). The management methods include manual, mechanical, chemical and biocontrol techniques.

(a) Manual and mechanical control

Mechanical control includes all action in which force is exerted to control the target invasive plant. Mechanical control options thus include the slashing, burial, removal, cutting or stumping of plants (Stirton, 1978:146). In addition, it includes practices such as burning, ploughing and afforestation. When fire is used, it can be applied in conjunction with manual control (for example fell and burn, or burn and follow-up with hand weeding).

(b) Chemical control

Chemical control refers to the application of herbicides. Herbicides, if used correctly, are safe and can play an important role in the control of alien plants. In certain cases, the use of herbicides is preferable to mechanical methods, for example, when the disturbance created by digging and uprooting, especially on steep slopes, could result in soil erosion. Chemical control may also be preferable in cases where it would be more economical than mechanical control.

(c) Biological control

Biological control describes the use of natural biological agents to control the targeted alien plant. The agents mostly include insects, mites and microbial pathogens (Bromilow, 2001). Although livestock and other local herbivores may also feed on the alien plants, these are of limited relevance in alien invader control. A biological control programme involves the identification of agents which infest and damage the alien plant in its native country, culturing of the agent in quarantine, screening for host specificity (to ensure that it will not attack other plants, also done in quarantine) and if found suitable, release of the agent in the field (Zimmerman, Moran and Hoffmann, 2004:34). The effectiveness of the agent as a control mechanism is then assessed. Seydack and Bekker (1995) maintain that if high and continuous control expenditures are to be avoided biological control of alien invasives will have to be used in the long-term. Wilson (1985) contends that biological control is the solution to the removal of alien invaders, which produce a high seed load, especially the *Acacia* species found in riparian zones.

3.5 THE BENEFITS AND COSTS OF THE WFW PROGRAMME

(a) Primary benefits

Currently, the increase in water yield is considered to be the major tangible benefit of clearing invasive alien vegetation from riparian habitats, mountain catchment areas and wetlands (Marais, pers. comm., 2006; Hosking and du Preez, 2004a:144). The WfW Programme's primary premise is that removing alien plant invaders and restoring indigenous vegetation increases runoff because the latter use less water than the former. Plantation forestry research into reduced water yields resulting from afforestation (controlled and uncontrolled) with alien tree species (Briers and Powell, 1993) is the basis for this theory.

(b) Secondary benefits

The secondary benefits of the WfW Programme include: training of workers and social upliftment, the conservation of biodiversity[4], the improvement of water quality, downstream industrial development, flood control and the prevention of soil erosion, fire hazard reduction, the improvement of the livestock holding capacity of land and improved river system services (Hosking and du Preez, 2004a:146; Marais *et al*., 2000).

(c) The special benefit of preserving biodiversity

Arguably, one of the most important benefits of the WfW Programme is the conservation of biodiversity (DWAF, 2002; du Plessis, 2003). The Convention of Biological Diversity defines biological diversity as "the variability among living

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[4] Marais (pers. comm., 2006), however, contends that the conservation of biodiversity should only be considered a secondary benefit of the WfW Programme when invasive alien plants are cleared from riparian habitats, mountain catchment areas and wetlands.

organisms from all sources, including, *inter alia*, terrestrial, marine and other aquatic ecosystems, and the ecological complexes of which they are part; this includes diversity within species, between species, and of ecosystems" (Gaston and Spicer, 1998:2). Diversity is the key to ensuring the continuance of life on Earth. It is a fundamental requirement for adaptation and survival and continued evolution of species (Gaston and Spicer, 1998). Another definition of biodiversity is that of Dr Peter Raven of the Missouri Botanical garden. According to Raven (1994) "biodiversity is the sum total of all plants, animals, fungi and micro-organisms in the world, or in a particular area; all of their individual variations; and all of the interactions between them".

For the purposes of this study, indigenous vegetation is being used as a proxy for optimum biodiversity. Indigenous vegetation yields direct and indirect benefits.

The direct benefits of indigenous vegetation are discussed below.

The Cape flora is known to be a rich source of medicines, perfumes and beverages (Stirton, 1978:38-39). Rooibos tea, honeybush tea, buchu tea and buchu brandy, all derived from the Cape flora, are popular beverages both nationally and internationally. These products, together with thatch and the cut-flower industry, together comprise a multi-million Rand industry. In 1999, the cut-flower industry in the Western Cape generated a gross income of R149.3 million per year, of which R91.5 million and R37.8 million were from the export of fresh and dried flowers, respectively. Local sales totalled R20 million (1999 Rands; Turpie *et al*., 2003). The cut-flower industry has subsequently experienced considerable growth. In 2004 the local cut flower market was valued at R240 million and export revenue was estimated to be approximately R280 million (Wesgro, 2005:10). This industry employs about 15 000 people in the Western Cape (Wesgro, 2005:8). Although the rooibos tea sector is relatively small in terms of the Western Cape's agricultural output of around R7 billion per annum, it has made a significant contribution to the region's economy. The rooibos tea industry employed approximately 4 000 people in 2000 and earned an estimated R460 million in 2004 (Wesgro, 2005:9), substantially up from just R17 million in 1995. In 2004, more than 6 300 tonnes of rooibos tea were exported (Wesgro, 2005:9), compared to 1 800 tonnes in 1999, 1 500 tonnes in 1998, 432 tonnes in 1990 and a mere 8.6 tonnes in 1966.

The management of South Africa's visual resources, of which Fynbos is one, play an important role in promoting tourism (see Section 1.1) and through this also the economy (Britton, 1995).

In KwaZulu-Natal, alien invaders such as Chromolaena and Lantana are drastically degrading the ecosystems of tourist attractions such as the Hluhluwe, Thula Thula and Ndumo Nature Reserves and the Greater St Lucia Wetland Park. Chromolaena casts shade on nesting areas, thereby reducing the incubation temperature and thus altering the sex ratio of the developing hatchlings in favour of females. If this continues, the crocodiles could become extinct in this area (Leslie, 2001), reducing its appeal to tourists. If one considers the fact that nature tourism[5] accounted for 6 per cent (R5.4 billion) of the gross domestic product of KwaZulu-Natal and provided more than 80 000 jobs (Aylward, 2003:14 - 15), the negative economic effect that Chromolaena and other invasive alien plants could have on the region is emphasised.

Dold and Cocks (2002) valued traditional medicinal plants in the Eastern Cape Province at R27 million annually. This figure is based on a survey of six urban centres in the Eastern Cape (Dold and Cocks, 2002:590). The survey found that the minimum number of traditional medicinal plants used was 166. The large number and variety of species used as traditional medicinal plants indicates the importance of biodiversity in meeting the health needs of the Eastern Cape's

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[5] Nature tourism is recreation or sightseeing based on the consumptive or non-consumptive use of destinations that have natural attractions.

population. Holdstock (1978) estimates that 80 per cent of the African people residing in South Africa use traditional medicines.

Furthermore, many plant species used by rural people, have a hidden cultural value (Cocks, Dold and Wiersum, 2003). For example, 30 per cent of the plants traded are used only for cultural purposes, i.e. for ritual and spiritual requirements (Cocks *et al*., 2003). To demonstrate the economic value attached to cultural species and sites, Cocks *et al*. (2003) examined the species used for the spiritually and culturally important kraal and igoqo (woodpile) for males and females respectively. They found that maintaining a kraal is valued at R170 per annum, while one igoqo woodpile is valued at R190 per annum, (Cocks *et al*., 2003).

Indirect benefits of indigenous vegetation include livestock grazing, orchard pollination and honey production (Turpie *et al*., 2003).

South Africa, as a signatory of the Convention on Biological Diversity, is committed to the conservation and sustainable use of all living resources. However, the invasion of ecosystems by alien invasives changes the structural make-up, genetic diversity and organisation of biodiversity, effectively eroding the foundations of ecosystems (Turpie, 2004:89). In this manner, these plants affect ecosystem functioning and resilience, and ecosystem efficiency. While the effect, that invasive alien plants have on biodiversity is often referred to, the full implications of these influences are not generally understood by many policy- and decision-makers (Turpie, 2004:89).

For example, studies have indicated that plant species richness is reduced in communities dominated by alien plants relative to uninvaded indigenous communities. This reduction has been documented in a study conducted by Richardson and van Wilgen (1986) of the Fynbos vegetation of Biesievlei. The Fynbos vegetation of Biesievlei, Jonkershoek was surveyed and described in

1945. A reassessment of the vegetation was made in 1984 using the same methods. After 35 years of afforestation with *Pinus radiata* the mean number of species per 0.1 m^2 quadrant was 2.1 (1.8 if alien species were excluded) compared with 8.5 prior to planting. The cover of the indigenous vegetation had decreased from 75 to 20 per cent and decreased the aggregate number of species by 58 per cent from 298 to 126 (Richardson and van Wilgen, 1986:309).

The mean plant density decreased from 260 plants m^{-2} to 78 plants m^{-2} (Richardson and van Wilgen, 1986:311). Different life forms showed varying degrees of resistance to suppression by alien plants. Proteaceous shrubs with canopy-stored seeds and limited dispersal capabilities were particularly susceptible (Richardson and van Wilgen, 1986:314), while streambank vegetation, comprising mainly large-leaved sprouting shrubs, persisted in a relatively unmodified state.

Richardson and van Wilgen (1986:309) postulated that certain indigenous groups may re-establish after clearfelling, but others, notably various groups of shrubs may be permanently eliminated. These findings led to the conclusion that afforestation results in a reduction in the number of plant species. Removal of the forest may, however, lead to some indigenous species re-establishing themselves, provided that this removal does not occur too long after afforestation is initiated (Richardson and van Wilgen, 1986).

Various factors can explain the reduction in plant species at Biesievlei. Firstly, Pines are more efficient users of the resources that are available. Not only do Pine trees grow faster than the indigenous plants (i.e. Fynbos and Grassy Fynbos) they also reach a much greater size. Furthermore, the accumulation of litter fall from Pines leads to a pronounced suppression of the understorey vegetation, while shading affects photosynthesis and the germination of understorey plants (Richardson and van Wilgen, 1986:314). Each individual limiting factor's proportional contribution to the suppression of components of the natural vegetation is unknown. However, the combination of these factors has undeniably led to the loss of several (groups of) species (Richardson and van Wilgen, 1986:314).

The loss of biodiversity has a direct impact on poverty since it sustains both livelihoods and life itself (Dalgliesh *et al*., 2004:60). For example, many of the rural Xhosa people in the Eastern Cape are dependent on their local resource base for survival, partly because of their traditional way of life, but also due to their limited survival options. They use plants for medicinal purposes, wood as fuel and as building materials and wild fruits and herbs as food (Shackleton, Shackleton, Ntshudu and Ntebeza, 2002). Without these natural resources, more expensive substitutes, such as Western medicines, would have to be purchased.

(d) Primary costs

Primary costs linked to the WfW Programme fall into two categories namely, investment costs and operating costs. Investment costs include the acquisition of capital equipment (chain saws, vehicles, tools and computers), whereas operating costs include the acquisition of herbicides (herbicides, diesel, dyes and wetters), protective clothing (gloves, masks, overalls, boots and helmets), wages and salaries, transport (including subsidised transport and repairs), clearing work contracted out to private institutions, and running expenses, including machinery running expenses (Hosking and du Preez, 2004a:145). Costs vary significantly from one project or site to the next. This variation is due to, among other things, the density of alien plant cover, the type of alien invader, ease of access to the area, and the maturity of the alien plants (Hosking and du Preez, 2004a:145).

(e) Secondary costs

Secondary costs include a decline in the availability of alien trees as a source of firewood (Hosking and du Preez, 2004a:145; de Neergaard, Saarnak, Hill, Khanyile, Berzosa and Birch-Thomsen, 2005:217) and building materials for many people residing in marginalised rural areas (de Neergaard *et al*., 2005:217). Marais (1998) argues that this cost could be lessened by encouraging small local industries to supply the community with alternative sources of firewood from indigenous sources. Furthermore, Working for Woodlots, an initiative which falls under the auspices of the WfW Programme, has attempted to ensure that communities that are dependent upon invasive alien plants for various uses, has access to appropriate woodlots (DWAF, 2004:24).

3.6 CONCLUSION

Currently the most important primary benefit of the WfW Programme is the increase in water yield (Hosking and du Preez, 2004a:144) and the most important primary costs are those capital, operating and maintenance outlays made in order to remove the alien vegetation. Secondary costs and benefits, although numerous and important, are difficult to quantify and value. It is on account of its capacity to cope with complications regarding the valuation of public goods and especially those yielding services to passive users (Carson, Flores and Mitchell, 1999:100) that the CVM is deemed an appropriate method by which to value the biodiversity benefit attributable to the WfW Programme (see Chapter Four).

CHAPTER FOUR

A THEORETICAL OVERVIEW OF TECHNIQUES THAT MAY BE USED TO VALUE ENVIRONMENTAL SERVICE FLOWS

4.1 INTRODUCTION

Environmental resources, such as ecosystem and biodiversity services, are systematically mispriced by the market due to their public good nature (Hanley, Shogren and White, 1997:22-23). In some cases, markets for these resources are simply non-existent. Policy makers have thus been forced to consider and develop other means to assess the value of these resources. Preferences of individuals are the starting point of non-market valuation (Alp, Clark, Melching and Novotny, 2002:4). Expressed preference techniques or revealed preference techniques may be used to compute values for these resources. The former entails finding a willingness-to-pay (WTP[6]) measure of economic value, whereas the latter entails drawing inferences from markets where it is believed preferences for environmental resources are captured or from costs individuals incur so as to gain access to these resources.

This chapter overviews methods that are used to value non-market environmental goods and services.

4.2 DIFFERENT FORMS OF VALUE

Environmental economists have developed a holistic valuation concept referred to as “total economic value”, with the aim of ensuring that all aspects of the value of environmental goods and services are taken into account. The “total economic value” of an environmental good may be broken down into two elements, namely “use values” and “non-use values” (see Figure 4.1).

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[6] WTP is the maximum amount of money an individual would pay in exchange for the benefits of the environmental amenity.

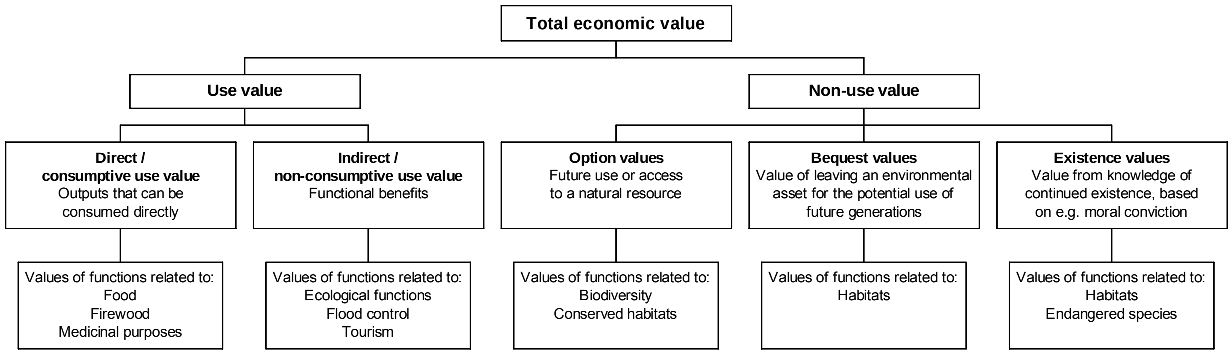

Figure 4.1: The total economic value of nature

Source: Adapted from Munasinghe and Lutz (1991)

Use values are those associated with the benefits gained from actual use (now or at some point in the future) of the environment and may include private sector uses, recreational uses and health benefits (Pearce and Turner, 1990:129). Non-use or passive use values relate to the intangible use of the environment, such as the satisfaction derived from preserving an environmental good.

Use values are divided into consumptive and non-consumptive types (see Figure 4.1). Consumptive use refers to the value associated with direct use of the environmental goods from an area. These include firewood, the use of indigenous vegetation for medicinal purposes, food plants and animals. The Fynbos biome, for example, has a consumptive use as a source of products such as thatch for roofing, rooibos tea, honey bush tea, herbs for medicinal purposes, grazing and cut flowers (Bond, 1993; Turpie *et al*., 2003). The value of this consumptive use is the gross monetary value of the harvest net of harvesting costs. Non-consumptive use value refers to the value obtained from any use of an environmental asset that does not involve the removal of the asset. It includes the value of game viewing and recreation and the value that natural areas add to property transactions. Both recreational and property values of natural areas are associated mainly with the “attributes” of ecosystems. The non-consumptive utilisation of biodiversity also relates to the importance of ecosystems as the “web of life”, providing an infrastructure for ecological processes necessary for survival (Gaston and Spicer, 1998:80).

Non-use values can be separated into three key types (see Figure 4.1) – option, bequest and existence values (Pearce and Turner, 1990:129). Option value relates to the premium individuals are willing to pay to retain future uses or access to a natural resource (Pearce and Moran, 1994:19-20; Turner, Pearce and Bateman, 1994:105). Bequest value is the WTP to preserve an environmental asset or general environmental quality for the potential use and benefit of future generations (Turner *et al*., 1994:113; Gaston and Spicer, 1998:82). Existence value refers to the satisfaction derived from the preservation of environmental assets so that a habitat for these assets (e.g. wildlife and plants) remains even though these people might never enjoy consuming it. An example of existence value relates to the campaigns in the United States of America and Europe to raise money for Black Rhino protection programmes in southern Africa. People donate money to save the species even though they may only see it in books or on television.

Whether or not the different types of values associated with natural ecosystems can actually be calculated is a contentious issue. It is particularly difficult to identify option, bequest and existence values separately (Pearce and Moran, 1994:20). Furthermore, many of the values identified are conflicting values or trade-offs. For example, the value of grazing or thatching may compete, if livestock graze the same species used for thatching. Similarly, the recreational value of an area may conflict with its conservation value.

4.3 MONETARY AND NON-MONETARY VALUES

Various measures have been developed to calculate a change in value. These include cardinal utility measures, ordinal utility measures, compensating variation, equivalent variation, Marshallian demand functions and Hicksian demand functions. A brief discussion of these methods is provided.

Cardinal utility measures (developed by Alfred Marshall) involve the use of money as a cardinal index of utility and interprets the consumer's demand curve for a good or service as his or her marginal utility function for that good. A constant relationship is assumed to exist between units of utility and units of money.

Ordinal utility analysis assumes consumers will be able to preferentially rank alternative bundles of goods in a manner consistent with certain axioms of rational behaviour (Just, Hueth and Schmitz, 2004:4). John Hicks (1942) developed the two most widely used WTP welfare measures, namely, compensating variation and equivalent variation.

Compensating variation is defined as the amount of money which, when taken away from an individual after an economic exchange, leaves that individual just as well off as before a given change (Just *et al*., 2004:9). The compensating variation of a fall in price is thus the maximum amount of money that has to be taken away from an individual to leave him / her at the same level of utility as before the fall in price.

Equivalent variation is defined as the amount of money paid to an individual which, if an economic change fails to occur, leaves the individual just as well off as if the change had occurred (Just *et al*., 2004:9). The equivalent variation of a fall in price is the quantity of money that, if given to the individual before the fall in price, would leave him / her just as well off as he / she would have been if the price had already fallen.

For normal goods, the compensating variation of a price rise is equivalent to the equivalent variation of a fall in price, and the equivalent variation of a rise in price is equivalent to the compensating variation of a fall in price. The concepts of compensated (Hicksian) and uncompensated (Marshallian) demand functions are used to interpret compensating and equivalent variation geometrically. Marshallian demand functions incorporate substitution and income effects, whereas Hicksian ones only incorporate substitution effects (Nicholson, 2002:129).

4.4 MARKET FAILURE AND THE VALUATION OF ENVIRONMENTAL RESOURCES

Markets will allocate resources efficiently if prices reflect both the social marginal costs of production and the social marginal benefits of consumption. Where prices do not reflect the social costs and benefits the market fails and resources may be used inefficiently, resulting in a loss of human welfare (Baumol and Oates, 1988). Reasons for market failure are considered below.

4.4.1 PUBLIC GOODS

The defining characteristics of a (pure) public good are non-exclusion and non-rivalry (Nicholson, 2002:662). The former means that once the good has been produced no one can be excluded from benefiting from its availability (Nicholson, 2002:671), while the latter means that one person's consumption of the good does not affect other people's consumption of the good (Nicholson, 2002:670).

Riverine vegetation provide public good type services, such as flood abatement, that benefit not only neighbouring farms that maintain riverine vegetation, but also other farms in the vicinity. This service provided by the riverine vegetation is an example of the non-excludability characteristic of a public good – the "owner" of the resource cannot impede other farmers from enjoying its benefits. The service is also non-rival in nature, since the consumption of this service by one farmer does not diminish the supply available to others.

The non-excludability characteristic of public goods and services gives rise to the free rider problem (Black, Calitz and Steenekamp, 2000:19). This problem refers to the fact that an individual may understate the benefits that he or she would receive from securing the good, knowing that he or she cannot be precluded from sharing the benefits (Black *et al*., 2000:22). The free-rider problem precludes efficient market price formation (du Preez, 1997:27).

4.4.2 EXTERNALITIES

Externalities occur whenever the production or consumption decision of one agent in the economy affects the welfare of another agent in an unintended way (a condition known as interdependency). Furthermore, the affected party does not receive any compensation from the agent producing the (negative) externality (Nicholson, 2002:660). This second condition is known as the non-price property effect. An example of an externality caused by the afforestation of grasslands is the decline in the availability of game and other non-timber forest products, such as fuel and medicinal products. Unless the logging company (or land owner) compensates the hunters and gatherers for their loss of livelihood, the full economic cost (i.e. the marginal social cost of production) of extracting timber will not have been paid. If similar conditions prevail elsewhere, market prices of environmental products will tend to understate true economic costs and consumers will use these products relatively inefficiently (Bishop, 1999:8).

Externalities can either be pecuniary or technological (Black *et al*., 2000:25). Pecuniary externalities are the effects of economic activities transmitted through the market mechanism. Its spillover effects are fully reflected in market prices (Black *et al*., 2000:25).

A pecuniary externality does not affect consumers' utilities or firms' productivities directly. For example, a large company locates its operations in an industrial development zone and bids up local wages and salaries, increasing labour costs for the other companies in the area. Consequently, workers in the area are better off, but the welfare of the firms already there is lowered.

Technological externalities, on the other hand, are defined as existing when the production level or input usage of one firm directly affects the production function of another firm (Holcombe and Sobel, 2000). An example of a technological externality is that of a steel firm whose smoke soils the freshly cleaned laundry of a nearby dry cleaner.

Traditional solutions to the misallocation of resources caused by externalities include mergers among the affected parties and adoption of suitable taxes or subsidies (Nicholson, 2002:678). Nicholson (2002:666) notes that Pigou suggested, in the 1920s, that the most direct solution to the harm caused by negative externalities would be to tax the externality-creating entity. Ideally, the tax collection imposed by the government on the firm creating the negative externality equals the exact value of external harm that the firm produces (Nicholson, 2002:666).

Figure 4.2 below provides the traditional illustration of an externality together with Pigou’s taxation solution.

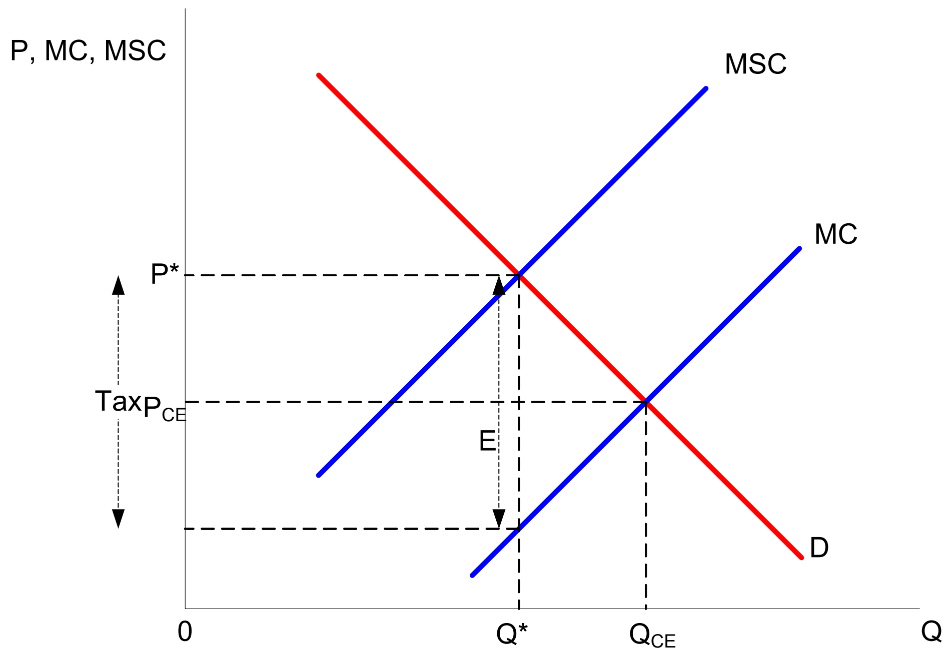

Figure 4.2: A graphic analysis of an externality

The curve labelled MC in Figure 4.2 describes the marginal cost of producing a certain product. This cost curve, however, only reflects the private costs of production, which excludes the externality. The externality imposes an additional cost, E, increasing the social costs of production above those of the private. The sum of the total marginal cost incurred by society in producing the good (the private cost) plus the external cost is described by the MSC curve. A per-unit Pigovian tax, equal to the externality, given by output level Q*, will internalise the externality for the production of this particular product, making the firm's marginal cost schedule coincide with the marginal social cost of production. As every unit produced will cost the full marginal social cost, the firm will be induced to produce the optimal amount (Q*) (Nicholson, 2002:667).

Environmental resources are often subject to externalities because of a lack of clearly defined property rights (social agreements that govern the ownership, use and disposal of property) (du Preez, 1997:26). If the problem can be remedied by a scheme that effectively assigns property rights, an efficient outcome can be achieved through bargaining, irrespective of who is assigned the property rights.

This proposition, that the assignment of property rights to a specific party has no effect on the outcome of the environmental problem under consideration, is known as the Coase Theorem. The Coase Theorem reduces the role of the government to one of assigning enforceable property rights and to ensuring that these property rights are properly enforced (du Preez, 1997:26).

Despite its appeal, however, the Coasian approach has several weaknesses. Firstly, the Coase-type outcomes will only hold in instances where the allocational benefits to be gained through bargaining exceeds the parties' costs of doing so (Nicholson, 2002:669). If the transactions costs (the monetary outlays for specifying, defining and enforcing property rights) are so high that any one party's share of them outweighs the expected benefits of the bargain, that party will withdraw from the bargain, or not even commence it (Pearce and Turner, 1990:74).

Secondly, the theorem assumes that resource owners can recognise the source and extent of damages to their property (du Preez, 1997:27).

4.4.3 OTHER REASONS FOR MARKET FAILURE

In addition to public goods, externalities and a lack of clearly defined or secure property rights, markets may fail to reflect the true value of environmental service flows due to a lack of information about their contribution to economic welfare (Bishop, 1999:8). In such cases, the question arises as to how decision-makers can compensate for market failure, and ensure that environmental service flows are given sufficient weight.

There are several ways to internalise non-market values in the behaviour of producers and consumers, ranging from the introduction of strict environmental standards to ecological tax reform, and from facilitating environmental damage claims in the courts to the promotion of tradeable pollution permits (Bishop, 1999:8).

4.5 VALUATION TECHNIQUES

As established in this chapter, the value of environmental goods and services are often not revealed by market prices due to market failure, and alternative ways to determine value must be sought in order to guide public allocation.

This section describes two broad categories of techniques whereby environmental values can be imputed: those that use expressed preference and those that use revealed preference. The demand curve for environmental goods can be derived using either method. Typically, consumer surplus forms the basis of demand curve valuation (du Preez, 1997:32).

4.5.1 REVEALED PREFERENCE TECHNIQUES

Revealed preference 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. This behaviour may involve the purchase of market goods or other types of economic decisions (Kahn, 1995:89).

The greatest advantage of these direct revealed preference techniques is that they are relatively simple to use (Navrud, 2000). However, the methods ignore the behavioural responses of individuals to changes in the environmental amenities (Navrud, 2000).

Revealed preference techniques can be divided into non-demand curve approaches and demand curve approaches.

(a) Non-demand curve approaches

Non-demand curve approaches include the dose-response method and the replacement cost method. These approaches are discussed below.

The dose-response method, also known as the production-function approach or input-output approach, seeks a physical or ecological relationship between environmental quality variables and their impacts on the output level of a marketed commodity or on health. The unit "price", or value per unit of physical damage, is then multiplied by the dose-response function to give a "monetary damage function" (Pearce and Moran, 1994). The costs of air pollution can be derived from, for example, the effects on agricultural crop production. An increase in pollution results in a decrease in crop quality and therefore constitutes a decrease in benefits for farmers. It is often, however, difficult to find perfect relationships between environmental and marketed goods and as such, this approach has attracted criticism because reliance is often placed on insufficient or unsuitable data (Hanley and Spash, 1993:103).

The replacement cost approach measures the cost imposed on society by the degradation of an environmental asset by the cost of replacing or restoring that asset (Turner *et al*., 1994:114). This approach tends to underestimate damage costs since it is usually impossible to restore something to its original state. However, this approach has been used to estimate economic damage from soil erosion, by using market prices for soil and fertilizers to calculate what it would cost to replace the lost soils. This approach has also been used to calculate loss of ecosystem functions. In the less usual case of an asset being replaced by a more valuable asset, such as a small building being burned down and a new larger building being erected in its place the replacement cost would overestimate the cost of the damage (Bann, 1997:107).

(b) Demand curve approaches

Two demand curve approaches that are used to value environmental goods and services are the hedonic pricing method and the travel cost method.

I. The hedonic pricing method (HPM)

The HPM derives from the characteristics theory of value first proposed by Lancaster (1966) and Rosen (1974). The HPM attempts to isolate the specific value of an environmental amenity or risk from the market price of a good or service. The most common applications of this technique are the property value approach and the wage differential approach.

Observing differences in the value of properties between locations and isolating the effect of environmental quality on these values is essential when applying the hedonic pricing approach to property values (Bishop, 1999:13). The market value of a residential property, for example, is affected by a variety of characteristics including attributes of the property itself. These include its size, location and construction materials used (Hanley and Spash, 1993:75). With sufficient data on property values and characteristics it is possible to control for other factors such that a residual price differential may be identified for differences in environmental quality (Bishop, 1999:13).

An example would be the case of a house that is close to a scenic landscape or beach. The proximity of this house to a scenic view or beach increases its value relative to a similar house in another less favourable location. By comparing the different prices attached to the two houses an indirect determination of the value of the environmental amenity can be made.

Hedonic wage models relate differences in city characteristics to intercity variation in the wage rate. This method is based on the theory that in a perfectly competitive market the demand for labour equals the value of its marginal product and that the supply of labour varies with working and living conditions in an area. The more undesirable the characteristics of the city are, the higher the wage rate necessary to attract workers to work in the city (Cuyno, 1999:17).

The economic valuation of changes in human health conditions, such as morbidity and mortality, primarily associated with occupational choices is another area where the HPM can be used (Hussen, 2004:152). Caution must, however, be exercised when utilising this type of measure of the value of a human life, as this method relies on private valuation of health risks, not necessarily social ones (Cuyno, 1999:17). The major challenge here is to control statistically for all the non-safety related differences (such as skill level, job responsibility and alternative employment opportunities available in the area) between the different occupational categories under consideration in order to isolate the differences in wage associated with difference in safety. Studies conducted in the Philippines observed that Filipino farmers barely understand the health and environmental risks of pesticide use and that precautionary and safety measures in applying pesticides are often neglected (Cuyno, 1999:17). This lack of understanding implies that they may not be consciously aware of their occupational hazards and therefore do not demand remuneration accordingly (Cuyno, 1999:17).

The application of the HPM

Information concerning all the factors that determine the price of a house need to be gathered before the HPM can be applied (Turner *et al*., 1994:120). Once this has been done, a two-stage model of individual choice, developed by Freeman (1971), is followed. In the first stage, a hedonic price function is estimated (Hanley and Spash, 1993:75). Second, a demand function or marginal WTP function is derived from these characteristics. The technique attempts to estimate how much of a property price differential is due to a particular environmental difference between properties.

Hedonic price studies have highlighted the fact that differences in residential properties can arise from a number of sources, such as the physical quality of the accommodation (property types, year of construction, construction materials used), accessibility to the central business district, availability of public facilities, proximity to shops and other local amenities, and environmental characteristics. For example, the impact of different measures of flood risk on property values has been considered in a number of different studies (see Speyrer and Ragas, 1991; Shabman and Stephenson, 1996). Generally, the results from these studies indicate that location on a floodplain negatively influences residential property values. Tyrvainen and Miettinen (2000) found that forest proximity positively influenced property values in the district of Salo in Finland. The authors estimated that in the semi-logarithmic case a one kilometre increase in the distance of a residential property from the nearest forested land implied a 5.9 per cent average decrease in the market price of the property. Correspondingly, properties that had a view of forested lands were on average 4.9 per cent more expensive than those properties without a view.

In order to understand the effects of any of the various variables on the value of property, they all have to be included in the analysis as the exclusion of a relevant variable could bias the result (Hanley and Spash, 1993:79). Hedonic price studies usually involve a vector of explanatory variables: structural variables, S_i (such as the number of rooms, presence / absence of central heating, garage space), neighbourhood variables, N_j (such as the number of schools in the area, crime rate), and environmental attributes E_k (such as noise levels and air quality) (Pearce and Turner, 1990:143-144). The formal form of the HPM can be expressed as follows (Hanley and Spash, 1993:76):

$$P_h = P\ (S_i, N_j, E_k) \qquad (4.1)$$

where:

P_h = the market price of the property.

P = the function that relates the house characteristics to price.

S_i = the different structural characteristics of the property.

N_j = the different neighbourhood characteristics.

E_k = the different environmental attributes.

Equation 4.1 can be estimated using ordinary least squares (OLS). According to Freeman (1993), this relation (Equation 4.1) will be linear only if consumers can "repackage" the attributes of a property. This repackaging is unlikely to happen, as consumers cannot combine the desired characteristics of different houses when they buy in the housing market (Rosen, 1974). For this reason, Equation 4.1 can be expected to be non-linear.

From the estimated hedonic price function (Equation 4.1), the marginal implicit price of any attribute, including environmental quality, can be calculated as the partial derivative of the housing price with respect to the given attribute (Hanley and Spash, 1993:76). For instance, the implicit price of environmental characteristic E_1 would be:

$$\partial P_h / \partial E_1 = \frac{\partial P(S_i, N_j, E_k)}{\partial E_1} \qquad (4.2)$$

The marginal implicit price, measures the aggregate marginal WTP for the attribute in question.

Rosen's (1974) work on implicit markets forms the basis of the second stage of the HPM. A compensated demand curve for environmental quality, using the information obtained from the previous stage, is estimated. Consumer surplus can be obtained using this demand curve (du Preez, 1997:35).

Problems associated with the HPM

The HPM is subject to several problems. These are discussed below.

- Multi-collinearity

Multi-collinearity arises when the independent variables contained in the hedonic price function are correlated (Hanley and Spash, 1993:79). Multi-collinearity is a problem both for structural, as well as neighbourhood variables. For example, Brookshire, Thayer, Schulze and d'Arge (1982), showed that the square footage of a house was strongly correlated with the number of bedrooms. Leggett and Bockstael (2000) argued that, "measures of the level of a pollutant will often be highly correlated over space with proximity to pollution emitters." Multi-collinearity can bring about a bias in the coefficient estimates (high standard errors). Furthermore, the confidence coefficient attached to model predictions can be reduced (Hanley and Spash, 1993:79).

- Omitted variable bias

Omitted variable bias can cause an overstatement of the final value estimate of the environmental variable of interest. The hedonic price function assumes that the researcher has identified all the pertinent variables that are important in influencing house values. Should a variable, that is correlated with some or all of the included variables, and yet have a considerable effect on house prices, be excluded it could influence the coefficients of the estimated variables (Hanley and Spash, 1993:79).

- Expected versus actual characteristics

In situations where the HPM is used to value environmental characteristics, the current levels of environmental quality are assumed to affect the prices of houses. House prices can also be affected by foreseeable changes in quality levels. The exclusion of a relevant variable to represent these foreseeable changes could result in omitted variable bias (du Preez, 1997:36).

- Restrictive assumptions

Only in situations where the three conditions discussed below hold, will the HPM provide an accurate approximation of the value of environmental quality (Hanley and Spash, 1993:80). Firstly, it is assumed that perfect information regarding the environmental amenity or hazard at every conceivable location is available to all buyers in the housing market. Secondly, it is assumed all buyers in the market are able to move to utility maximising positions. Finally, it is assumed that the HPM will only work under the assumption of housing market equilibrium. However, these assumptions may never be fully realised in practice.

- User unfriendly

A reasonably high degree of statistical expertise is required to estimate the relationship between house prices and environmental quality. Further skills are required to sort out the relevant variables for a suitable regression (Turner *et al*., 1994:120).

- Choice of functional form

As theory does not provide any guidance regarding the choice of functional form[7] when estimating hedonic regressions, the choice of the form of the hedonic pricing equation can introduce error in the measurement of the marginal prices. Previous studies have estimated linear[8], log-linear (double log)[9], semi-log (log of dependent variable)[10], and Box-Cox forms[11] (Mathis *et al*., 2003:56). The most common functional form used in these studies is the semi-log form (Mathis *et al*., 2003:56). The semi-log form, with the natural log of the housing price a linear function of its attributes, assumes that a given change in an attribute has a constant percentage impact on housing prices.

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[7] The choice of functional form refers to the mathematical transformation that is believed to explain the relationship between each explanatory variable and the dependent variable in the best manner (Mathis, Fawcett and Konda, 2003).

[8] Linear regression estimates the coefficients of the linear equation, involving one or more independent variables, that best predict the value of the dependent variable.

[9] In the log-linear model, the dependent variable as well as all the explanatory variables are transformed to logarithms. The relationship among the log variables is linear. This type of relationship is often used in economic applications since it displays the property of constant elasticities between the variables.

[10] The semi-log form is a method of illustrating economic variables that change over time. For example, if income growth is constant, data may be plotted as a straight line on a graph that has the logarithm of income on the vertical axis and time on the horizontal axis.

[11] Box-Cox regression models are generalised regression models in which an appropriate functional form is selected based on a likelihood ratio test. The functional forms include linear, log-linear and various quadratic forms. The Box-Cox transformation can be applied to an independent variable, a combination of independent variables, and / or to the dependent variable in a regression. The objective of doing so is usually to make the residuals of the regression more homoskedastic and closer to a normal distribution (Davidson and Mackinnon, 1993).

- Other biases

The hedonic pricing technique is best adapted to value non-market goods that are already in place (Novotny, Clark, Griffin, Bartošová, Booth and Anderson, 2001). For example, the benefits of flood control can be derived by examining the housing price differentials that result from properties that face different levels of flood risk. In contrast, goods that are only proposed, such as ecological restoration, could not be evaluated if there were no experience with the good in the particular market.

The benefits that can be derived from the HPM would reflect private direct benefits, and neglect indirect benefits to other residents (such as those resulting from philanthropic beliefs) within the community (Novotny *et al*., 2001). As a result, the hedonic model would be expected to underestimate the general level of benefits that could result if the good had important public good attributes.

II. The travel cost method (TCM)

The TCM estimates the benefits produced by recreation sites (parks, lakes, forests, and wilderness) that usually have a zero or nominal admission price (Alp *et al*., 2002:6). The main application of the TCM in developing countries is to value tourists' WTP for national parks. For example, Geach (1997) used the TCM to estimate the recreation value of the Addo Elephant National Park. A value of over R300 million per annum (R2 142 per hectare) (1996 prices) was found. A travel cost study conducted by Turpie and Joubert (2001) in the Kruger National Park calculated a total recreational value of over R1 billion per annum, or US$ 98 per hectare.

The TCM is based on three premises. The first is that the cost of using a recreation site is more than the admission price. It includes the monetary and time costs of travelling to the site and may include other costs such as the entry fee to enter the recreational site. The second is that people who live different distances from a recreational site face different costs for using the site. The third is that the travel cost can be used as a proxy for price in deriving a demand curve for the recreation site (Lesser, Dodds and Zerbe, 1997).

The application of the TCM requires researchers to undertake an on-site questionnaire survey of visitors aimed at eliciting estimates of household or individual visit frequencies over a given time period (Alp *et al*., 2002:7). In addition, information regarding the cost of travel to the site, recreational preferences, use of substitute sites, and socio-economic characteristics are also gathered.

The application of the TCM

A demand curve (trip generating function), from which consumer surplus may be estimated, is derived using the data gathered during the survey phase mentioned above (Hanley and Spash, 1993). The costs experienced in consuming the services of the environmental asset are used as a proxy for price (Hanley and Spash, 1993:82). These costs include costs of getting to the site, foregone earnings, admission fees and on-site expenses. This surplus represents an estimate of the value of the environmental good in question (Munasinghe and Lutz, 1991). There are two main variants of the TCM that can be distinguished, namely the individual travel cost method and the zonal travel cost method (Garrod and Willis, 1992:415).

The individual TCM attempts to estimate the demand for recreational goods for each individual at a given site (Centeno and Prieto, 2000). In this case, the dependent variable is the number of site visits made by each visitor over a specified period. The cost of travel may vary from one person to another even where the point of origin is the same. By aggregating the individual demand functions, an aggregate demand function may be derived.

Travel costs (TC) to a given site “j” are the sum of the following:

$$TC_{ij} = DC_{ij} + TTC_{ij} + F_{ij}; \quad i = 1 \ldots n \tag{4.3}$$

where:

DC = distance costs for each individual “i”, dependent on the distance travelled and the cost per kilometre.

TTC = time costs. These depend on how long it takes individual “i” to get to the site and on the valuation of that individual’s time.

F = on-site costs, including an entrance fee that might be charged to enter site “j”.

The zonal TCM (Clawson-Knetsch method) assumes that users would react to an admissions fee as if it were an increase in the cost of travel (Centeno and Prieto, 2000). In the zonal TCM, a sample of visitors to a given point of interest is taken. The information from this sample is then grouped according to distance travelled from the point of origin to the site (Centeno and Prieto, 2000). The dependent variable is the rate of visits per capita for each zone.

During the application of the zonal TCM the area surrounding a recreation site is divided into zones of origin and travel costs for each zone are calculated to generate the demand curve. Typically, the surrounding area of the site is divided into concentric circles of specified distance to establish zones of origin. Zones of origin can also be derived with some reference to the administrative districts as the population size of each zone must be determined in order to predict the number of trips per person per zone (Zerbe and Dively, 1994; Tietenberg, 1992). The trip generating function for the zonal TCM can be expressed as follows:

$$V_{zj} = V(C_{zj}, P_z, SE_z); \; z = 1 \ldots Z \tag{4.4}$$

where:

V = the total number of trips by individuals from zone z to the recreational site j per unit of time.

C = the travel cost including time cost.

P = population of zone z.

SE_z = the socio-economic characteristics of the population of each zone, which include, amongst others, factors such as income levels, spending on other goods, the existence of substitute sites and entrance fees.

The visitor or visitation rate (V_{zj} / P_z) is generally calculated as visits per unit of population to a particular zone. Based on data obtained from a survey of site users, the above equation is estimated using regression analysis. Using the statistical coefficients from the regression, a demand curve or WTP curve representing the relationship between the number of visits and the cost of a trip can be traced. This estimation is done by determining the effect that an increase in the admissions fee (the admissions fee is a proxy of actual price) will have on predicted visits per annum (individual TCM) or visits from each zone in the zonal TCM. An important assumption underlying the demand curve is that the number of visits decrease as travel costs increase. This is shown in Figure 4.3.

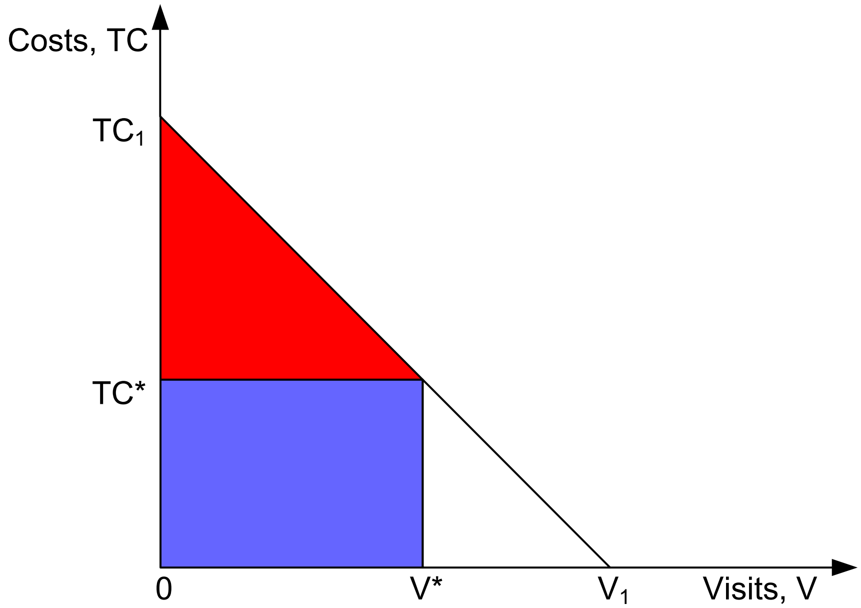

Figure 4.3: Demand curve and consumer surplus

The figure shows that at cost, TC_1, no more visits would be made. On the other hand, when costs are zero, the number of visits will be highest (V_1). At any price higher than zero, the number of visits will decrease; for example, at a positive price TC* visits will trop to V*.

Measuring the area under the demand curve provides an estimate of the visitor's net WTP or consumer surplus attributed to the site (Loomis and Walsh, 1997). It is the surplus benefit (red triangle) over and above the cost (blue rectangle). The recreational value of the natural area can then be deduced by totalling the consumer surplus per visit per visitor. This represents what would be lost if the environmental good is lost to recreation.

While the TCM is widely used as a technique for valuing environmental assets, there are a number of practical problems that arise when using the TCM to make empirical estimates (Centeno and Prieto, 2000). A summary of these problems is given below.

Problems associated with the TCM technique

- Multi-purpose trips

One of the difficulties that arises in estimating the cost of travel is that, very often, a visit to a site forms only part of the reason for the trip. If an individual leaves home and drives directly to the recreation site and returns home directly afterwards, costs of making the trip can be exclusively attributed to the site visit. This type of visitor can be referred to as a "purposeful visitor" (Hanley and Spash, 1993:87). Those visitors for whom a visit to the site is only part of the purpose of their trip may be called "meanderers". In the latter case, taking into account the full cost of the trip will lead to an overestimation of benefits attributable to the recreation area (Loomis and Walsh, 1997). There are a number of different methods of addressing this problem. One method proposed by Hanley and Ruffel (1993) suggests that people be asked to score the significance of a visit to the recreational site, relative to the enjoyment they gained from the whole trip. Their weighted aggregate travel cost can then be calculated using this score, expressed as a number between 0 and 1. Alternatively, meanderers may be excluded from the travel cost analysis (Hanley and Spash, 1993:88). A per visit consumer surplus figure can instead be computed and can then be added across all visitors. This is based on the assumption that recreational sites, are on average, valued no less highly by meanderers than by deliberate visitors (Hanley and Spash, 1993:88).

- Calculation of distance costs

Travel cost is calculated by multiplying the distance travelled in kilometres by a price per kilometre using either petrol costs only or the full cost of motoring, which includes allowances for depreciation and insurance. As utility maximising individuals are presumed to equate their marginal benefit with their marginal costs of consumption, the choice an individual makes depends upon what that individual perceives his / her marginal costs to be (Hanley and Spash, 1993:88).

- The value of time

Travel time costs are calculated by multiplying the duration of the visit (depending on distance and mode of transport) by the value of travel time (Moons, 2002:7). The opportunity cost of time spent travelling to the site is the value of the best alternative activity that a person might engage in (for example, working at a second job, playing a sport or participating in an organisation) instead of spending the time on a recreational trip. The cost of the alternative activity being valued ought to comprise not just the cost of the trip itself, but also the opportunity cost of the time utilised and alternative uses of time. Consequently, it must be borne in mind that not considering the value of time implies that the consumer surplus will be underestimated (Centeno and Prieto, 2000).

Many attempts have been made to estimate a value for time (Rosen, 1992:254). One frequently used method, based on the theory of leisure-income choice uses an after-tax wage rate (Rosen, 1992:418). The approach, however, suffers from two major problems. Firstly, most recreation time is spent at the expense of alternative recreational activity. For this reason, the opportunity cost should be measured with reference to the marginal value of other recreation activities foregone and not in terms of forgone income (Hanley *et al*., 1997:406). Secondly, not all uses of time away from the job are similar (Rosen, 1992:254).

- The effect of visit length

Variation in the length of visits may also cause difficulties, since the amount of time one spends at a site affects the cost of travel and the utility derived therefrom. People who travel from greater distances often spend more time at the site in order to spread the cost of the trip over more days. One solution to the problem of representing stays of varying lengths is to treat each of the visits separately according to duration, and to calculate a different demand curve for each of the durations observed (Centeno and Prieto, 2000).

- Site quality and congestion

The quality of sites, as well as the congestion faced at these sites, may be deciding factors in an individual's choice of destination (Centeno and Prieto, 2000). A site is congested when the number of visitors is such that other visitors cannot gain access, or where the utility of the marginal user is diminished because of the presence of a great number of other visitors. It has been shown that in cases of congestion, demand is underestimated, and the TCM gives an estimate of consumer surplus below true value (Wetzel, 1977).

- Statistical problems

Several statistical problems can occur when estimating a (recreation) demand function. There are problems related to the independent variables in the regression equation. All relevant variables affecting visit behaviour need to be included. Omission of variables will bias the coefficient estimates and therefore bias the consumer surplus estimates. Another problem arises when the dependent variable, namely visit frequency, is subject to both truncation and endogenous stratification (Hellerstein, 1992). Truncation arises when observations are only available greater than (or less than) some lower (or upper) bound. This situation arises in many TCM studies when observations originate from on-site surveys and all respondents make at least one visit to the site (Moons, 2002:8). Endogenous stratification takes place when the probability of being sampled is a function of the value of the dependent variable. When interviewing visitors at specific checkpoints on site, people with higher visit frequencies have a higher likelihood of being interviewed (Moons, 2002:8).

Truncation and endogenous stratification necessitate the functional form of the recreation demand function to be chosen with care. One solution is to use count data models that are based on probability distributions that are defined for non-negative integers only (Hellerstein, 1992).

4.5.2 EXPRESSED PREFERENCE METHODS

Direct or expressed preference models are broader in focus than revealed preference models. Stated preference models can measure 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, which is oriented toward use values (Khan, 1995). The primary stated preference methods in use by environmental economists are the contingent valuation method and the choice modelling method. They are discussed below.

(a) The contingent valuation method (CVM)

The CVM is used to estimate economic values for many types of ecosystem and environmental services including wastewater dilution, water purification, erosion control and recreation (King and Mazzotta, 2002). In South Africa, this method has been used in water-pricing studies, *inter alia* (Turpie, Winkler, Spalding-Fecher and Midgley, 2002) and to estimate the existence value of Fynbos (Turpie *et al*., 2003).

The term, CVM, was first introduced in 1947 by S.V. Ciriacy-Wantrup, who pointed out that the appropriate procedures in surveying should use interviews in which subjects are "asked how much money they are willing to pay for successive additional quantities of a collective extra-market good" (Epstein, 2002). Contingent valuation infers the value of a product not on the basis of the effective observed behaviour of subjects on the market, but with reference to an artificially structured market (Sirchia, 1997).

The simulation of a direct market is achieved through a survey. The questionnaire plays the role of a market and the market conditions are clearly explained. The researcher simulates the supply side. The researcher usually offers a change in the quantity or quality of a good at a given price. The respondent, who accepts or refuses the payment of the suggested price, acts as the demand side. Different prices (also called bids) are offered, one to each subsample (Riera and Mogas, 2002).

An important advantage of the CVM is that it is applicable, technically, to all circumstances. It is able to uncover existence values (for example, preservation of rare species, biodiversity for its own sake), which generally do not pass through markets and do not have substitutes or complements that pass through markets. Artificially structured markets can also account for the existence of uncertainty (option values) and are therefore the only source of evidence on the value of future changes in environmental quality. Furthermore, it suggests that, if sequenced properly, artificially structured markets provide the opportunity to estimate an internally consistent set of value components (use and non-use values) that can be added into a true measure of total economic value (Randall, 1992).

The application of the CVM

The CVM can be divided into six steps (Hanley and Spash, 1993).

The first step is to set up a hypothetical market for the environmental good. A detailed description of the good being valued should be provided. The situation before and after any proposed change in environmental quality and subsequent provision of the good should be clearly stated. In addition, it is vital that the respondents perceive the correct good. The basic idea of the CVM is to elicit hypothetical bids that conform to actual bids if an actual market existed (Pearce and Turner, 1990:148). Further, an explanation should be provided of the mechanism (bid vehicle) through which payments would be collected. An appropriate bid vehicle is credible, realistic, relevant and acceptable. Some examples of bid vehicles are: property taxes, income tax, trust fund payments, entry fees or a voluntary contribution (Hanley *et al*., 1997:384). While respondents are often hostile towards taxes, this bid vehicle is often the most realistic payment method. The following information should also be given to the respondent: whether the cost (in the form of a fee) will be shared amongst all consumers if there is an alteration in the environmental good, how the fee concerned will be determined and how the decision will be reached on whether to carry on with the project or not.

The second step entails administering the survey. Numerous types of survey instruments are available, such as: personal interviews, telephonic interviews or mail surveys (Hanley *et al*., 1997:385). Each of the aforementioned instruments has its own benefits and costs. Telephone surveys, for example, have higher response rates than mail surveys (Lesser *et al*., 1997). However, the former are more expensive to undertake and they also preclude the use of visual material, such as photographs showing pollution levels. Mail surveys do not provide opportunities to explain questions that respondents find confusing or to clarify confusing answers and suffer from a high non-response rate (Alp *et al*., 2002:14). Personal interviews are the most reliable survey method, because concepts can be explained at length. It is, however, also the most costly method. The CVM requires individuals to state either what they are willing to pay in order to ensure that an environmental asset will be preserved or that an environmental improvement will occur or, alternatively, what they are willing to accept in compensation for tolerating the deterioration of the asset (Turner *et al*., 1994:123). A variety of questioning formats have been used in contingent valuation studies to obtain WTP / willingness-to-accept (WTA) figures, such as: a bidding game, a payment card, an open-ended question, and a close-ended referendum (Alp *et al*., 2002:14).

The bidding game technique involves suggesting higher and higher amounts to the respondents until their maximum WTP is reached (Hanley *et al*., 1997:386). The enumerator suggests the first bid and the respondent agrees or denies that he / she would be willing to pay it. Then, the starting point price is increased to see if the respondent would still be willing to pay it, and so on until the respondent declares he / she is not willing to pay the extra increment in the bid (Pearce and Turner, 1990:148-149). The final accepted bid, then, is the maximum WTP. An advantage of this method is that it facilitates the respondent's thought process and encourages him / her to carefully consider his / her preferences. However, bidding games are subject to anchoring bias and can lead to a large number of outliers and "yea-saying" (Arrow, Solow, Portney, Learner, Radner and Schuman, 1993). Furthermore, the bidding game method cannot be used in mail surveys and other self-completed questionnaires (Arrow *et al*., 1993).

The payment card method presents the respondent with a visual aid containing a large number of monetary amounts which facilitates the valuation task by providing a context to their bids while avoiding starting point bias (Hanley *et al*., 1997:387). In contrast to other formats, the number of outliers is also reduced. However, the payment card method is vulnerable to range bias and cannot be used in telephone interviews (Arrow *et al*., 1993).

When the open-ended choice method is adopted, respondents are asked to state their maximum WTP with no value being suggested to them (Hanley *et al*., 1997:387). Advantages of this method include the fact that it is straightforward, that the maximum WTP can be identified for each respondent and that the results may be assessed using simple statistical techniques (Arrow *et al*., 1993). However, the open-ended choice method can induce large non-response rates, protest answers, zero answers and outliers and unreliable responses (Arrow *et al*., 1993). Furthermore, respondents may find it difficult to formulate their true maximum WTP, as they have never had to value the good before (Arrow *et al*., 1993).

In the close-ended referendum method, also known as the dichotomous choice format, a single payment is suggested, to which respondents either agree or disagree (yes / no reply). Such responses are often known as dichotomous choice responses. Dichotomous choice responses range from simple single bound ones, through one and one half bound and double bound ones. In the single bound format each respondent is asked once whether he / she would be willing to pay a specified bid amount, and in the double bound format, after the first question, the respondent is asked once again whether he / she would be willing to pay another bid amount (Hanley *et al*., 1997:387). The single bound format has the advantage of making the responses easy since it is similar to an individual's real purchase actions. Although the double bound format does not have such advantages, it is more efficient in estimating the true WTP (Terawaki, 2003).

For any given sample size, survey costs tend to be higher for the double bound model, since the interactive procedure requires that the interview is made either personally or telephonically (Calia and Strazzera, 1999). Further, the double bound method can be affected by bias in responses that are due to the introduction of the follow-up. On the other hand, the single bound model provides less information than the double bound model, and produces less precise estimates for the WTP (Calia and Strazzera, 1999).

The dichotomous choice and open-ended formats are the commonly used response formats to estimate the WTP. Most CVM studies that have compared estimates of WTP obtained using the dichotomous choice and open-ended formats have found that dichotomous choice yields higher estimates. The open-ended direct question may provide a lower more conservative estimate of value than would the interactive bidding technique. The iterative procedure has been preferred because it is specifically designed to assist respondents as they approach the point of indifference between having the amount of income stated or the environmental amenity. However, open-ended questions in mail surveys may have several advantages of their own as the questions can be answered at home and at a time convenient to the respondents (Alp *et al*., 2002:16).

The third step in applying the CVM entails analysing the data once all responses have been collected. An average (mean) bid can then be calculated. Some responses, for example outliers (strategically high bids), may distort the results and for this reason, a median bid may be preferred as a predicted value. Another issue that needs to be addressed is that of protest bids of zero. Protest bids occur when respondents abstain from providing a WTP amount. Two reasons have been given for this behaviour – the respondent does not wish to take part in the survey or the respondent refuses to put a monetary value on environmental services that he / she is being asked to bid for (Hanley and Spash, 1993:56). It has been suggested that these bids be excluded from the calculation (Hanley and Spash, 1993:56). However, the exclusion of invalid responses is incorrect from a statistical point of view (Carson, 1991) as the characteristics of the non-respondents may differ markedly from those of respondents. Methods that have been proposed to reduce the number of protest and strategic bids include:

- Avoiding open-ended question formats, which are inclined to be associated with high levels of protest zeros.
- Asking why a zero WTP was offered. Zero responses may be valid, but could reflect strategic behaviour of low WTP respondents. Scenarios may be poorly formulated and this needs to be checked in the follow-up questions.
- Comparing very high bids with the respondent's uncommitted income (WTP cannot exceed ability to pay).
- Sensitising interviewers to recognise protest and strategic bids.

- Inferring the WTP of any respondent who fails to answer the valuation question but answers other questions. Inferred values can be taken from the WTP statements of respondents who have similar characteristics (e.g. income) to those who protest.
- Removing non-respondents and adjusting the sample to reflect any change in representativeness (Bateman, Jones, Lovett, Lake and Day, 2002:82).

The fourth step in applying the CVM entails deriving a bid curve. Bid functions are estimated by relating WTP to various characteristics of respondents. The main purpose of estimating bid functions is to verify whether responses statistically correspond with what would be expected (Dimopoulos, 2005:33).

Estimating bid curves can be a one-stage or two-stage process. The first stage entails estimating a bid function that includes all the relevant explanatory variables for which data has been collected (Hosking and Sharp, unpublished). This first stage is also known as estimating the complete model. Typically, the complete model bid function takes the following form:

$$WTP = f(S_1, C_1, O_1) \tag{4.5}$$

where:

S_1 = socio-economic characteristics of the respondent.

C_1 = characteristics of the environmental good.

O_1 = other relevant characteristics of the respondent.

Following an analysis of the significance of the coefficients in the complete model, another model may be estimated in which only coefficients significant in the complete model are included. The significance of the coefficients and overall explanatory power of this reduced model may shed further insight into the relations being explored. The reduced model would typically be the preferred model used to predict WTP because it only contains significant variables (Hosking and Sharp, unpublished).

Step five in applying the CVM involves the aggregation of data, which refers to the procedure where the mean or median bids are converted to a total value figure for the population (Hanley *et al*., 1997:391). To compute the total benefits (consumer surplus) that people attach to a particular service flow, one typically multiplies the predicted mean or median WTP of respondents by the size of the population affected by the environmental service flow (Turner *et al*., 1994:122). Issues arise concerning the definition of the population, the sampling choice, and the time period of the environmental benefits. The careful definition of the target population is important as it can affect the size of society's aggregate maximum WTP / minimum WTA. For issues with many stakeholders, the choices may be difficult. The objective is to choose all those people whose utility will be significantly affected by the action (Hanley and Spash, 1993:56-57).

The success of the application of CVM is reviewed in the final step. The success of the survey is assessed in terms of its reliability and validity. Reliability refers to the degree of replicability of a measurement or low variation between results of different samples of the same population (Pearce and Ozdemiroglu, 2002:78). Tests of reliability aim to determine whether the survey instrument can be relied upon to provide the same values if it were to be administered repeatedly under similar conditions.

One test for reliability examines the variation encountered in responses. Breedlove (1999:8) contends that valuations with a relatively low variation among responses are more reliable estimates of value than those with a high variation. Variability of response may be caused by various biases, but may also be perfectly normal. Individuals behave differently in different settings and have unique characteristics that affect their responses. Furthermore, respondents may interpret the survey instrument differently, may be motivated by different characteristics of the scenario when making decisions and use different cost-minimising methods or rules-of-thumb to make decisions when they know little about the good in question (Acks, 1995:7).

Validity, on the other hand, measures the degree to which a study succeeds in measuring the respondent's actual values (Pearce and Ozdemiroglu, 2002:78). The main obstacle when testing the validity of WTP / WTA values, obtained from a contingent valuation study, is to find a definitive benchmark against which to compare the survey results. Validity is assessed in terms of the following three types of validity tests: content validity, construct validity and expectations-based validity tests (Pearce and Ozdemiroglu, 2002:79). Content validity tests whether the survey asked the correct questions in a clear, understandable and appropriate manner. Convergent validity tests, meanwhile, compare results obtained from the study with results from other methods, e.g. TCM, or from other stated preference studies or from surrogate markets. Expectations-based validity tests assess whether the WTP / WTA values produced by the contingent valuation study are statistically related to other variables reported by the respondents in a theoretically plausible manner (Pearce and Ozdemiroglu, 2002:82).

Content validity:

If a survey has a high content validity, respondents would be encouraged to answer seriously, thoughtfully and truthfully (Bateman *et al*., 2002:80). Evaluating the content validity of a study is a subjective expert appraisal task. The content validity judgments are pertinent to the entire study process, from the aims of the research to the clarity, interpretation and plausibility of the questions and how the interviewer carried out the survey. Specific questions must be asked in assessing whether a contingent valuation survey has content validity (see Appendix 1).

A stated preference questionnaire should address all the content validity questions mentioned in Appendix 1. Surveys that fail to address these questions should be re-designed to comply with all the requirements stated. Designers of contingent valuation questionnaires should be aware that the following factors characterise stated preference studies with a low content validity:

- Inadequate sample size or poor coverage of the relevant population.
- Non-stratified or biased sampling methods (where the representativeness of the sample is an issue).
- High survey or individual question (or item) non-response rates.
- Large numbers of protest bids.
- Free-riding behaviour is prevalent.
- High numbers of improbably large bids.
- Inadequate sensitivity to the scope of the good / service in question, i.e. WTP does not vary with quantity of the good / service.
- The valuation scenario and corresponding valuation task is poorly understood and / or has low credibility.
- The description of the change in the provision of the good / service is poorly understood and / or has low credibility.
- The relevant authorities are not trusted or considered to be of low competence or efficiency.
- Responses have a low explanatory power in terms of theoretical or other expectations.
- Survey or post-survey respondents provide answers that indicate that strategic behaviour may have affected their responses, e.g. respondents under or overstate their WTP (Dimopoulos, 2005:37-38).

Convergent / Construct validity:

Convergent validity, also called construct validity, compares different valuation techniques for consistency (Breedlove, 1999:10). Convergent validity typically compares CVM results for a particular environmental good / service with results obtained:

- From revealed preference valuation methods, e.g. travel cost or hedonic pricing.
- From other stated preference studies, such as choice modelling.
- From the analysis of actual or surrogate (proxy) markets (Dimopoulos, 2005:38).

Caution should, however, be exercised in the interpretation of convergent validity assessments as neither the value derived from the contingent valuation study nor the value against which it is being compared can automatically claim superiority in terms of being a naturally closer approximation of the "true" value (Bateman *et al*., 2002:82).

Expectations-based validity:

The WTP / WTA values produced by a stated preference study may also be tested for expectations-based validity. A researcher would expect the WTP measure to be statistically related to the other variables reported by the respondents in a theoretically plausible way. If it is not related in this way doubt will be cast on the plausibility of the WTP measure (Bateman *et al*., 2002:83).

Expectations-based validity testing is typically achieved by estimating a bid function which relates WTP or WTA responses to a variety of covariates collected in the survey. The Logit, Probit, Ordinary Least Square (OLS) and Tobit[12] statistical models can be used for this purpose. To show expectations-based validity, coefficients should be significant in determining valuation

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[12] The Logit and Probit statistical models are used to explain the WTP probabilities. They are binary response dependent variable models (Buckland, MacMillan, Duff and Hanley, 1999). The Tobit and Ordinary Least Square statistical models are used to explain the variation of the WTP amount in monetary terms. The Tobit and Ordinary Least Square models are continuous dependent variable models (Lauria, Whittington, Choe, Turingan and Abiad, 1999).

responses. Validity tests should compare WTP estimates resulting from different question formats for consistency, e.g. analysts could compare WTP responses acquired using close-ended questions with those responses acquired using open-ended questions or, respondents' WTP for a small amount of the good with respondents' WTP for a large amount of the good.

Expectation-based testing is the chief form of validity testing conducted in contingent valuation studies. For this reason, it is crucial to use high quality data analysis techniques that are appropriate to the study conducted. Expectations that should be considered include (Bateman *et al*., 2002:83):

- *Price of the good*. Following a central theme of economic theory, it would be expected that as the price of the good increases, consumption of that good would fall, *ceteris paribus*.
- *Respondent income*. An expectation is that individuals / households with higher incomes will be willing to pay more towards the protection of the environmental good / service than low-income individuals / households.
- *Quantity of the good*. It would be expected that a respondent's WTP be related to the quantity of the good available - that WTP for extra units of the good would decrease as the quantity supplied increases. Contingent valuation surveys often include tests to see if this expectation holds and the results of these tests may show:
  - Scope insensitivity[13], which occurs when WTP does not vary with the quantity of the good offered.

[13] This scope insensitivity / embedding may be the result of:

- Satiation. This occurs when the WTP for a good remains the same for increasing quantities of a good, i.e. the incremental WTP is zero when the respondent is satiated in a particular good on offer. The insensitivity is therefore rational.
- Warm glow. It also could occur that respondents obtain a moral satisfaction from the act of paying for the good and this may not vary with the amount of the good on offer.

- Embedding (also known as part-whole bias), which occurs when WTP does not vary between two alternative “offers”, one which contains a quantity of a good that is also included in the second offer, i.e. is embedded in the second group of goods.

Problems associated with the CVM

A large part of the literature on the CVM deals with the types of biases that can be encountered when using the CVM. "Bias" implies systematic over- or under-statement of true WTP / WTA. These biases and other problems are discussed below.

- Strategic bias

Strategic bias can arise when respondents deliberately shape their answers to influence the study outcome in a way that serves their personal interest. This is either done by free-riding (where the respondent provides a lower value for the good) or by overbidding (when the respondent perceives that the interviewer is interested in mean WTP and so overstates his / her WTP). One common method of counteracting strategic bias is to ask respondents a “yes / no” question about whether they would be willing to pay a particular sum. Another precaution to reduce strategic bias is to inform respondents that the provision of services would depend on the demonstration of adequate WTP (Bann, 1997:102). Respondents should, however, be warned against overstating their WTP.

- Information bias

In traditional market models, individuals are assumed to have perfect information about the good in question. However, in the case of non-market goods, the individual does not necessarily have perfect information. When respondents are asked to value something that does not usually carry a price, information bias can occur as the valuation given may be based on a false perception (du Preez, 1997:44). The aggregate WTP function might not necessarily represent the marginal social value function. Further, if interviewers fail to provide sufficient information to assist respondents in determining their true WTP, information bias can occur (Callan and Thomas, 1996:239).

- Starting point bias

A starting point bias occurs in the bidding game question format. Starting point bias arises whenever the first bid suggested by the interviewer influences the final bid the respondent makes in some way (Hanley and Spash, 1993:60). This bias occurs either due to impatience of the respondents or because the starting point indicates what the interviewer perceives to be a relevant bid size.

A related problem is “yea-saying”. This bias can occur when respondents simply accept a bid, even if it does not match their true valuation.

- Part-whole bias (embedding bias)

One common error is for the respondent to make associations among environmental goods that the researcher had not intended. Respondents may therefore interpret a hypothetical offer of a particular good or service to indicate an offer for a more extensive set of similar goods and services (Bann, 1997:100). This is referred to as the part-whole bias (alternatively known as embedding bias) since the value of the good being sought is embedded in the value of the more encompassing set of goods or services reported by the respondent. If, for example, people were asked their WTP for the preservation of a particular natural habitat, their answer may betray their values for the whole of that natural habitat in the country (or even in the world, in the case of threatened species). It has been determined that the WTP for improved air quality in one Rocky Mountain Park does not differ greatly from that WTP for improved air quality in a system of Rocky Mountain parks (Schultze and McClelland, 1991). The only safeguard against this bias is for the background information to be clear that the questions relate solely to the case in point (Bann, 1997:100).

- Hypothetical bias

Hypothetical bias may arise because respondents are asked to state their WTP for changes that are hypothetical rather than actual. The fundamental difference between an actual and a hypothetical market is that in actual markets consumers will suffer a cost if they get their choice wrong (Pearce and Turner, 1990:151). If the respondent does not understand the hypothetical market, he / she may state a WTP for a completely different market. Questioning that focuses attention on WTP for future changes rather than WTA compensation for damages that have already occurred is most likely to be consistent with scenarios credible to respondents (Perman, Ma and McGilvray, 1996).

- Interviewer bias

Interviewer bias occurs through erroneous sampling procedures and processes, incorrect questionnaire layout, and the wrong wording of questions contained in the questionnaire.

- WTA vs WTP

People generally feel the cost of a loss (WTA) more severely than an equivalent benefit or gain, and thus WTA may be higher than WTP. With WTP, respondents need to allocate their budget with their limited income, while there is no budget constraint with WTA, because the payment comes from other sources (Field, 1997).

- Lexicographic preferences

Spash and Hanley (1995) have found evidence that when people are asked to participate in CVM surveys concerned with wildlife protection, a considerable proportion of respondents refused to make trade-offs between biodiversity and other goods. Spash and Hanley (1995) argue that such preferences may be characterised as "lexicographic", derived from an ethical system based on rights. Respondents with lexicographic preferences refuse to make trade-offs between an increase / decrease in biodiversity and losses / gains in income. The implication is that these individuals have a WTA that is infinite, and a WTP that will be either zero (i.e. a protest bid) or a positive amount that entails the individual's total budget, because they want welfare to remain at its existing level.

Individuals with lexicographic preferences are of the opinion that particular species must be protected, irrespective of the cost to society or the utility obtained from the species. They are unwilling to accept any form of compensation in order to keep their welfare constant as the level of biodiversity decreases. WTP methods cannot be used if people are not willing to trade the good in question (Ortolano, 1997:118).

- Scenario misspecification

Scenario misspecification occurs when the scenario is incorrectly specified according to theoretical or policy information (theoretical bias) or when the respondent incorrectly perceives some aspect of the scenario (methodological bias) (Breedlove, 1999:11).

Some ways in which methodological biases can occur include:

- Respondents valuing the symbolic nature of the good, rather than the amount (resulting in the same WTP for different levels of the good).

- Respondents including items in their thinking other than the good in question (e.g. benefits that are often associated with, but not part of, the good in question).
- Respondents using a different measurement scale to the researcher.
- Scepticism amongst respondents regarding the provision of the good and the likelihood that the study will achieve any of the desired goals.
- A respondent becoming tired or bored. In this case, a bias occurs due to the respondent complying with expected answers to complete the interview as soon as possible.
- Respondents who value the good differently based on who is funding the good or who is providing it.
- Respondents do not keep their budget constraint in mind.
- Respondents using other questions or information in the interview to come to their decisions.
- Respondents who fail to treat other unrelated valuations as independent (Breedlove, 1999:11).

Sufficient research and interviewer training prior to conducting the survey can minimise scenario misspecification. Information provided about the good must be clear and complete in order to prevent misunderstandings by the respondents (Perman *et al*., 1996).

- Payment vehicle biases

Payment vehicle bias arises due to differences in WTP based on methods of payment (Wattage, 2001:15). Typical payment vehicles used include utility bills, entrance fees, taxes, user fees and higher prices. Potential payment vehicle bias and public payment preference can be determined through the use of pilot surveys before the final study is undertaken (Dimopoulos, 2005:35).

- Sample design bias

Failure to perform sample design and benefit aggregation properly also causes biases (Breedlove, 1999:11). The sample used for the contingent valuation survey must represent the target population. It is, however, difficult to determine this population when the people who pay for the good differ from those who receive the most benefit from the use of the good (Breedlove, 1999:11). It is essential to have as large a sample as possible. If different groups who comprise the population are improperly represented, sample selection bias will result.

Inference bias occurs when one contingent valuation is used to estimate the value of different goods (Breedlove, 1999:12). Forms of inference bias include temporal selection and sequence aggregation biases.

Temporal selection bias occurs when information from one study is used for a different time period (Breedlove, 1999:13). Society's preferences for environmental goods / services change over time. The information acquired using contingent valuation studies is most applicable as close to the time of administering the questionnaires as possible. However, the problem of time lag is often not a serious one because evidence from public opinion polls and contingent valuation studies has shown that valuation results tend to stay fairly stable over time (Breedlove, 1999:12).

Sequence aggregation bias refers to a situation where the researcher aggregates data from independent studies over additional locations or goods (Breedlove, 1999:14). If several WfW project sites are to be cleared of alien vegetation, the valuations of each site measured in a particular sequence may differ from the valuations of each site measured independently or in a different sequence, because of income and substitution effects. Money "spent" on the first site in the survey typically reduces the amount identified as being "spent" on other sites (income effect) and the first site may act as a substitute to some of the features of additional sites to be valued (substitution effect). For this reason, each site should be valued independently (Breedlove, 1999:14).

(b) Choice modelling

The term choice modelling (CM) represents an array of stated preference techniques that have been employed by psychologists and researchers in both marketing (see Tables 4.1 to 4.4) and transport economics to determine individuals' decision-making and choice behaviour (Kahn, 1995:103). These techniques are, however, becoming more frequently applied to the valuation of non-market goods.

The survey instruments used for CM analysis are similar to the CVM questionnaires with the exception of the design of the WTP scenario (Eftec and Entec, 2002). Louviere and Hensher (1982) and Louviere and Woodworth (1983) have been credited with developing the CM approach. It was originally designed to separate the value of individual product characteristics typically supplied in combination with one another. The basis of these techniques is the idea that any good can be described in terms of its attributes, and the levels that these take. Altering attribute levels will essentially result in a different "good" being produced (Eftec and Entec, 2002).

CM approaches thus provide a direct route to the valuation of the attributes of a good and of marginal changes in these characteristics. The value of the change in the bundle of attributes can also be estimated using CM provided the bundle consists of the attributes (and levels) that are presented in the questionnaire (Eftec and Entec, 2002). While the CVM could also be used to value changes in individual attributes, the number of scenarios that can be considered in any one study is limited. For this reason CM approaches are preferred over contingent valuation in contexts where it is important to value individual attributes (Eftec and Entec, 2002).

Choice modelling techniques include:

- choice experiments;
- contingent ranking;
- contingent rating; and
- paired comparisons.

- Choice experiments

In a choice experiment, respondents are offered a series of alternatives, differing in terms of attributes and levels, and asked to choose their most preferred option (Hanley, Mourato and Wright, 2001:438). Of these attributes, one will be monetary, offered at different levels across options. Analysts can then observe how respondents' choices change as the attributes and monetary amounts are varied and from this information deduce the value placed upon each attribute. A baseline status quo or “do nothing” alternative is usually included in each choice set to help anchor the other alternatives in relation to the respondent's actual experience (Hanley *et al*., 2001:436).

Table 4.1 presents an example that could be used to study respondents’ preferences for buying a motor vehicle. In this study, the good would be a motor vehicle, defined in terms of its attributes such as price and maximum speed.

Table 4.1: Illustrative choice experiment question

Suppose you are facing the choice of buying a new motor vehicle. Choose one of the following motor vehicles according to your preferences. You may even choose not to buy any of these motor vehicles.

Vehicle attributes	**Toyota Corolla 160i GSX specifications***	**Ford Focus 1.6 Ambiente****	**Volkswagen Polo 1.6 Comfortline*****
Price (in 2006)	R 170 000	R 150 000	R 140 000
Number of passengers	5	5	5
Engine capacity (cc)	1598	1596	1598
Gear	Manual	Manual	Manual
Maximum speed	179 km / h	183 km / h	184 km / h
Boot volume	437 litres	490 litres	270 litres
Consumption – urban cycle (litres / 100 km)	8.3	9.6	9.2

* www.toyota.co.za

**www.ford.co.za

***www.volkswagen.co.za

Which vehicle would you purchase?

Toyota Corolla? ☐

Ford Focus? ☐

Volkswagen Polo? ☐

Would you prefer not to purchase any of these vehicles? ☐

- Contingent ranking

In a contingent ranking survey, respondents are requested to rank a number of alternative options according to their preferences. Each alternative is made up of a number of attributes and prices, which are offered at varying levels across options (Hanley *et al*., 2001:441). From the ordinal rankings, the WTP associated with each attribute can be calculated indirectly. As such, not only does contingent ranking provide a monetary measure for each scenario, it also uncovers the monetary value of each individual attribute within the scenario.

Furthermore, contingent ranking avoids the need for an explicit elicitation of respondent WTP by relying instead on the ranking of a series of alternative scenarios or packages of attributes. It is important that one of the options must always be a baseline alternative for estimates to be consistent with standard welfare economics (Hanley *et al*., 2001:443).

In the following illustrative example, (Table 4.2) respondents are asked to rank a set of alternative representations of a motor vehicle from the most preferred to the least preferred.

Table 4.2: Illustrative contingent ranking question

Rank the following alternatives for buying a new motor vehicle according to your preferences. One of the following options is not buying a motor vehicle. Assign 1 to the most preferred option, 2 to the second most preferred, 3 to the third most preferred and 4 to the least preferred.

Vehicle attributes	**Toyota Corolla 160i GSX specifications***	**Ford Focus 1.6 Ambiente****	**Volkswagen Polo 1.6 Comfortline*****	**Do not buy any car**
Price (in 2006)	R 170 000	R 150 000	R 140 000	
Number of passengers	5	5	5	
Engine capacity (cc)	1598	1596	1598	
Gear	Manual	Manual	Manual	
Maximum speed	179 km / h	183 km / h	184 km / h	
Boot volume	437 litres	490 litres	270 litres	
Consumption – urban cycle (litres / 100 km)	8.3	9.6	9.2	
Ranking	□	□	□	□

* www.toyota.co.za

** www.ford.co.za

*** www.volkswagen.co.za

- Contingent rating

In a contingent rating survey, respondents are presented with a number of scenarios and are asked to rate them individually on a semantic or numeric scale (Hanley *et al*., 2001:443). The contingent rating technique does not involve a direct comparison of alternative choices and as a result, there is no formal theoretical link between the expressed ratings and economic choices (Hanley *et al*., 2001:443). An example is provided in Table 4.3 below.

Table 4.3: Illustrative contingent rating question

On the scale below, please rate your preferences in buying the following motor vehicle?

<table>
<tr><th colspan="5">Vehicle attributes</th><th colspan="5">Toyota Corolla 160i GSX specifications*</th></tr>
<tr><td colspan="5">Price (in 2006)</td><td colspan="5">R 170 000</td></tr>
<tr><td colspan="5">Number of passengers</td><td colspan="5">5</td></tr>
<tr><td colspan="5">Engine capacity (cc)</td><td colspan="5">1598</td></tr>
<tr><td colspan="5">Gear</td><td colspan="5">Manual</td></tr>
<tr><td colspan="5">Maximum speed</td><td colspan="5">179 km / h</td></tr>
<tr><td colspan="5">Boot volume</td><td colspan="5">437 litres</td></tr>
<tr><td colspan="5">Consumption – urban cycle (litres / 100 km)</td><td colspan="5">8.3</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td></tr>
<tr><td colspan="5">Very low preference</td><td colspan="5">Very high preference</td></tr>
</table>

* www.toyota.co.za

- Paired comparisons

In a paired comparison, also known as a graded or rated pairs exercise, respondents are requested to choose their preferred alternative out of a set of two choices. Respondents are then required to indicate the strength of their preference in a numeric or semantic scale (Hanley *et al*., 2001:444). Table 4.4 provides an example.

Table 4.4: Illustrative paired comparisons question

Which motor vehicle would you prefer to purchase, given the two motor vehicles described below?

<table>
<tr><th colspan="3">Vehicle attributes</th><th colspan="4">Ford Focus 1.6 Ambiente*</th><th colspan="3">Volkswagen Polo 1.6 Comfortline**</th></tr>
<tr><td colspan="3">Price (in 2006)</td><td colspan="4">R 150 000</td><td colspan="3">R 140 000</td></tr>
<tr><td colspan="3">Number of passengers</td><td colspan="4">5</td><td colspan="3">5</td></tr>
<tr><td colspan="3">Engine capacity (cc)</td><td colspan="4">1596</td><td colspan="3">1598</td></tr>
<tr><td colspan="3">Gear</td><td colspan="4">Manual</td><td colspan="3">Manual</td></tr>
<tr><td colspan="3">Maximum speed</td><td colspan="4">183 km / h</td><td colspan="3">184 km / h</td></tr>
<tr><td colspan="3">Boot volume</td><td colspan="4">490 litres</td><td colspan="3">270 litres</td></tr>
<tr><td colspan="3">Consumption – urban cycle (litres / 100 km)</td><td colspan="4">9.6</td><td colspan="3">9.2</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td></tr>
<tr><td colspan="5">Strongly prefer Ford Focus 1.6 Ambiente</td><td colspan="5">Strongly prefer Volkswagen Polo 1.6 Comfortline</td></tr>
</table>

* www.ford.co.za

** www.volkswagen.co.za

Not all of the CM techniques are founded in economic theory. The choice experiment approach is the only approach that definitely fits the theory, while contingent ranking may do so. As such, only the choice experiment approach will be discussed in more detail.

I. *Choice experiments*

The choice experiment approach is relatively new, but already a number of applications to estimate the value of recreational and environmental goods have been made (for example, Adamowicz, Boxall, Williams and Louviere, 1995; Hanley, Wright and Koop, 2002). Adamowicz *et al*. (1995) presented the first choice experiment investigation into passive use values in a study that examined hypothetical choices concerning the protection of old growth forests in Alberta, Canada. The choice experiment questions were designed from the attributes of the situation - caribou populations, wilderness area, recreation restrictions (a categorical variable), forest industry employment and a change in provincial income taxes. These five attributes each took on four levels (Adamowicz *et al*., 1995:6). The four levels of each attribute reflected the current levels of the attribute, one level below, and two levels above the current condition (see Table 4.5 below).

Table 4.5: Extract of attributes and levels used in the choice experiment

Attribute	Levels
Mountain Caribou Population (number of caribou)	50
	400 (current situation)
	600
	1600
Wilderness area (hectares)	100 000
	150 000 (current situation)
	220 000
	300 000
Recreation Restrictions (categories)	Level 1 No restrictions
	Level 2 Activities in designated areas (current situation)
	Level 3 No hunting, fishing, off-road vehicles, helicopters, horses and overnight camping in designated areas
	No hunting, fishing, off-road vehicles, helicopters, horses and overnight camping
Forest Industry Employment (direct employment)	450
	900
	1200 (current situation)
	1250
Changes to Provincial Income Tax (annual change)	$50 decrease
	No change (current situation)
	$50 increase
	$150 increase

Source: Adamowicz *et al*. (1995:23)

Respondents were asked to choose between the current situation (as described by current levels of the attributes) and two alternative “futures”. Using data from a mail survey completed by 447 Edmonton, Canada, residents, estimates were obtained across each attribute dimension, as measures of convergent validity (Adamowicz *et al*., 1995:17).

The advantage of choice experiments is that they are more flexible and give greater information than a CVM for the whole scenario. Moreover, the process mirrors the kinds of decisions that are made in real life consumption decisions and "choice modelling is ideally suited to inform the choice and design of multidimensional policies" (Hanley *et al*., 2001:452). These experiments also seem more sensitive to scope, that is to say that WTP is proportional to the amount of the increased environmental good or service (Foster and Mourato, 2003). Furthermore, choice experiments often offer a more distributed focus on paying for the environment, which reduces the incidence of protests (Pearce and Barbier, 2000).

The application of choice experiments

The means of obtaining welfare measures in choice experiments is similar to that used in the random utility model of the dichotomous choice contingent valuation approach. According to this framework, each choice the respondent makes (e.g. buying a particular type of motor vehicle) generates utility for that motor vehicle according to an indirect utility function (see Equation 4.6).

The indirect utility function for each respondent i (U_i) can be represented by a deterministic component (V), which is usually specified as a linear index of the attributes (X) of the j different alternatives in the choice set, and a random component (e), which represents unobservable influences on individual choice:

$$U_{ij} = V_{ij}\left(X_{ij}\right) + e_{ij} = \beta X_{ij} + e_{ij} \qquad (4.6)$$

where:

U_{ij} = the utility gained by individual i.

X_{ij} = a vector of observable attributes.

β = a vector of estimated parameters.

e_{ij} = the random error component.

The choice experiment model then makes the assumption that individual i will select option g if expected utility (U_{ig}) exceeds the expected utility (U_{ih}) for all alternative options, as stated in Equation 4.7 (Hanley *et al*., 1997:402):

$$P(iIC) = Pr\left[U_{ig} > U_{ih}\right] = Pr\left[\left(V_{ig} + \varepsilon_{ig}\right) > \left(V_{ih} + \varepsilon_{ih}\right)\right], \forall\ h \in C \qquad (4.7)$$

Equation 4.7 implies that the probability of selecting an alternative increases as the utility associated with its selection increases. Similar to Lancaster's characteristics theory of value, the utility that an individual derives from a commodity is considered to be a function of the attributes of that commodity (List, 2002).

A typical assumption of Equation (4.6) is that the distribution of the error terms are independently and identically distributed with an extreme-value (Weibull) distribution (Hanley *et al*., 2001:439). This implies that the probability of any particular alternative g being chosen as the most preferred by individual i can be expressed in terms of the logistic distribution (see Equation 4.8):

$$P\left(U_{ig} > U_{ih}, \forall\ h \neq g\right) = \frac{\exp\left(\mu V_{ig}\right)}{\sum_{j} \exp(\mu V_{ij})} \qquad (4.8)$$

where:

μ = a scale parameter usually assumed to equal 1 (Hanley *et al*., 2001:439).

Once parameter estimates, using Equation 4.8, have been obtained, compensating surplus welfare measures, that conform to demand theory, can be derived (Hanley *et al*., 2001:440). This derivation is done by using the formula given by Equation 4.9, where V_0 is the calculated value of the deterministic component of utility under initial conditions, and V_1 represents deterministic utility evaluated under changed conditions. The coefficient β_y is the marginal utility of income and is generally represented by the coefficient of the monetary opportunity cost attribute:

$$\text{Welfare measure} = -\frac{1}{\beta_y}\left(V_0 - V_1\right) \tag{4.9}$$

The value of a marginal change in any of the attributes specified in Equation 4.6 above can be simplified to the ratio of coefficients given in Equation 4.10 where β_C is the coefficient on any of the attributes. These ratios are often known as implicit prices:

$$\text{WTP} = \frac{-\beta_C}{\beta_y} \tag{4.10}$$

These implicit prices allow some understanding of the relative importance that respondents give to attributes within the design.

An important implication of this condition is that selections from the choice set must observe the “independence from irrelevant alternatives” (IIA) property (or Luce’s Choice Axiom; see Luce, 1959). This property states that the relative probabilities of two options being selected are unaffected by the introduction or removal of other alternatives. The IIA property follows from the independence of the Weibull error terms across the different options contained in the choice set. If a violation of the IIA hypothesis is observed, then more complex statistical models are necessary that relax some of the assumptions used, such as the random parameters logit model[14] (Train, 1998).

While a status quo option is included in the choice set, choice experiments are consistent with utility maximisation and demand theory (Hanley *et al*., 2001:440).

Problems associated with the choice experiment method

The large number of attribute combinations and need for simple mental calculations places a higher cognitive burden on respondents which may mean that their responses do not reflect their true preferences for the attributes (Hanley *et al*., 2001:448). Further, since respondents are usually presented with a large number of choice sets, both learning and fatigue effects can occur. This may lead to apparently irrational choices (Tversky and Shaffir, 1992). Another important problem that arises is that in order to estimate the total value of an environmental programme or good, as opposed to the change in one of its attributes, it is necessary to assume that the value of the whole is equal to the sum of the parts. This raises two potential problems. Firstly, there may be additional attributes of the good that were not included in the design, but which generate utility. Secondly, the value of the whole must be assumed to be equal to the sum of its parts, despite the fact that objections have been raised against this assumption (Hanley *et al*., 2001:449). Finally, welfare estimates obtained from choice experiments are sensitive to study design. For example, the choice of attributes, the levels chosen to represent these attributes, and the way in which choices are communicated to respondents (e.g. use of photographs versus

[14] The random parameters logit model allows for variation in preferences across households, and can adjust to allow for error correlation across the choices made by each respondent.

text descriptions) are not neutral. This lack of neutrality may influence the values of estimates of consumers' surplus and marginal utilities (Pearce, Atkinson and Mourato, 2006).

4.6 CONCLUSION

There are two general methods for valuing the non-market aspects of the environment, namely revealed preference techniques and expressed preference techniques. The revealed preference techniques included the travel cost and hedonic pricing methods. The expressed preference techniques examined included the CVM and CM. All of the valuation techniques discussed in this chapter have been shown to suffer from numerous problems in their application.

The one employed in this study, because of its appropriateness is the CVM. It has become widely accepted in economics and a powerful tool of valuation due to the fact that it is applicable to problems and circumstances that fall outside the scope of other methods (Bann, 1997:102). The CVM's other merits lie in its versatility, and in the fact that it is the only method available which is capable of obtaining estimates of both non-use and use values.

The results from the contingent valuation studies conducted by du Plessis (2003) at six WfW sites in the Eastern and Southern Cape will be presented and then critiqued in Chapter Five, after which this author's own application of the CVM to vegetation changes proposed / achieved by the WfW Programme will be reported (Chapters Six, Seven and Eight).

CHAPTER FIVE
A CRITIQUE OF THE DU PLESSIS (2003) STUDY

5.1 INTRODUCTION

Results from contingent valuation studies rely greatly on how well the study is designed, performed and interpreted. If these tasks are well executed the CVM is a useful technique for estimating economic values for various non-market resources (Hanley and Spash, 1993:67). A good CVM study:
"must be informative; clearly understood; realistic by relying on established patterns of behaviour and legal institutions; have uniform application to all respondents; and, hopefully, leave the respondent with a feeling that the situation and his responses are not only credible but important" (Rowe and Chestnut, 1983: 70).

5.2 A BRIEF SYNOPSIS OF THE DU PLESSIS (2003) STUDY

Hosking *et al*. (2002) investigated the economic case for the WfW Programme on six sites in the Eastern and Southern Cape, by performing a CBA, based on increased water yield and livestock potential. While this study was an important one, it suffered from a number of shortcomings. One of these shortcomings was that only a part of the benefit stream was compared with the cost stream (du Plessis, 2003:23). With the exception of increased livestock capacity, non-water benefits associated with the WfW Programme were excluded (du Plessis, 2003:22).

In an attempt to extend the Hosking *et al*. (2002) study du Plessis (2003) identified, estimated and incorporated three non-water benefits into a revised CBA. The benefits that were included in the du Plessis (2003) study were: the gain in potentially productive land (grazing potential, livestock production and other agricultural practices), the reduction in direct fire-fighting costs due to the removal of alien vegetation, and the satisfaction of people's taste for indigenous vegetation, often referred to as the biodiversity and ecosystem resilience benefit.

For the purposes of the du Plessis (2003) study, the biodiversity benefit of the WfW Programme was deemed to be the increase in area covered by indigenous vegetation. The CVM was used to ascertain people's willingness to contribute money towards the restoration of indigenous vegetation through continued WfW activities. The valuations were carried out as pilot studies at the six sites identified in the Hosking *et al*. (2002) study namely, Albany, Kat River / Balfour, Kouga, Pot River / Ugie, Port Elizabeth Driftsands and Tsitsikamma (see Figure 5.1).

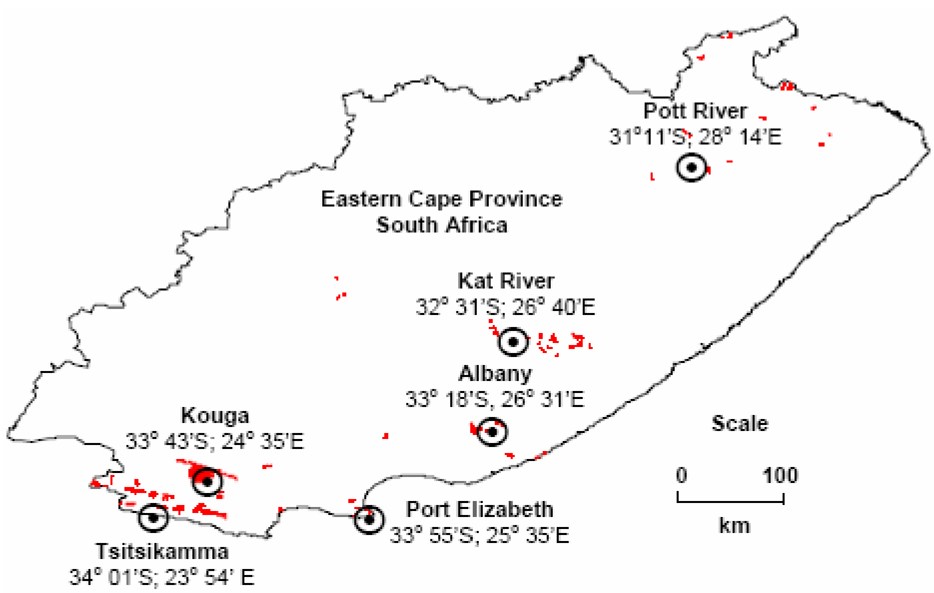

Figure 5.1: Location of the WfW project sites used in the du Plessis (2003) study

Source: DWAF

5.2.1 POPULATION AND SAMPLE

The first step taken by du Plessis (2003) was to determine the sampling frame and select a representative sample from it. The sampling frame was deemed to consist of both users and non-users of biodiversity at the six sites. These people were determined through consultation with local municipalities, the Department of Nature Conservation, the Parks Board and Eastern Cape Tourism.

In total 219 people out of the sample frame were interviewed. The sample sizes were set as follows:

Albany: 33;
Kat River: 34;
Kouga: 30;
Port Elizabeth Driftsands: 60;
Pot River: 32; and
Tsitsikamma: 30.

5.2.2 ADMINISTRATION OF THE QUESTIONNAIRE

The questionnaire was pre-tested using a pilot study, in order to streamline, revise and clarify questions. Owing to the complex nature of contingent valuation questions, it was considered to be extremely important that the questions be made as user-friendly as possible. Following the pilot study, the questionnaire was simplified and some technical terms were replaced with those used in everyday language (du Plessis, 2003:105).

Three enumerators administered the questionnaire during November 2002. One enumerator administered the questionnaire to the users selected at the Pot River, Kat River and Albany sites, while two enumerators administered the questionnaire at the remaining sites (du Plessis, 2003:105). The enumerators randomly selected respondents.

5.2.3 EMPIRICAL ANALYSIS

The WTP question in the du Plessis (2003) study was linked to the possible future event of an increase in alien vegetation up to a point where indigenous vegetation would be totally compromised, causing biodiversity to be compromised at that location. Respondents' WTP to prevent such a situation from occurring is shown in Table 5.1.

Table 5.1: The average WTP per Rand per site

Site	Sample size	Mean WTP (R)	Standard deviation of WTP (R)	Minimum WTP (R)	Median WTP (R)	Maximum WTP (R)	95% Low (R)	95% (High) (R)
Albany	33	75.76	68.35	0	75	350	51.52	99.99
Kat River	34	111.76	75.05	0	150	350	85.58	137.95
Kouga	30	304.83	1391.92	0	5	7500	-224.63	834.29
Port Elizabeth Driftsands	60	76.58	272.77	0	5	1500	6.12	147.05
Pot River	32	68.12	135.25	0	35	750	19.36	116.89
Tsitsikamma	30	80	153.75	0	35	750	22.59	137.41
All sites combined	219	111.54	532.43	0	15	7500	40.46	182.61

Source: du Plessis (2003:110)

From Table 5.1 it is clear that the average WTP at the Albany, Pot River, Tsitsikamma and Port Elizabeth Driftsands sites was lower than the average WTP for all the sites combined. The average WTP for the WfW Programme at the Kouga and Kat River sites was, however, higher than the combined average WTP. Kouga respondents had the highest average WTP. Most respondents in the Kouga area were familiar with the WfW Programme in South Africa (76.7 per cent) and 83.3 per cent knew about the activities of the local Kouga WfW Programme (du Plessis, 2003:111). The Kouga results contrast with du Plessis' (2003) findings at the combined sites level. At the combined sites level only 41.1 per cent of the respondents knew about the WfW Programme in South Africa, while 45.7 per cent of the respondents were familiar with the WfW Programme in their area.

The average WTP was lowest in the Pot River area. The Pot River area is a poor part of South Africa, with a high unemployment rate (approximately 34 per cent) and high dependency ratio, where 42 per cent of the population is under the age of 15 (du Plessis, 2003:111).

Using the chi-square test of significance, du Plessis (2003) determined that several variables were insignificant factors of people's WTP for the preservation of indigenous vegetation (p–value < 0.05). These included: reason for being in the area; familiarity (knowledge) with the WfW Programme in South Africa and at the specific site; age, household size and gender. The respondent's education level was also not a meaningful explanatory variable. It was, however, determined that the respondents' taste for indigenous vegetation and their level of income were meaningful indicators of their WTP (du Plessis, 2003:111). The analysis of the significant variables is shown in Table 5.2 below.

Table 5.2: Analysis of variance (ANOVA) of significant variables affecting WTP for preservation of indigenous vegetation (n=210*)

Variable	Mean squares	D.F.	F-stat	p-value
Taste for vegetation	30.16	2.202	8.74	0.0002
Level of education	8.75	2.202	2.54	0.0818
Income	10.5	2.202	3.04	0.0498

Source: du Plessis (2003:112)

*This sample size differs from the total sample size (n=219) as some responses were missing and these responses were automatically omitted from calculations by the statistical programme (du Plessis, 2003:112).

The respondents' taste for a particular vegetation type was significant in explaining their willingness to contribute money towards WfW activities. Respondents with a preference for commercial plantations were willing to pay

R3.16 more for the preservation of indigenous vegetation (see Table 5.3) through continued WfW activities than respondents who ranked invasive alien plants and other vegetation as their first choice (du Plessis, 2003:112).

Table 5.3: Regression of factors affecting WTP for preservation of indigenous vegetation (n=169*)

Independent variable	**Dependent variable Money contribution (Rand) R^2 = 0.2188; F-stat = 7.562; p-value = 0.000**			
	Coefficient	Std error	t-statistic	p-value
Taste for plantations	3.16	0.111	4.53	0.00
Taste for indigenous vegetation	2.34	0.1314	2.81	0.01
Level of education: lower than Grade 12	-0.54	0.2156	-1.25	0.21
Level of education: Grade 12	-0.69	0.1149	-1.41	0.16
Income	1.00**	0.0059	2.08	0.04

Source: du Plessis (2003:112)

*This sample size differs from the total sample size (n=219) as some responses were missing and were automatically omitted from calculations by the statistical programme.

** Categorical values were used for the income variable, and not numerical values.

Respondents who ranked indigenous vegetation as their most preferred vegetation type were prepared to pay R2.34 more for the preservation of indigenous vegetation (see Table 5.3) than those who preferred alien plants growing wild, and other vegetation types (du Plessis, 2003:112). The difference in WTP between respondents who ranked indigenous vegetation first, and those who ranked commercial plantations first, was unanticipated (du Plessis, 2003:112). Du Plessis (2003:112) argues that this difference could be attributed to respondents' belief that even though they recognise the importance of indigenous vegetation from a conservation perspective, commercial plantations created work for them. The explanation provided by du Plessis (2003), however, leads one to question whether her study might have been affected by scenario misspecification and / or by embedding bias (see Section 4.5.2 (a) and Section 5.4.4) as it appears as if respondents were including additional items in their valuation, rather than confining their WTP value to the preservation of indigenous vegetation.

Respondents with an educational level below Grade 12 and those who had a Grade 12 qualification respectively were prepared to pay R0.54 and R0.69 more for the preservation of indigenous vegetation (see Table 5.3) than respondents with a tertiary qualification. A rather unconvincing reason for the inverse relationship between the education level and WTP of respondents – namely that respondents with higher educational levels were better equipped to understand their budget constraint is offered by du Plessis (2003:112).

The income coefficient was positive: for every R12 000 increase in income, respondents were willing to pay R1 more for WfW activities at the specific site.

As stated previously, respondents' taste for biodiversity was equated, in the du Plessis (2003) study, to their preference for indigenous vegetation. To calculate the total value that people would be willing to pay to preserve indigenous vegetation, the sample mean WTP per site was multiplied by the total sample population. The latter was estimated to be the total number of household heads residing in the local municipal area in which the six sites are situated. The total population from local municipalities was used to determine the total WTP. These calculations are shown in Table 5.4.

Table 5.4: The average and total value (benefit) of preference for indigenous vegetation over alien vegetation

Site	Local municipality	Number of households	Mean WTP (R)	Total WTP (R)	WTP per hectare (R / ha)
Albany	Makana / Grahamstown	16 300	75.76	1 234 888.00	108.32
Kat River	Nkonkobe	28 635	111.76	3 200 247.60	2 675.79
Kouga	Kouga	14 605	304.83	4 452 042.15	28.06
Port Elizabeth Driftsands	Nelson Mandela Metropolitan Municipality	220 000	76.58	16 847 600.00	1 936.51
Pot River	Elundini	29 279	68.12	1 994 485.48	4070.38
Tsitsikamma	Greater Plettenberg Bay area	15 516	80	1 241 297.78	9.64

Source: du Plessis (2003:113)

Expectations were that the WTP would be low, but the results revealed that the biodiversity benefit could be the biggest benefit of the WfW programme, as total WTP values elicited were, in fact, high. At five of the six sites, the biodiversity benefit was substantially higher than the water and non-water benefits already estimated (du Plessis, 2003:115). Only at the Albany site was the fire and agricultural benefit calculated by du Plessis (2003) higher than the biodiversity benefit.

5.2.4 CONCLUSIONS DERIVED FROM THE DU PLESSIS (2003) STUDY

Following the valuation of the benefits, distinct cost benefit profiles were constructed for each site. The costs used were those determined by Hosking *et al.* (2002), adjusted to 2001 price levels. In order to establish a standard of comparison the net benefits calculated were discounted to present values. Following the same procedure as Hosking *et al.* (2002), a social discount rate of 10.1 per cent was used to derive present values. This rate reflected the opportunity cost of government and foreign funding for the WfW Programme in South Africa (du Plessis, 2003:v).

When the preference for indigenous vegetation was added to the cost benefit profiles, the WfW Programme at the Port Elizabeth Driftsands, Pot River and Kat River sites became efficient.

The du Plessis (2003) study indicated that the biodiversity benefit attributable to the WfW Programme is substantial. The study, although insightful, however, was simply a pilot one and suffered from a number of deficiencies. The most serious deficiency was the small sample size utilised in the contingent valuation study. This shortcoming, together with various other deficiencies, will be discussed in Section 5.4.

5.3 THE MERITS OF THE DU PLESSIS (2003) STUDY

The du Plessis (2003) study has some notable strengths. The scientific approach taken to calculate selected non-water benefits associated with the WfW Programme is laudable. It is also commendable that the design of the survey instrument was undertaken with reference to a number of the guidelines proposed by Arrow *et al*. (1993) (see Appendix 2). The survey instrument reminded respondents that their WTP for the programme in question would reduce their ability to spend on other goods and services. It also reminded respondents of the existence of substitute goods, including other similar undamaged natural resources. Personal interviews were also used which allowed for the use of visual aids and ensured that respondents could be enticed to participate, thereby reducing the non-response rate. This method for collecting contingent valuation data also offered the best opportunity to explain difficult concepts to the respondent. Furthermore, the survey included a variety of questions that helped to interpret replies to the primary valuation questions. These included income and other socio-economic indicators.

5.4 SHORTCOMINGS OF THE DU PLESSIS (2003) STUDY

Ideally, a contingent valuation questionnaire should successfully pass all the tests of content validity suggested in the Bateman *et al*. (2002) study (see Chapter Four and Appendix 1). However, upon examining the du Plessis (2003) study in light of the checklist provided by Bateman *et al*. (2002) it was found to suffer from some shortcomings. This critique focuses attention on five of these shortcomings:

- inadequate sample size;
- poor coverage of the relevant population;
- the choice of elicitation method;
- embedding bias;
- failure to include follow-up questions to determine the motivation behind the different WTP responses.

These shortcomings are briefly discussed below.

5.4.1 SAMPLE SIZE

The aim of any survey is to obtain information on certain characteristics of the population as a whole. This can be done either by studying every element of the population (i.e. a census survey) or by selecting a number of elements from the population and studying this subset of elements of the population (i.e. a sample survey). Information obtained from the sample elements in a sample survey is generalised by using methods of statistical inference to reach valid conclusions regarding characteristics of the population as a whole. However, to obtain reliable results and to ensure that the sample is representative of the population it is essential that the sample should not systematically exclude or under-represent certain types of people (de Vaus, 2004:70).

Sample size refers to the number of respondents that must be surveyed in order for the study to result in reliable findings. The power of the statistical tests of significance is undermined by a sample size that is too small (Hair, Anderson, Tatham and Black, 1998). For this reason, Arrow *et al*. (1993) suggests that a professional sampling statistician should help with the choice of sample size and design. As a base guideline Pearce and Ozdemiroglu (2002:57) note that a sample size of between 500 and 1000 respondents is required should the payment card or dichotomous choice method be used.

As acknowledged by du Plessis (2003), possibly one of the most important shortcomings of her study relates to the small sample size. The pilot study sample sizes, together with the estimated sample sizes at 2 per cent of the sample population and in terms of the Cochran (1977) method, were as follows:

Table 5.5: Sample size of the du Plessis (2003) study together with preferred sample sizes

Site	Sample size	Number of households*	Sample size of households at 2% of sample population	Preferred sample size**
Albany	33	16 300	326	353
Kat River	34	28 635	573	353
Kouga	30	14 605	292	353
Port Elizabeth Driftsands	60	220 000	4400	353
Pot River	32	29 279	586	353
Tsitsikamma	30	15 516	310	353

*Source: du Plessis (2003)

** Using Equation 6.2 (see Chapter Six) and du Preez's (2002) Keurbooms data

The preferred sample sizes (Table 5.5) are significantly higher than those that were selected (see Table 5.1). The main impact of this shortcoming was to undermine the significance of the WTP function. The small sample size means that each individual response has a much greater weighting in both calculations of the mean and in correlation analysis, so that the trends and relationships that are revealed are not reliable.

5.4.2 POOR COVERAGE OF THE RELEVANT POPULATION

It is essential that the respondents are representative for the population concerned, as several biases can appear when the selection procedure has not been carried out carefully. A potential source of bias identified by Mitchell and Carson (1989) includes the sampling frame bias.

Sampling frame bias may occur in cases when the sampling frame, a list of units drawn from the general study population, differs from the general study population. Sampling frame bias does not give every member of the population chosen a known and positive probability of being included in the sample (Mitchell and Carson, 1989).

Determination of a sample frame from the affected populations at the six project sites presented a problem for the du Plessis (2003) study. While a random sampling method was used, the samples were not representative of the total population residing in the area of the project sites, implying that the sample was not normally distributed. For example, the educational level of respondents was high. A tertiary qualification in the form of a diploma, degree or postgraduate degree had been achieved by 72.5 per cent of the respondents (du Plessis, 2003:107). This is in sharp contrast to the findings of the second democratic Census which indicate that only 6.3 per cent of the Eastern Cape Province's residents have obtained some form of tertiary qualification (Stats SA, 2003). Comparisons of the education levels of respondents at the Albany, Kat River, Port Elizabeth Driftsands and Tsitsikamma sites to Census data of the local municipality of which they form part revealed discrepancies (see Table 5.6).

Table 5.6: Comparison of education levels reported in the du Plessis (2003) study to Census 2001 data

Education level	**Albany (Makana)**		**Kat River (Nkonkobe)**		**Port Elizabeth Driftsands (Nelson Mandela Metropolitan Municipality)**		**Tsitsikamma (Kou-Kamma)**	
	Percentage of total							
	Du Plessis*	Census**	Du Plessis*	Census**	Du Plessis*	Census**	Du Plessis*	Census**
Less than Grade 12	6.0%	72.73%	3.2%	79.79%	1.7%	66.88%	3.3%	83.48%
Grade 12	6.1%	16.88%	3.2%	14.13%	31.7%	24.40%	20.0%	12.20%
Tertiary	87.9%	10.39%	93.6%	6.08%	66.6%	8.72%	76.7%	4.32%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

* Source: du Plessis (2003:107)

** Source: Stats SA (2003)

Furthermore, du Plessis (2003:110) reports that the median income for all the sites combined, as well as for the Port Elizabeth Driftsands, Pot and Kat River sites was R90 000. At the Kouga and Albany sites, the median income level was R42 000, while it was R135 000 at the Tsitsikamma site. The median income levels at the Kouga and Albany sites are more in line with average household income levels in the Eastern Cape (calculated to be R43 097; Stats SA, 2003) than the other sites. Only, 5.4 per cent of people employed in the Eastern Cape earn more than R6 000 per month, and 53.7 per cent of employed people earn less than R500 per month (ECSECC, 2001).

Due to more educated and higher earning respondents being selected the total WTP (a product of the average WTP and the population) may not reflect the population's true WTP. Bearing in mind that the unemployment rate for the Eastern Cape stood at 27.1 per cent in 2005 (Stats SA, 2005), and that 72 per cent of households in the Eastern Cape Province were estimated to have been living below the poverty line[15] in 2001 (HSRC, 2004), the WTP figures calculated by du Plessis (2003) may be an overestimation of the population's true WTP.

The sample frame bias evident in the du Plessis (2003) study jeopardises the accuracy of projecting the results of this survey to any population beyond the socio-economic group comprising the majority of respondents who themselves were a subset of potential respondents.

5.4.3 CHOICE OF ELICITATION METHOD

The elicitation method establishes the manner in which the question for obtaining the value judgement is posed. Formulation of an accurate answer to a WTP question can require a significant amount of effort. For this reason, should respondents believe that they will not in fact be required to pay their stated amount, they may only make a token effort to generate a WTP value. A random value may even be chosen. As respondents are in most cases unfamiliar with expressing their preferences for public goods in Rand amounts, they have a tendency to make WTP estimates based on some initial value embedded in the survey instrument (Mathis *et al*., 2003:27). This phenomenon, known as anchoring or starting point bias, leads to a bias towards the initial value (Kahneman, Slovic and Tversky, 1982).

Various elicitation methods, such as the payment card elicitation method employed in the du Plessis study (2003), have been developed to combat this behaviour. This method presents the respondent with a visual aid containing a set of ordered monetary amounts (usually, ordered from smallest to largest). The respondent is asked to consider these amounts and to report the highest amount he / she would be willing to pay.

[15] Poverty estimates are calculated using a poverty line that varies according to household size. A household of four persons has a poverty income of R1 290 per month, measured in constant 2001 Rands (HSRC, 2004).

However, the payment card elicitation method is vulnerable to range bias (Mitchell and Carson, 1989). While the payment card method may reduce or eliminate starting point bias, as mentioned above, Mathis *et al*. (2003:27) note that respondents may instead take cues from the range of possible responses presented on the payment card. Should the highest amount on the payment card be less than the respondent's maximum WTP, a downward bias could be introduced, and *vice versa*. To avert this outcome, the maximum amount on the payment card can be made particularly high. However, respondents may also assume that the maximum amount presented on the payment card is a reasonable upper bound, thus biasing responses upwards (Mathis *et al*., 2003:27). Furthermore, if the respondent's true WTP falls between the gaps of the various amounts printed on the payment card responses could be biased in either direction (Mitchell and Carson, 1989).

Moreover, the use of the payment card approach may be limited, especially in rural areas of developing countries where the people have very limited experience with such an elicitation method (Venkatachalam, 2004:106). Finally, following the Exxon Valdez oil disaster a National Oceanic and Atmospheric Administration (NOAA) panel of experts, chaired by Kenneth Arrow and Robert Solow, recommended that the valuation question should be posed as a vote on a referendum, that is, a single bounded dichotomous choice question related to the payment of a particular level of taxation, because this was the most realistic proposition (Arrow *et al*., 1993).

Du Plessis (2003) used a payment card with 11 payment categories (see Table 5.7).

Table 5.7: Payment card used in the du Plessis (2003) study at the Port Elizabeth Driftsands site

Rand	The Working for Water Programme at the site (budget of R1.95 million in 2002)	The Working for Water Programme in South Africa (budget of R403 million in 2002)	Conservation projects in South Africa (budget of R560 million in 2002)
0			
1 – 10			
11 – 20			
21 – 50			
51 – 100			
101 – 200			
201 – 500			
501 – 1000			
1001 – 2000			
2001 – 5000			
5000 +			

Source: du Plessis (2003:147)

According to the results reported in the du Plessis (2003) study, approximately 20.2 per cent of respondents were unwilling to pay a levy towards the preservation of indigenous vegetation through continued WfW activities. Approximately 42.2 per cent of respondents were prepared to pay between R1 and R50, 15.1 per cent were willing to pay between R51 and R100, and 22.5 per cent of respondents were willing to pay more than R101 annually (du Plessis, 2003:111).

Examining the distribution of WTP reveals that the lower tail contains a large number of observations. It thus appears as if a certain amount of range bias occurred thereby bringing the results obtained by du Plessis into question.

5.4.4 EMBEDDING

Significant concern has been expressed regarding embedding bias in CVM results, first noted by Kahneman and Knetsch (1992) and then extensively studied in Hausman (1993). This bias arises when respondents confuse the subject of the survey with other, wider, questions that arise in their minds. The WTP that respondents tend to put on a less inclusive good differs insignificantly from the WTP for a more inclusive good because of the manner in which the respondents allocate their budget (Bateman and Willis, 1999). For this reason, similar valuations are given for the protection of, for instance, one conservation project and all conservation projects in general, as people tend not to separate the parts from the whole.

Two reasons have been offered to explain the existence of embedding bias. The first, known as the "warm glow effect" and suggested by Kahneman and Knetsch (1992), involves the moral satisfaction of contributing to a good cause. Respondents pay for the good feeling of contributing to a worthy cause rather than on the quantity of the good being offered or of the resulting benefits. The second explanation involves the mental model the respondent uses for constructing his / her valuation (Desaigues and Rabl, 1995). This model can be completely different from the one assumed by the investigator. For example, respondents who are asked for their WTP for improving visibility in a particular area may include health benefits in their valuation or even additional public goods.

Embedding bias affects the validity of contingent valuation results. Minimising this problem can be achieved by adequate survey design and by giving a clear and appropriate description of the good to be valued. A realistic payment vehicle should be used to ensure that the respondent feels that he / she is being asked to participate in a transaction rather than simply making a donation to a charity (Cummings, Brookshire and Schulze, 1986). However, survey design is not infallible and internal tests should also be used to assess the validity of results. Arrow *et al*. (1993) therefore recommend that every contingent valuation study should have an "internal consistency test" to assess the validity of results. One method of assessing the internal consistency of contingent valuation results is to use a scope test. A scope test investigates whether respondents are willing to pay more for a good that is larger in scope, either from a quality or quantity perspective.

In the du Plessis (2003) study, an attempt was made to reduce embedding bias by asking respondents their WTP for WfW activities at the specific site, WfW activities in South Africa, and conservation projects in South Africa. However, those administering the surveys expressed concern that respondents may have reported values for commodities that were more inclusive than what was desired in the investigation and that embedding may have occurred whilst they were conducting the surveys (du Plessis, 2003:114). This brings the validity of the results obtained by du Plessis into question.

5.4.5 FOLLOW-UP QUESTIONS

After obtaining the respondent's WTP valuation du Plessis' (2003) survey instrument proceeded to ask the respondent various questions pertaining to his / her socio-economic status. No follow-up question was provided after the valuation question.

In terms of the recommendations made by Arrow *et al*. (1993) it is desirable to follow questions that elicit WTP with questions to understand the motives behind these answers. Follow-up questions are particularly useful where there is some form of protest or unwillingness-to-pay for the good in question. Zero valuations are not necessarily protests: respondents may genuinely be unwilling to pay anything for the good because of their financial situation. By asking respondents to give a reason for their zero response the true zero bids can be separated from those who are reporting zero because they protest to having to pay for the environmental improvement, or how or who they have to pay.

This failure to include a follow-up question made it difficult to determine whether the 20.2 per cent of respondents (du Plessis, 2003:111) who entered a zero bid were protesting or whether they entered a zero bid due to financial constraints.

5.5 CONCLUSION

The du Plessis (2003) study has some notable strengths. The derivation of selected non-water benefits, in particular people's preference for indigenous vegetation, for six representative WfW sites was done in a scientific manner following many of the guidelines provided by Arrow *et al*. (1993) (see Appendix 2). However, some shortcomings are evident. These shortcomings include: inadequate sample size; poor coverage of the relevant population; embedding bias; the choice of elicitation method, and failure to include follow-up questions to determine the motivation behind the various WTP valuation amounts given, in particular zero bids.

Admittedly, due to practical considerations (namely the time frame and resources available) the contingent valuations performed at each of the six sites were derived from pilot studies and as such were never going to comply with all of the guidelines drawn up by Arrow *et al*. (1993). However, careful questionnaire design is crucial to the success of contingent valuation. Many studies, including the du Plessis (2003) study, can be criticised precisely because inadequate effort is spent on designing and testing the questionnaire.

Chapter Six identifies the population from which the samples were selected for the current study's contingent valuation and describes the sample decision issues that were encountered in the study.

CHAPTER SIX
SAMPLE DESIGN

6.1 INTRODUCTION

Chapter Six provides a brief overview of some of the theoretical factors that need to be taken into account when designing a sample. It identifies all the WfW project sites from which the sites for this study were selected and describes the sample design issues that were encountered.

6.2 THEORETICAL SAMPLE DESIGN ISSUES

A primary aim of research is to draw reliable conclusions about a wider population, on the basis of the findings in a particular study, where a sample of the said population was used. Sampling refers to the selection of only some elements (persons, objects or events) out of a theoretically specified population of elements, from which information will be collected (Deflem, 1998). Once the scope of the population has been established, a sampling frame (a list of the population elements) can be obtained.

When selecting a sample from a sampling frame, the aim is to do so in such a manner that it is representative of the population. A representative sample is one in which the profile of the sample is the same as that of the population (e.g. gender, class, age, race, etc.).

Representivity ensures that certain types of people in the population are not systematically excluded or under-represented (de Vaus, 2004:70). Probability or non-probability sampling designs are most often used in research.

6.2.1 PROBABILITY SAMPLING

The principles of probability theory, which state that increasing the sample size, will lead the distribution of a statistic to more closely approximate the distribution of the parameter (the summary description of that variable in the population), form the basis of probability sampling. The standard error, inversely related to sample size, indicates how closely a sample statistic approximates the population parameter (Deflem, 1998).

A randomly selected sample of adequately large size (absolute size, not size proportionate to the population) will be more representative of the population as the relevant statistics will more closely approximate the parameters (Deflem, 1998). Alternatively, the findings in the sample will be more generalisable to the population (Deflem, 1998). The representivity of samples, or the degree to which sample findings can be generalised, both matters of degree, are the main advantages of probability sampling designs (Deflem, 1998). The accuracy of a sample statistic is described in terms of a level of confidence with which the statistic falls within a specified interval from the parameter (the broader the interval, the higher the confidence). The main disadvantage of probability sampling is that the theoretical assumptions (of infinity) never actually apply (Deflem, 1998).

There are four main types of probability samples. Choosing between these sample types depends on the nature of the research problem, the availability of good sampling frames, financial resources, the required level of accuracy in the sample and the sample collection method (de Vaus, 2004:71).

(a) Simple random sampling

Simple random sampling (SRS) is a probability selection scheme where each subject in the population has an equal likelihood of being selected (Fink, 2003). De Vaus (2004:71) identifies five steps in selecting a SRS.

1. Obtain a complete sampling frame.
2. Give each member a unique number starting at one (1).
3. Decide on the necessary sample size.
4. Select numbers for the sample size from a table of random numbers.
5. Select the members who correspond to the randomly chosen numbers.

Once they have been selected, members are not eligible for a second chance and are not returned to the pool of possible subjects. Random samples are considered relatively unbiased due to this equality of opportunity (Fink, 2003).

One of the disadvantages of the SRS approach is that it requires a complete list of all population units as each unit needs to have a unique number associated with it to enable random selection. While these may be available for some populations (e.g. churches), adequate lists are often not available for larger population surveys of a city, region or country. In addition, the cost of SRS is prohibitive when the population comes from a large area and the data are to be collected by personal interviews, as is the case in national surveys. Furthermore, random sampling may not pick up all the elements of interest in a population (de Vaus, 2004:71).

(b) Systematic sampling

Systematic sampling requires that the frame of sampling units be numbered, sequentially, beginning with the number one (1) and concluding with a number equal to the size of the frame. Using a random start, the first sampling unit is selected according to that random number, and the remaining sampling units that comprise the sample are selected using a fixed interval thereafter (de Vaus, 2004:72).

To obtain a systematic sample the following steps are followed:

- Determine the population size (e.g. 120).
- Determine the sample size required (e.g. 20).
- Calculate a sampling fraction by dividing the population size by the required sample size (120 / 20 = 6).
- Select a starting point by randomly selecting a number between 1 and the calculated sample fraction (6).
- The selected number is the starting point.
- Use the sampling fraction to select every n^{th} case. With a sampling fraction of 6 select every 6^{th} case and obtain a sample of 20 cases (de Vaus, 2004:72).

Systematic sampling often gives more accurate estimates than SRS. However, aside from the problems systematic samples share with SRS, systematic samples can encounter an additional one: periodicity of sampling frames (de Vaus, 2004:73). A certain kind of person may reoccur at regular intervals within the sampling frame. The sample may include only certain kinds of people and systematically exclude others, if the sampling fraction is such that it matches this interval. An example of this would occur if a researcher used a sampling frame of adult residents in an area composed of predominantly couples or young families. If this list was arranged: Husband / Wife / Husband / Wife etc. and if every tenth person was to be interviewed, there would be an increased chance of males being selected. A further disadvantage of this method is that there is no technique of estimating the standard error of the mean (Robinson, Hay, Booth and Truscott, 1996).

(c) Stratified sampling

Stratified sampling is a variation of SRS (de Vaus, 2004:74). It is based on the principle that samples are more representative and thus more accurate when the population out of which they are selected is homogeneous. The target population is separated into non-overlapping strata or sub-populations that are known or thought to be more homogeneous. On the whole, stratified sampling has similar limitations to SRS. For a sample to be representative, the proportions of various groups in the sample should be the same as in the population. However, due to chance (sampling error) this will not always occur. Furthermore, strata must be well defined so that items (e.g. boaters and swimmers in the case of an estuary) are not inadvertently classified into more than one group.

The following steps are followed when stratifying a sample (de Vaus, 2004:74):

- The stratifying variable (e.g. ethnic background) is selected.
- The sampling frame is divided or stratified into separate lists – one for each category of the stratifying variables.
- The sample is selected using SRS or systematic sampling within each stratum and independent of the other strata.

This procedure will improve the accuracy of estimates because the population variability can be thought of as having components within strata and between strata (de Vaus, 2004:74). By independently sampling within each stratum the researcher ensures that each stratum (e.g. ethnic group) is represented in the correct proportion.

(d) Cluster sampling

A cluster is a naturally occurring unit, such as a university, which has many lecture halls, students, and lecturers. Cluster sampling is used in large surveys.

It differs from stratified sampling in that with cluster sampling, a naturally occurring constituency is the starting point (Fink, 2003).

Cluster sampling involves selecting a sample in a number of stages (usually two). The units in the population are arranged into convenient (typically naturally occurring) clusters. These clusters are non-overlapping, well-defined groups which usually represent geographic areas. At the first stage of selection, clusters of groups of elements are selected. At the second stage, elements in each of the chosen clusters are selected to form the sample (Deflem, 1998).

While cluster sampling is more efficient and eliminates the need for a complete list of all the units in the population, this method is subject to a number of disadvantages. Firstly, there are sampling errors involved at each stage of sampling. This problem is not only repeated at each stage, but also intensified since the sample size grows smaller at each stage (Deflem, 1998). However, since elements in clusters are often found to be homogeneous, this problem can be overcome by selecting relatively more clusters and fewer elements in each cluster (at the expense of administrative efficiency) (Deflem, 1998).

Secondly, there is increased complexity in the analysis of data, especially if clusters were not selected with probability proportional to size and there is a need to weight the data (de Vaus, 2004:75). Finally, if the parameter being studied is not similar across clusters, then the variance for the cluster survey will be higher than for a SRS.

6.2.2 NON-PROBABILITY SAMPLING

If the probability of selection for all eligible units is unknown, or cannot be calculated, the sample is called a non-probability sample (Fink, 2003). The main advantages of non-probability samples are that they are convenient and economical, they do not require a sampling frame and they are suitable for use in many surveys. The main disadvantage of non-probability samples is that they are vulnerable to selection biases (Fink, 2003).

While it is dangerous to make conclusions about the target population on the basis of a non-probability sample, non-probability methodology is often used to test aspects of a survey such as questionnaire design, processing systems, etc.

Different types of non-probability sampling methods are discussed below.

(a) Convenience sampling

A convenience sample is a group of individuals who are ready and available, for example, a survey that relies on people in a shopping mall. Magazine and newspaper questionnaires and phone-in polls are further examples of convenience or haphazard samples. As only those individuals who feel strongly about the topic will respond, convenience-sampling surveys are subject to biased or unrepresentative samples. These surveys are also inclined to ask questions that are loaded or have a biased wording (National Statistical Service, 2006).

(b) Quota sampling

Quota sampling divides the different variables known to be distributed in the population being studied into subgroups, such as male and female or race (Fink, 2003). The researcher estimates the proportion of people in each subgroup. The interviewers select respondents until the pre-determined number of respondents in each subgroup has been surveyed. When top up units are selected randomly to fill a quota, and no element of judgment is used by the researcher for unit selection, it is very similar to a probability sample. However, when non-response is significant (which is often the case for voluntary surveys), quota sampling can under-represent those sections of the population that are unwilling to respond or who are hard to contact. This is of particular concern when the data items collected influence the likelihood of response (National Statistical Service, 2006).

(c) Judgement or purposive sampling

Judgement or purposive sampling occurs when an expert in the field of study chooses a “representative” sample. Judgement sampling is subject to unknown biases but may be justified for very small samples. This form of sampling can be useful when testing questionnaires and other research instruments or in explorative studies. In explorative studies, elements can purposively be selected to disclose data on an unknown issue, which can later be studied in a probability sample (Deflem, 1998).

(d) Theoretical non-probability sampling

Since observations on "everything" or "everybody" can effectively never be achieved, it is more appropriate to study only those elements relevant from a particular research perspective. This is sometimes called theoretical sampling or creative sampling (Deflem, 1998).

When the elements in a natural setting clearly appear in different categories, quota sampling "in the field" can be used. It is the same as regular quota sampling, but the decisions on relevant cells and proportions of elements in cells are based on field observations (Deflem, 1998).

Snowball sampling is used when a population listing is unavailable and cannot be compiled (Fink, 2003). The selection of one element leads to the identification and selection of others and these in turn to others, and so on. The theory of saturation, indicating the point when no more new data are revealed, determines when the snowball stops (Deflem, 1998). Surveys of illegal aliens might use snowball sampling because no membership lists are available for such groups.

The sampling of deviant cases can be used to learn more about a general pattern by selecting those elements that do not conform to the pattern (Deflem, 1998). For example, if it was determined that 99 per cent of the students at a university voted for a particular candidate during the annual Student Representative Council elections, this method would target those students who did not vote for this particular candidate so as to find out why they are "deviant".

These samples are purposive samples with a theoretically founded purpose. Their use may be acceptable and, even the only feasible ones, but they suffer a lack of representativeness for a wider population (Deflem, 1998).

6.2.3 SAMPLE SIZE

An important feature of sample design is deciding upon the sample size given the objectives and constraints that exist. Since every survey is different, there are no fixed rules for determining sample size. However, a number of factors need to be considered before a suitable sample size can be determined. These factors include:

- the population size;
- the variability within the population;
- the available resources (time and money);
- the level of accuracy required of the results;
- the likely non-response level;
- the sampling methods used; and
- the relative importance of subgroups.

Population size:
An aspect that affects the sample size required is the population size. When the population size is small, a small increase in sample size can lead to a substantial increase in accuracy. However, when the population size is large changing the

sample size may yield little benefit (de Vaus, 2004:81). In order to halve the sampling error the sample size must be quadrupled (de Vaus, 2004:81). It may be argued that beyond a certain point the cost of increasing the sample size may not merit the extra precision that may be gained. For this reason many survey companies limit their samples to 2 000 (de Vaus, 2004:81).

It must also be borne in mind that the absolute size of the sample is more important that its size relative to the population (de Vaus, 2004:81).

Variability:
The degree of variability[16] in the attributes being measured must be considered. All other things being equal, the less variable the responses are, the smaller the sample size required to achieve the same level of accuracy (Deflem, 1998). Thus for a study on voting, a larger sample would be required for a population where 50 per cent intend voting for Party A and 50 per cent for other parties (i.e. a 50 / 50 split) than for a population where 90 per cent intend to vote for Party A (i.e. a 90 / 10 split).

Financial resources available and accuracy:
The sample size and design need to fit within the available financial resources. The more time and money that is available to conduct a survey, the more accurate the results one would expect to achieve.

A measure of the accuracy of the estimate is the standard error. In general, the larger the sample size, the more likely it is to have a smaller standard error (Deflem, 1998). However, smart sample designs can often be used to reduce the sample size without reducing the accuracy.

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[16] The degree of variability in the attributes being measured refers to the distribution of attributes in the population.

Likely level of non-response:

Non-response can create at least two problems. The higher the non-response, the larger the standard errors will be for a fixed initial sample size. This problem can be compensated for by drawing an initial sample that is larger than needed (Deflem, 1998). A second problem with non-respondents is that the characteristics of non-respondents may differ from those of respondents, e.g. age and education level. The latter problem may cause the survey results to be biased. The lower the response rate, the less representative the final sample will be of the total population and the bigger the potential bias in the sample estimates. Non-response bias can sometimes be reduced by post-stratification, as well as through intensive follow-up of non-respondents, particularly in groups with poor response rates (Deflem, 1998).

Sampling method:

Many surveys involve complex sampling and estimation procedures. An example of this is a multi-stage cluster method. This technique of obtaining a final sample involves combining the basic probability sampling procedures in such a manner that the cost of final interviewing is minimised (de Vaus, 2004:75). A multi-stage sampling method can often lead to higher variance in resulting estimates than might be achieved by a SRS design. If, the same degree of accuracy is desired, it is necessary to increase the sample size to take into account the fact that SRS is not being used (Deflem, 1998).

Relative importance of subgroups:

When the researcher breaks the sample into subgroups, comparisons between different subpopulations (subgroups) may be of interest. For example, in a survey of people some answers may be required to be broken down by gender and some questions, such as number of pregnancies, may only be relevant to one gender. The overall sample size needs to be large enough to ensure that an adequate level of accuracy for these subgroups (e.g. age, gender) can also be achieved. The smallest subgroup should contain at least 50 cases (Hoinville and Jowell, 1978).

The sample size must take into account the degree of diversity in the population on key variables, the level of sampling error that is tolerable and the reliability required of the sample. Decisions about one factor have implications for other factors. As such, the final sample size will be a compromise between cost, accuracy and ensuring sufficient numbers for meaningful subgroup analysis.

6.3 THE SAMPLE FRAME OF WFW SITES IN SOUTH AFRICA

A sample frame of 274 active WfW projects sites was identified for this study (see Table 6.1).

Table 6.1: WfW project sites

	2002 / 2003	2003 / 2004
Western Cape	50	52
Eastern Cape	38	37
Mpumalanga	31	22
KwaZulu-Natal	83	58
Limpopo	18	18
SANParks	22	18
North-West and Gauteng	33	31
Northern Cape and Free State	24	38
Working for Wetlands	31	
Forestry South Africa	24	
Total	354	274

Source: Wannenburgh, pers. comm. (2005)

From the complete list of active WfW project sites in South Africa three sites were selected. These were the Worcester (Western Cape), Port Elizabeth Driftsands (Eastern Cape) and the Underberg (KwaZulu-Natal) sites. These sites were selected in consultation with advisors from the national WfW Programme and because it was felt that they characterised the variety of areas in the Eastern

Cape, Western Cape and KwaZulu-Natal where WfW teams are operational. These sites were chosen on the basis of their geographical location, the indigenous and alien vegetation present and their value as tourist attractions.

6.4 RESPONDENT SELECTION

6.4.1 TARGET POPULATION

The target population in this CVM study was all those people with a demand for the indigenous vegetation[17] present at the three sites. Identifying these people proved to be a complex task and could not be performed beforehand as visitors to the area also form 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 (vacation or permanent) from the sites, and that at some distance, the demand for indigenous vegetation becomes trivial. With respect to non-users, it was assumed that a demand from them would only exist if the site hosted something unique.

The following institutions were used to identify the target populations: municipalities, tourism authorities, National Parks Boards and any other authorities that could help in determining how many users utilise the sites and for what purpose they do so. In addition, census data on the size and characteristics of the population living within 5 kilometres of the urban sites, namely Port Elizabeth Driftsands and the Worcester site was obtained. Due to the rural nature of the Underberg site, census data on the Kwa Sani Municipality was obtained. It was also decided to focus on individuals who fall within the 15 – 64 year old age bracket.

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17 In this study, respondents' taste for biodiversity was equated to their preference for indigenous vegetation.

Based on this information, the target population groups were sub-divided into tourists and local residents. The sub-category “tourists” was further sub-divided into:

- Tourists from within the particular site’s province;
- Tourists from within any one of the other provinces of South Africa;
- Tourists from within Africa; and
- Tourists from elsewhere.

It proved impossible to identify all the individuals making up this target population, as no records exist of them.

(a) Determination of the target population in Port Elizabeth

It was determined that the user population for the Port Elizabeth Driftsands survey should include residents, tourists and subsistence users.

According to the Census of 2001, there were 1 005 776 people and 260 798 households residing in the Nelson Mandela Metropolitan Municipality (Stats SA, 2003). The racial makeup of the Nelson Mandela Metropolitan Municipality was: African 58.90 per cent, coloured 23.48 per cent, Indian / Asian 1.12 per cent, and white 16.51 per cent (Stats SA, 2003). The average household size was 3.86 people, but 15.3 per cent of all households were made up of single individuals (Stats SA, 2003).

A breakdown of the population age in comparison to the National and Eastern Cape averages is shown in Table 6.2. The first and last category of 0 – 14 years and 65+ years are the mostly economically inactive and the 15 – 64 year age group reflects the most potentially economically active category.

Table 6.2: Comparison of the population age

Region	0 – 14 Years	15 – 64 Years	65+ Years
Nelson Mandela Metropolitan Municipality	37%	58%	5%
Eastern Cape	36%	58%	6%
RSA	32%	63%	5%

Source: Stats SA (2003)

There were 66 726 permanent residents living within 5 kilometres of the Port Elizabeth Driftsands site (see Table 6.3). These people make up 17 287 households.

Table 6.3: Residents living within 5km of the Port Elizabeth Driftsands site

Population group (race)	Population size	%
African	28 821	43.19
Coloured	2 385	3.57
Indian or Asian	644	0.97
White	34 876	52.27
Total	66 726	100.0

Source: Stats SA (2003)

A tourist is defined as an individual who spends at least one night away from his / her regular place of residence. It includes people on holiday, business or visiting friends and family. A breakdown of tourist numbers per origin and purpose of visit (holiday, business, visiting friends and relatives (VFR), and other) is shown in Table 6.4.

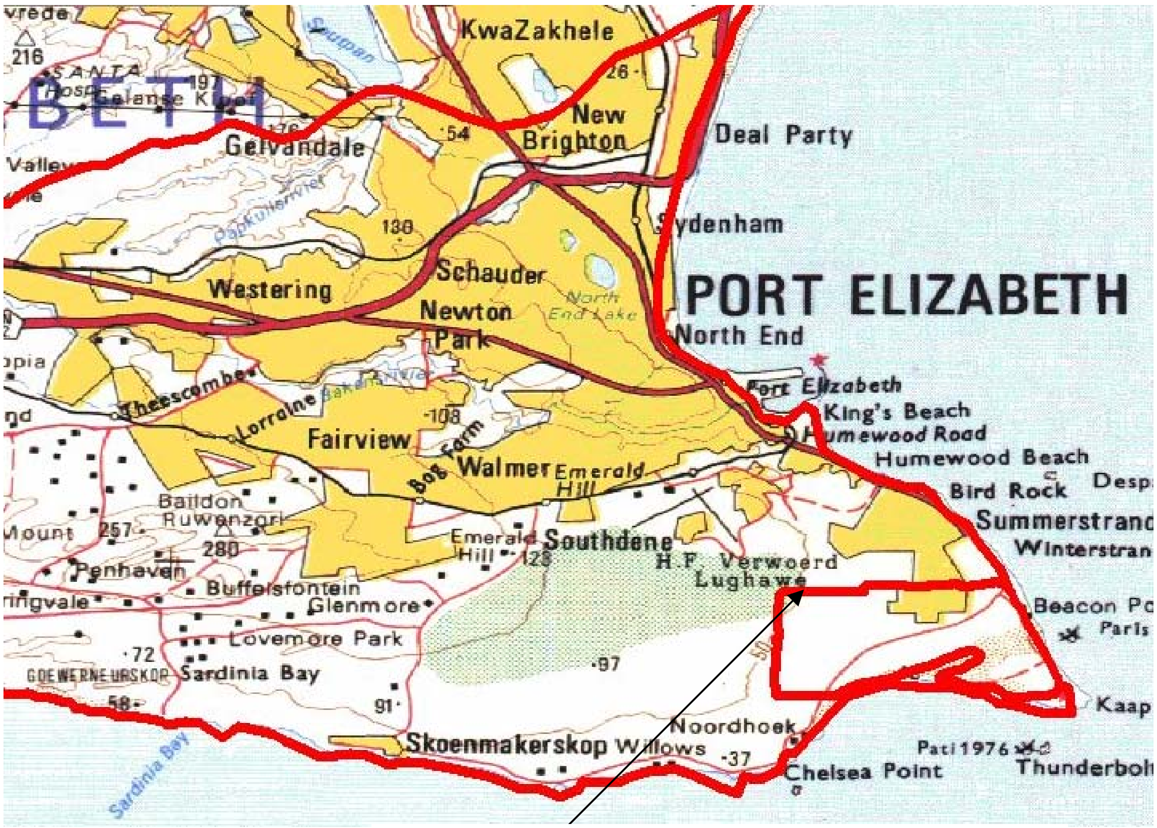
Table 6.4: Breakdown of tourists per origin and purpose of visit

Origin	Total trips	Leisure	VFR	Business	Other
Foreign (excluding Africa)	75 000	47 250	13 500	8 250	6 000
Africa	15 000	9 450	2 700	1 650	1 200
Domestic	1 200 000	240 000	600 000	360 000	0
Total	1 290 000	296 700	616 200	369 900	7 200

Source: Myles (2003)

These data indicate that the majority of tourists to the Nelson Mandela Metropolitan Municipality visit friends and relatives (47.7 per cent), followed by business visitors (28.6 per cent).

The road leading to the Port Elizabeth airport borders the site (see Figure 6.1).



Port Elizabeth Driftsands WfW Project

Figure 6.1: Port Elizabeth Driftsands site

Source: Conservation Support Services (2003)

Travellers can enjoy the view of the Port Elizabeth Driftsands site, even if they have no intention of staying in the city. As a result, there are a large number of passive users of the site. Another complicating factor in determining the target population for the site is that major roads run along its boundary, with the result that many people derive a “forced / involuntary” benefit from the site in the form of a view. Furthermore, residents of the Gqebera Township collect firewood and hunt in the area (McGwynne *et al*., 1996).

Although Dune Fynbos is found on the site, it was assumed that the non-user population would be trivial as this vegetation type is relatively well conserved in the neighbouring Nelson Mandela Metropolitan University (South Campus) and Cape Recife reserves.

Based on the aforementioned background information the target population was estimated by user categories. The proportions deduced per user group for administering the questionnaires are shown in Table 6.5.

Table 6.5: Guideline proportions for questionnaire administration: Port Elizabeth Driftsands

User group description		**%**
Residents (Proximity use)	African	46
	Coloured	12
	Indian / Asian	1
	White	31
Residents	Subsistence use	2
Tourists	Domestic	7
	Foreign	1

(b) Determination of the target population in Worcester

It was decided that the user population for the Worcester survey should also include residents and tourists.

According to the 2001 Census there were 146 029 people and 34 099 households residing in the Breede Valley Municipality (Stats SA, 2003). In terms of racial characteristics, most residents are coloured (65.61 per cent), with Africans and whites respectively making up 20.13 per cent and 13.93 per cent of the total. Asians constituted about 0.33 per cent of the population. The average household size was 4.28 (Stats SA, 2003).

The permanent residents living within 5 kilometres of the Worcester site totalled 44 688 people (see Table 6.6). Based on the aforementioned household size, it was concluded that these people make up 10 441 households.

Table 6.6: Residents living within 5km of the Worcester site

Population group (race)	Population size	%
African	9 222	20.64
Coloured	32 740	73.26
Indian or Asian	104	0.23
White	2 622	5.87
Total	44 688	100.0

Source: Stats SA (2003)

Table 6.7: Tourism regions* visited in the Western Cape, according to purpose of visit in 2000 / 2001

Tourism region	Total trips (%)	Leisure (%)	VFR (%)	Business (%)	Health (%)	Religious (%)
West Coast	6.6	53.6	40.2	0.6	3.5	2.1
Winelands	5.9	22.4	51.5	5.0	5.7	15.4
Breede River	7.6	51.7	38.4	2.7	0.0	7.2
Central Karoo	2.2	49.5	39.8	5.1	0.0	5.6
Garden Route	16.4	66.0	27.0	2.7	0.8	3.5
Klein Karoo	2.5	48.0	40.3	4.1	0.8	6.9
Cape Metropole	44.3	27.9	56.4	7.7	3.3	4.6
Swartland and Sandveld	1.5	14.4	65.6	8.0	0.0	11.9
Olifants River Valley	5.1	39.0	51.4	6.3	0.0	3.3
Overberg	8.1	57.7	34.6	1.0	0.5	6.3
Average	100	41.1	46.2	5.1	2.2	5.4

Source: Rule, Struwig, Langa, Viljoen and Bouare (2001:103)

Holiday trips (51.7 per cent) constitute the main purpose of domestic overnight trips taken to the Breede River Valley (see Table 6.7). About 7.6 per cent of all domestic tourists visiting the Western Cape Province visit the Breede Valley

* For more information about the ten tourism regions in the Western Cape Province, see Appendix 3.

making this region the fourth most popular domestic tourist destination in the Province.

Domestic tourists found the beach and sea, the scenery and the beauty of the mountains to be the main attractions of the Western Cape Province (Rule *et al*., 2001:105). Seven out of ten tourists to Western Cape destinations were very interested in going to the beach. Nature reserves were the second most popular attraction at 59 per cent (Rule *et al*., 2001:106).

As was the case in Port Elizabeth, major roads (e.g. the road to Rawsonville) run along the Worcester site's boundary (see Figure 6.2), with the result that many people derive a "forced / involuntary" benefit from the site in the form of a view.

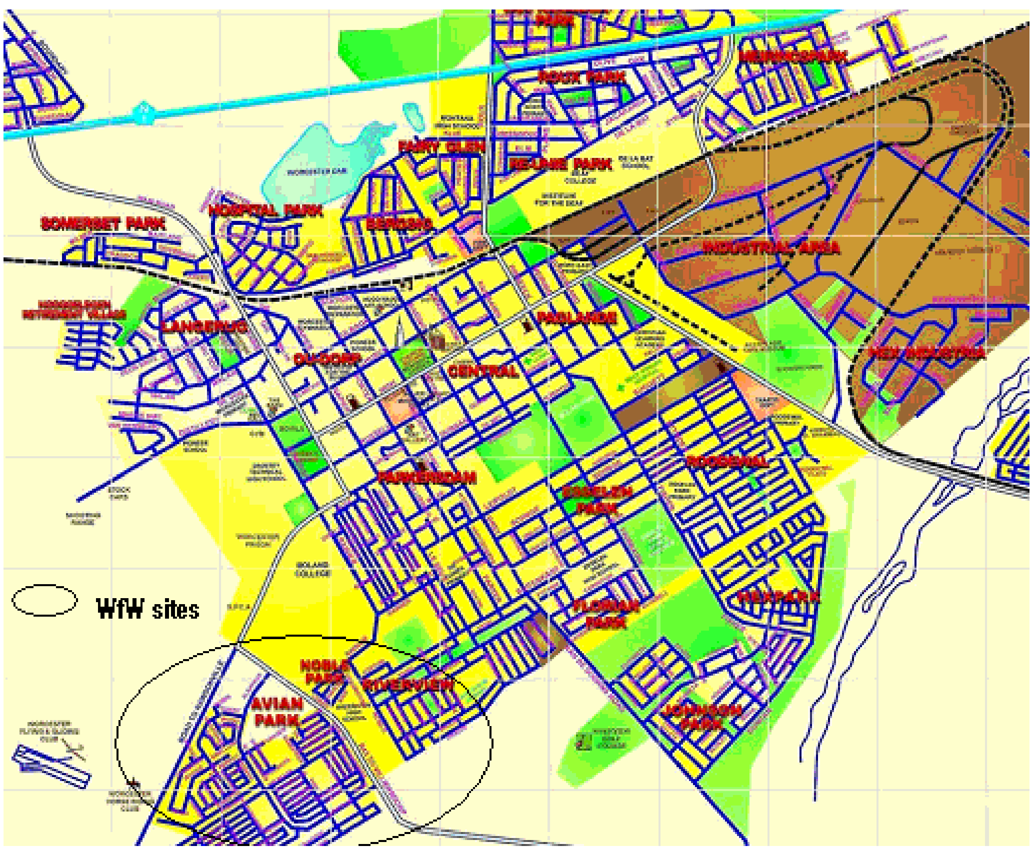


Figure 6.2: Worcester site

Source:
http://www.tourismcapewinelands.co.za/za/images/RGN/61za/map_big.jpg

Furthermore, the possibility exists that there are also passive users who value the Worcester site purely because the area between Rawsonville and Worcester forms the western most boundary of the Little Succulent Karoo vegetation type.

Research into the size of the target population with a demand for the ecosystem services of the Worcester site led to the conclusions shown in Table 6.8.

Table 6.8: Guideline proportions for questionnaire administration: Worcester

User group description		**%**
Residents	African	18.35
	Coloured	62.46
	Indian / Asian	0.28
	White	8.91
Tourists	Domestic	7.0
	Foreign	1.0
Non-users		2.0

(c) Determination of target population in Underberg

It was also decided that the user population for the Underberg survey should include residents and tourists.

According to the 2001 Census the population of the Kwa Sani Municipality was estimated to have increased from 14 568 in 1996 to approximately 15 309 in 2001 (see Table 6.9).

Table 6.9: Residents living within the Kwa Sani Municipality

Population group (race)	**Population size**	**%**
African	14 418	94.18
Coloured	90	0.59
Indian or Asian	6	0.04
White	795	5.19
Total	15 309	100.0

Source: Stats SA (2003)

Using this population growth rate, it can be estimated that Underberg's population increased from 979 in 1996 (UDIDI, 2002) to 1 029 in 2001, while Himeville's population is estimated to have increased from 717 (UDIDI, 2002) to 753. The permanent residents of the Kwa Sani Municipality made up 4 654 households with an average of 3.22 people per household (Stats SA, 2003). It was deduced that there were 542 households in the towns of Underberg and Himeville. While no racial demographics are available for the towns of Underberg and Himeville discussions with residents led to the conclusion that the towns are predominantly inhabited by whites.

Table 6.10: Tourism regions* visited in KwaZulu-Natal, according to purpose of visit in 2000 / 2001

Tourism region	Total trips (%)	Leisure (%)	VFR (%)	Business (%)	Other (%)
Battlefields	11.3	8.6	69.7	1.9	19.9
Drakensberg	2.9	50.8	24.2	16.7	8.3
Durban Central	31.3	37	44.4	5.2	13.4
Durban South	5.5	16.8	66.2	0.2	16.9
Durban North	2.9	23.2	65.9	0.0	10.9
Durban Outer West	3.1	3.5	76.5	2.2	17.8
North Coast	3.7	40.3	47.1	0.0	12.6
South Coast	9.6	58.8	33.4	2.0	0.9
PMB-Midlands	11.3	12.5	70.7	1.6	15.2
Zululand-Vryheid	9.4	24.7	53.8	2.3	19.3
Maputaland	3.4	29.8	51.9	0.3	18.0
East Griqualand	5.7	6.7	81.3	0.0	12.0
Total	100	28.0	54.7	3.0	14.3

Source (Rule *et al*., 2001:53)

Leisure trips proved to be the main reason domestic tourists travelled to the Drakensberg (see Table 6.10). Visiting nature reserves was the second most popular activity among travellers to KwaZulu-Natal destinations (Rule *et al*., 2001:58). The Drakensberg and East Griqualand region were the second most

* For more information about the twelve tourism regions in KwaZulu-Natal see Appendix 4.

popular foreign tourist destinations in KwaZulu-Natal in 2001, with 36 per cent visiting the Drakensberg region (Tourism KwaZulu-Natal, 2003).

The Vergelegen Nature Reserve forms part of the Ukhahlamba Drakensberg National Park. Travellers, who are being taken on a guided tour of the Park, may derive a "forced / involuntary" benefit from the alien vegetation clearing project in the form of a changed view. Residents of the tribal areas surrounding the site collect firewood in the area.

While moist upland grassland is found on the site, it was assumed that the non-user population would be trivial as this vegetation type is relatively well conserved within neighbouring reserves.

The background research mentioned previously was used to estimate the target population and numbers of the different user types in the Underberg area. The proportions per user group selected for administering the questionnaires are shown in Table 6.11.

Table 6.11: Guideline proportions for questionnaire administration: Underberg

User group description		**%**
Residents	African	52.0
	Coloured	0.8
	Indian / Asian	0.4
	White	26.8
Tourists	Domestic	18
	Foreign	2

6.4.2 SAMPLE SIZE

As already mentioned there are many aspects to consider in sample design; the sample size being one. The statistical test of significance will almost certainly be undermined should the sample size be smaller than the minimum (Hair *et al*., 1998). In order to be acceptable a sample must be representative of the entire target population.

There are several approaches to determining the sample size. These include using published tables and applying formulas to calculate the sample size.

Published tables provide the sample size for a given set of criteria. In Table 6.12 a heterogeneous population is assumed.

Table 6.12: Sample size for ± 5% precision levels where the confidence level is 95% and p = 0.5* (SRS)

Size of population	Sample Size** (n) for Precision (e) of ±5%
500	222
1 000	286
2 000	333
3 000	353
4 000	364
5 000	370
6 000	375
7 000	378
8 000	381
9 000	383
10 000	385
15 000	390
20 000	392
25 000	394
50 000	397
100 000	398
>100 000	400

Source: Israel (2003)

*This assumes a 50 / 50 split on the variable. These sample sizes would be smaller for more homogenous samples (see Section 6.2.3).

**The equation used to calculate the sample sizes in Table 6.12 is presented below. A 95 per cent confidence level and maximum variability of p = 0.5 are assumed.

$$n = \frac{N}{1 + N(e)^2} \qquad (6.1)$$

where:

n = the sample size.

N = the population size.

e = the level of precision (0.05).

The figures in Table 6.12 indicate that a researcher can be 95 per cent confident that the results in the population will be the same as the sample plus or minus the sampling error (assuming that SRS has been used to select the source).

Another approach that can be followed to determine sample size is the application of one of several formulas. Cochran's formula (Cochran, 1977) is used more often than other approaches (Bartlett, Kotrlik and Higgins, 2001:44). This formula is used to compute the sample size in this study.

As a starting point for respondent selection it was assumed that individuals with a demand for the biodiversity services, available at the two urban sites, namely Port Elizabeth Driftsands and Worcester, would locate themselves at some stage in a given year within a 5-kilometre radius of these sites. Due to the rural nature of the Underberg site, it was assumed that individuals with a demand for the biodiversity services available at this site would locate themselves at some stage in a given year within a 15-kilometre radius of the site. A second decision made with respect to sample design was to set its size at 2 per cent of the preliminary estimated target populations. Given the available budget and time constraints this size was the maximum that could be surveyed. These preliminary estimates were approximate and are shown in Table 6.13 below.

Table 6.13: Sample size based on user population estimates

Site	Local municipality	Estimates of number of households in municipality	Estimates of number of households within radius	Sample size of households at 2% of sample population
Port Elizabeth Driftsands	Nelson Mandela Metropolitan Municipality	260 798	17 287	345
Underberg	Kwa Sani Municipality	4 654	1 200	24
Worcester	Breede Valley Municipality	16 448	10 441	209

Source: Stats SA (2003) and own calculations

The sample sizes were re-examined in the light of statistical theory with respect to random sampling with continuous data (Cochran, 1977). It is a two-stage theory (see Equations 6.2 and 6.3 below).

$$n_o = \left(\frac{(z_{\alpha/2} s)}{(r\bar{Y})} \right)^2 \qquad (6.2)$$

where:

n_o = first approximation of n.

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

s = is the estimation of the standard error in the population. To estimate the standard error, Cochran (1977) used the result of a pilot study. The standard error of the pilot study carried out on the Albany site was R68.35 (see du Plessis, 2003).

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

$\overline{Y}$ = sample mean

Sample sizes are assumed to be normally distributed. Normal distributions, also called Gaussian distributions, are symmetric and are usually represented by a bell-shaped curve (Gujarati, 2003:887). The shape of the curve implies that for a large population of independent random numbers, the majority of the population are concentrated in the middle, and the frequency tapers off at higher and lower values.

In order to populate these formulas, the relevant mean and standard deviation statistics were needed. Estimates of these values were obtained from a pilot study that was carried out on the Albany site[18] in 2003 (see du Plessis, 2003). The mean was calculated to be R75.76 while the standard error / standard deviation came to R68.35. It was assumed that the sample mean WTP for each of the selected sites would vary within 10 per cent of the real mean and with a 95 per cent confidence level.

Thus:

$$n_o = \left(\frac{(1.96 * 68.35)}{(0.1 * 75.76)}\right)^2$$

$$= 312.69$$

Therefore, the required sample size is 313. However, since this sample size exceeds 5 per cent[19] of the Underberg population (1 200*0.05=24), Cochran's (1977) finite population correction formula should be used to calculate the final

[18] The Albany site's data was used as this site had the lowest reported standard error of the six sites surveyed in the du Plessis (2003) study.

[19] The finite population correction factor has very little effect on the sample size when the sample is small relative to the population, but should be applied when the sample is large relative to the population.

sample size for this site. The sampling size equation solving for the new sample size when taking the finite population correction factor into account is:

$$n = \frac{n_o}{1+\left(\frac{n_o}{N}\right)} \qquad (6.3)$$

$$n = \frac{313}{1+\left(\frac{313}{1200}\right)}$$

$$= 248$$

The minimum required sample sizes for the three sites in terms of Cochran's (1977) method are shown in Table 6.14. These sample size estimates are based on the preliminary target population estimates (which was the actual reference used for determining the sample size).

Table 6.14: Preferred sample sizes using random sampling theory

Site	Estimates of number of households	Minimum recommended sample size of target population	Actual sample size of respondents
Port Elizabeth Driftsands	17 287	313	502
Underberg	1 200	248	260
Worcester	10 441	313	220

The minimum required sample sizes (Table 6.14) were exceeded with respect to the Port Elizabeth and Underberg sites, but not met for the Worcester site. The main impact of the latter failure was to undermine the significance of the WTP function estimates for this site (see Chapter Eight).

6.5 CONCLUSION

Sample design is one of the most important aspects of a contingent valuation study. The aim of the population sample selection was to achieve representative and unbiased samples. Of the 274 WfW sites identified, a sample of three was selected for immediate evaluation.

At the three WfW project sites it proved impossible to identify the exact user populations. The sample user population was estimated using secondary sources, and sample selection was delegated to the interviewers. In an attempt to keep costs within the budget provided, the sample sizes were set at 2 per cent of the target population. This sample size was larger than indicated for the Port Elizabeth and Underberg sites in terms of Cochran's (1977) formula. However, given the preferred significance levels used in this study, the sample size was smaller than indicated by statistical theory at the Worcester site. Only the Port Elizabeth sample size was larger than indicated in terms of the recommendations made in the published table (see Table 6.12).

Chapter Seven discusses selected issues relating to the administration of the CVM surveys.

CHAPTER SEVEN
ADMINISTRATION OF THE QUESTIONNAIRE / SURVEY

7.1 REQUIREMENTS

A well-designed survey instrument is crucial should accuracy and validity in a contingent valuation study wish to be achieved. As such, an attempt was made to follow as many of the NOAA recommendations as possible (see Appendix 2), given the budget and time constraints.

One of the guidelines mentioned in the NOAA report is that the survey instrument should be carefully pre-tested (Arrow *et al*., 1993). To meet this requirement a series of focus group interviews were carried out in order to develop and test different sections of the questionnaire. These interviews focused primarily on the best manner to ask the WTP questions. After the revisions to the WTP questions and the questionnaire in general, as guided by the focus groups, the questionnaire was pre-tested in the Port Elizabeth area. The pre-test showed the need to make certain modifications to the language used in the questionnaire. It was also used to approximate the time needed to complete each survey and to test for the presence of different types of biases.

After the required modifications were made, training of the interviewers commenced. Interviewers were trained and educated about the sites in order to limit information bias. Interactive group discussions and role-playing sessions, in which one trainee took the role of the interviewer and another played the role of the respondent formed part of the training sessions.

The finalised questionnaire was administered in the field from July 2005 to October 2005. Personal interviews were used to conduct the survey in line with the recommendations of the NOAA panel's report (Arrow *et al*., 1993). Interviewers were charged with the responsibility of ensuring that the sample selections made at the sites were representative. Interviewers were provided with the following guidelines to assist them with carrying out this task:

- The proportions of user groups within the respondents were to match those estimated for the target population (see Chapter Six); and
- All of the suburbs within a 5-kilometre radius were to be covered for the urban sites, while all communities within a 15-kilometre radius of the Underberg site were to be covered.

Interviewers were asked to ensure that the concepts were properly understood, in an effort to minimise invalid and non-responses. Photographs of different vegetation types were used in the administration of the questionnaire, to point out the differences between the different vegetation types (see Appendices 7 to 9 for examples). A map indicating the location of the WfW sites was also used in the administration of the questionnaire (see Appendix 6 for an example).

7.2 KNOWLEDGE AND INFORMATION

An important element of a contingent valuation survey is the respondent's knowledge and information about the service that he / she has been asked to value. The term "biodiversity loss" was not used in the survey because there was no specific loss or gain of species that could be identified at the sites and because pilot trials conducted by du Plessis (2003) showed that there was uncertainty amongst the public over the meaning of the term. For the survey, it was decided that the following information be conveyed to the respondents:

- The concept "biodiversity" was redefined in terms of the indigenous vegetation found at every site. The questionnaire explained the biodiversity implications of WfW activities in simple terms that it was hoped the respondent would understand.

- *Responsibility of payment towards biodiversity preservation*: The interviewed household member was required to answer on behalf of his / her household.

- *The nature of the public good*: Removing alien invasive species and restoring displaced indigenous species by WfW project teams was defined as the public good / service to be rendered. It was argued that through these operations the biodiversity status at the relevant site would be improved.

- *Payment for the preservation of biodiversity*: WfW activities remove alien invasive vegetation and restore indigenous vegetation. A financial contribution was requested from residents and tourists in order to ensure that these activities continue. Residents were informed that this would take the form of a fee similar to municipal service levies, while tourists were informed that they would be required to pay a tourist levy.

7.3 QUESTIONNAIRE (See Appendix 5)

A pre-coded questionnaire was prepared with contingent valuation questions, the design of which was undertaken with reference to the recommendations mentioned in Chapter Four (see Appendix 5 for an example). The questionnaire used to conduct the contingent valuation comprised of three sections. The first section of the questionnaire attempted to obtain demographic information (age, education level, income, etc.) from the respondent. This information was used to test the theoretical validity of the hypothesis that the WTP average was a valid estimate for the sample population.

The second section of the survey instrument presented the valuation scenario. Respondents were told that additional taxes would be needed to raise the revenue necessary to fund the WfW Programme. The payment question was phrased as a referendum on the ballot. Should the referendum result in a majority of “yes” votes, the Programme would be funded through an increase in income tax; otherwise the proposal would be abandoned, and no additional tax / levy would be imposed on the respondents. The tax amount was varied across households to mitigate starting point bias, and respondents were asked whether they would vote against or in favour of the Programme at that cost to their household. This section also attempted to elicit respondent’s vegetation preferences and their knowledge of the WfW Programme.

The final section captured information about the respondent, namely the respondent’s understanding of the key WTP question. Furthermore, the interviewer was also required to capture certain potentially sensitive, but easily observable demographic information, such as the respondent’s race and gender.

The questionnaires consisted of 20 questions. The number of questions was kept to a minimum so as not to impose excessively on respondents and induce respondent fatigue. A balance had to be struck between providing sufficient information for respondents to understand the problem being researched and minimising the time imposition on them. These questions are described below.

Questions 1 and 1.1

Question 1 asked if the respondent was a resident or a visitor. Should the respondent have indicated that he / she was a visitor a follow-up question, Question 1.1 was then asked. Question 1.1 attempted to determine the geographical area from which the respondent originated. It was expected that permanent residents would have a stronger desire than visitors to conserve the indigenous vegetation. It was thought that visitors, especially international tourists, would not have as high a willingness to conserve a specific site, where the WfW Programme is removing alien invasive vegetation, as they had many alternative options to visit.

Questions 2 and 3

Question 2 asked the respondent to divulge his / her age, while Question 3 asked the respondent to divulge the average number of people living in the household of which he / she is a member. The inclusion of these questions was motivated by a desire to test statistically whether or not age and household size explained differences in WTP.

Question 4

Question 4 sought the highest level of education that the respondent had attained. Individuals who had attained higher education levels were expected to be more aware of and sensitive to the ecological benefits associated with the preservation of indigenous vegetation. Further, as individuals who had attained higher education levels would be expected to have more income and knowledge at their disposal, it was hypothesised that they would be willing to pay more for the preservation of indigenous vegetation.

Question 5

Question 5 asked what the respondent's level of income is. It was hypothesised that individuals with higher annual incomes would be willing to pay more towards the protection of the relevant environmental resource than low-income earners, simply because their budgets allowed for this.

Question 6

Question 6 asked the respondent to estimate the value of any houses and / or land owned by the household to which the respondent belongs. It was hypothesised that households who owned more expensive properties or houses would be in a better position to pay for the preservation of indigenous vegetation.

Question 7

Question 7 asked the respondent to rank his / her preference for various vegetation types. The purpose of this question was to reinforce the knowledge of the different vegetation types, both indigenous and alien, to the respondent. It was hypothesised that the higher the respondent rated indigenous vegetation, the higher the respondent's WTP was likely to be.

Questions 8 and 9

Questions 8 and 9 pertained to the WfW Programme. Question 8 tested respondents' prior knowledge of the WfW Programme. Question 9 was an interactive question and the interviewer's responsibility was to fill in the gaps in the respondent's knowledge. Specific knowledge about biodiversity was excluded, on the basis that it is a complex concept (Gowdy and Carbonell, 1999). Respondents with knowledge of the WfW Programme and its objectives were expected to be willing to pay more than uninformed individuals, because of their understanding of the connection between indigenous vegetation and the health of the ecological system.

Question 10

Question 10 asked what the respondent was willing to pay to finance the national WfW Programme based solely on his / her preference for indigenous vegetation over alien vegetation. The main goal of a contingent valuation survey is to determine each respondent's WTP. The payment vehicle was in the form of an increase in the respondent's income tax if he / she was a resident, or in the form of a levy, if the respondent was a tourist. The annual tax to be paid was over and above what the respondents already paid and was specifically to fund the removal of invasive alien vegetation and the rehabilitation of indigenous vegetation. The interviewers were asked to make sure that respondents were mindful of their budget constraints in answering this question. The double bound dichotomous choice method was used to elicit the WTP as this method simplifies the cognitive task faced by respondents in making such bids.

Question 11

Question 11 was a follow-up question on possible zero responses to Question 10. The respondents who stated that they would not pay anything towards the Programme were asked for their reasons for this response. This question was included as it is essential to determine whether or not a zero WTP is a protest against the payment collection system or scenario set rather than a real bid.

Question 12

Question 12 was a follow-up on a specific answer provided to Question 11. Respondents who indicated that they preferred alien vegetation to indigenous vegetation, were asked what they would be willing to pay to increase alien vegetation coverage in South Africa.

Question 13

Question 13 tested respondents' prior knowledge of the WfW Programme operations at the particular site in question.

Question 14

Question 14 asked respondents for information about the frequency with which they use the site. The higher the frequency, the higher the WTP was expected to be.

Question 15

Question 15 asked what the respondent was willing to pay to finance the site-specific WfW Programme based solely on his / her preference for the indigenous vegetation over the alien vegetation of the relevant area. The payment vehicle was in the form of a levy. Depending on the respondent's answer to Question 1, the levy would either be in the form of a tourist or municipal levy. The annual levy to be paid was over and above what the respondents already paid to the municipality (in the case of local residents) and was specifically to fund the removal of invasive alien vegetation and the rehabilitation of indigenous vegetation.

Question 16

Question 16 was a follow-up question on the possible zero responses to Question 15. As was the case in Question 11, respondents who stated that they would not pay anything were asked for their reasons for this response.

Question 17

Question 17 was an open-ended question in which respondents were invited to raise any other issues related to the research being undertaken. The purpose of this question was to highlight issues affecting WTP that were not covered in the questionnaire.

Question 18

Question 18 asked the interviewer to make a subjective judgement regarding the respondent's understanding of the research question after the completion of the survey.

Questions 19 and 20

Questions 19 and 20 asked the race and gender of respondents. Their inclusion was motivated by a desire to test if race and gender explained differences in WTP.

7.4 SURVEY ADMINISTRATION OBSERVATIONS

As far as possible, every effort was made to provide respondents with realistic and credible information about the contingent market. Preferential treatment of indigenous vegetation was avoided, by not listing it as a first option.

Respondents were made aware of substitutes available for the indigenous vegetation at the site. Respondents were also informed that the alternative to indigenous vegetation was alien vegetation.

Respondents' WTP to prevent the possible future increase in alien vegetation coverage, up to a point where indigenous vegetation and biodiversity at that site would be compromised, was determined using a pre-coded questionnaire. The double bound dichotomous choice method was used to elicit the respondent's WTP amount. The starting bid amount in Questions 10 and 15 was varied to the respondents. There were a total of 12 bid sets. Initial bid levels ranged from R2 to R90.

The questionnaire also contained an explanation concerning the mechanism through which payments would be collected (the bid vehicle). It was stated that tourists would be required to pay a tourist levy. Residents would be required to pay additional income tax or municipal levies depending on the answers they had provided to Questions 10 and 15. These bid vehicles were seen as realistic to respondents. Money raised through the additional income tax payment or municipal and tourist levies were to be used to provide funds for WfW activities.

The interviewers were required to remind respondents that spending more money on the preservation of indigenous vegetation would mean they would have less money to spend on all other goods and services, i.e. that they had to operate within their respective budget constraints. This reminder was given in an attempt to reduce mental account bias.

In an attempt to reduce embedding bias respondents were asked their WTP for WfW activities at the specific site, as well as for national WfW activities in South Africa. This served as a reminder that their WTP for WfW activities at one site did not include their payment for other important environmental resources. Interviewers were also required to remind respondents that the WfW Programme was only one of many natural resource conservation projects in South Africa and the World.

7.5 CONCLUSION

In this chapter the design and composition of the questionnaire was discussed. Students, ranging from undergraduate to Master's level, administered the surveys. Every effort was made to ensure consistency in generating the same information bases for decision making and eliciting authentic responses.

The data gathered for this study are intended to provide values for the preference for indigenous vegetation at three WfW sites, namely Port Elizabeth Driftsands, Worcester and Underberg. Chapter Eight analyses the contingent valuation results obtained at the three WfW sites.

CHAPTER EIGHT

THE SURVEY RESULTS, THEIR VALIDITY AND RELIABILITY

8.1 INTRODUCTION

Chapter Eight presents the results of the survey undertaken. The socio-economic profiles of the respondents are reported as are their WTP bids at the three sites surveyed. As mentioned previously, contingent valuations are subject to numerous biases and, for this reason, need to be subjected to tests for validity and reliability. Various statistical models are typically utilised for this purpose, namely the OLS, Tobit, Logit and Probit models. The statistical methods used in this study are also described. The data were collected during the period July 2005 to October 2005.

8.2 DESCRIPTIVE STATISTICS

8.2.1 SAMPLE INFORMATION

Non-response rates of 20 –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 and Carson, 1989). The non-response rate of the current study thus falls well within this norm. A total of 959 valid responses were obtained from the total of 982 administered questionnaires. Most of the incomplete questionnaires were due to the fact that respondents refused to provide interviewers with information they considered confidential (especially annual pre-taxed income). It appears that the respondents' reluctance to divulge this information was in part due to the interview technique used. The revealed estimated sample sizes and valid responses are shown in Table 8.1.

Table 8.1: Number of questionnaires completed and valid responses

	Port Elizabeth	Underberg	Worcester	Total
Questionnaires completed	502	260	220	982
Valid responses	493	259	207	959

As would be expected, in view of the composition of the target population (see Chapter Six), most of the people interviewed were residents. Visitors to the area accounted for approximately 10.5 per cent of all respondents (all sites) (see Table 8.2).

Table 8.2: Respondent categories as proportions of the valid responses

User Category	All sites	Sites		
		Port Elizabeth	Underberg	Worcester
Resident	89.47%	92.09%	81.85%	92.75%
Tourist	10.53%	7.91%	18.15%	7.25%

The proportions of questionnaires actually administered to the various user groups are shown in Table 8.3. The proportions of the different user groups included in the sample differed slightly from those of the estimated target population. For example, more Africans were included because they were found in greater concentrations than had been anticipated in the relevant targeted areas.

Table 8.3: Actual proportions of user groups selected to answer questionnaires at the three sites in terms of race

Race	PE guideline %	PE actual %	Underberg guideline %	Underberg actual %	Worcester guideline %	Worcester actual %
African	46.0	48.48	52.0	51.35	18.35	31.40
Other	44.0	43.61	28.0	30.50	71.65	61.35
Tourists	8.0	7.91	20.0	18.15	8.0	7.25
Subsistence users / Non-users	2.0	*	-	-	2.0	*

* Captured in the racial demographics of residents

8.2.2 SOCIO-ECONOMIC PROFILES

The socio-economic characteristics of the respondents are shown in Table 8.3 and Figures 8.1 and 8.2. Approximately 50 per cent of all respondents were African (see Figure 8.1).

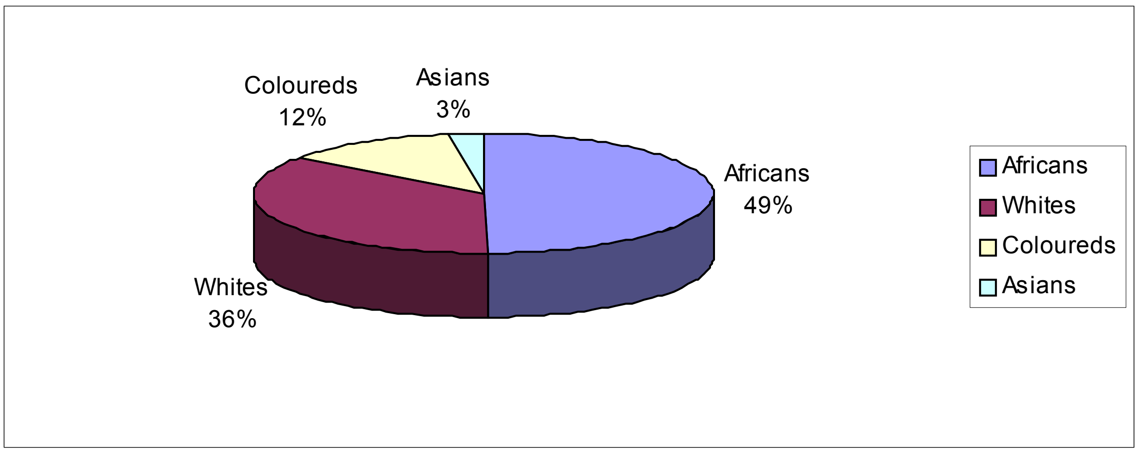


Figure 8.1: Race of respondents (total for Port Elizabeth, Underberg and Worcester)

Although Africans constitute approximately 79 per cent of the South African population, (Stats SA, 2003) in the Worcester area there is a particularly large coloured community and in the area surrounding the Port Elizabeth Driftsands site there are significant white and coloured communities (see Chapter Six).

Figure 8.2 shows that 53 per cent of respondents at the three sites were male.

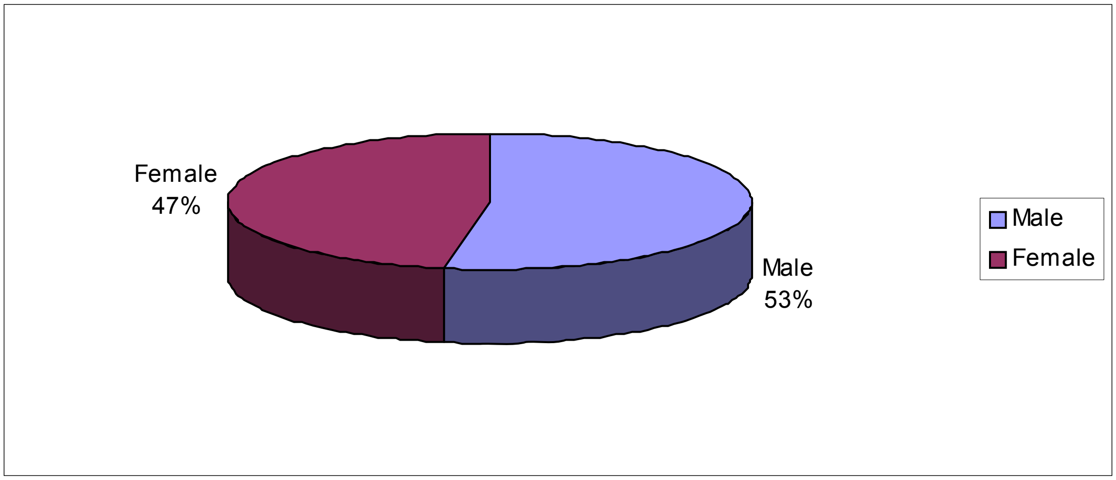


Figure 8.2: Gender of respondents (Port Elizabeth, Underberg and Worcester)

Household size is defined as the "average number of people living in each household where household is defined as a person, or a group of persons, who occupy a common dwelling (or part of it) for at least four days a week and who provide themselves jointly with food and other essentials for living" (Stats SA, 2003). Household size ranged between 1 and 15 people. Households with between two and four members accounted for more than 58 per cent of the total. About 6.4 per cent of respondents lived alone, but more than 13.3 per cent stated that they lived in households consisting of more than seven people (see Table 8.4).

Table 8.4: Proportions of sample responses – selected socio-economic variables

Variable	Classes	All sites	Sites		
			Port Elizabeth	Underberg	Worcester
Age	16-34	45.67%	42.39%	52.12%	45.41%
	35-64	50.57%	53.14%	44.02%	52.66%
	65+	3.75%	4.46%	3.86%	1.93%
	Total	**100.00%**	**100.00%**	**100.00%**	**100.00%**
Household size	1	6.36%	4.67%	10.42%	5.31%
	2-4	58.29%	57.00%	54.44%	66.18%
	5-6	22.00%	24.95%	17.76%	20.29%
	7+	13.35%	13.39%	17.37%	8.21%
	Total	**100.00%**	**100.00%**	**100.00%**	**100.00%**
Income in Rands	0	4.17%	3.04%	8.88%	0.97%
	1-17500	29.72%	21.30%	48.65%	26.09%
	17501-25000	16.16%	18.05%	6.18%	24.15%
	25001-60000	14.91%	17.44%	8.88%	16.43%
	60001-90000	9.59%	11.97%	7.72%	6.28%
	90001-120000	7.61%	8.32%	6.56%	7.25%
	120001-150000	4.07%	4.46%	3.86%	3.38%
	150001-180000	3.34%	3.85%	2.70%	2.90%
	180001-210000	1.77%	2.03%	1.93%	0.97%
	210001-240000	2.19%	2.64%	0.77%	2.90%
	240001-300000	1.98%	2.03%	0.39%	3.86%
	300001-350000	2.09%	1.83%	2.32%	2.42%
	350001-500000	1.56%	2.03%	0.39%	1.93%
	500001 +	0.83%	1.01%	0.77%	0.48%
	Total	**100.00%**	**100.00%**	**100.00%**	**100.00%**
Property value in Rands	0	21.48%	23.12%	23.94%	14.49%
	1-50000	23.98%	13.59%	40.54%	28.02%
	50001-100000	12.20%	17.65%	2.32%	11.59%
	100001-200000	8.13%	11.97%	1.93%	6.76%
	200001-500000	11.57%	11.56%	6.56%	17.87%
	500001-1000000	12.30%	11.36%	15.06%	11.11%
	1000001-1500000	4.59%	6.90%	3.09%	0.97%
	1500001-2000000	2.71%	2.64%	3.86%	1.45%
	2000001 +	3.02%	1.22%	2.70%	7.73%
	Total	**100.00%**	**100.00%**	**100.00%**	**100.00%**

The respondents (for all sites) had an average of almost twelve years of education (see Table 8.6). Of the respondents 29.63 per cent had not obtained a Grade 12 qualification, 37.43 per cent had obtained a Grade 12 qualification and 32.64 per cent had tertiary qualifications in the form of diplomas, degrees or postgraduate degrees (see Table 8.4). On the whole, the educational level of respondents appeared to be higher than would be representative of the general population in the three provinces in which the surveys were conducted. The higher than expected educational level observed in the Port Elizabeth Driftsands sample could, however, be due to the presence of the Nelson Mandela Metropolitan University close to the site. Data obtained from the 2001 Census indicates that 24.2 per cent (Stats SA, 2003) of residents living within a 5-kilometre radius of the Port Elizabeth Driftsands site had obtained a tertiary education.

More than half of all respondents (54.95 per cent) reported that they were unfamiliar with the WfW Programme in South Africa (see Table 8.5), which is consistent with the findings of the du Plessis (2003) study. Only 41.5 per cent of respondents were familiar with the WfW Programme in their region, while 58.5 per cent of respondents were unfamiliar with it. Combining the responses of questions 8 and 13 of the questionnaire (on familiarity with the Programme in South Africa and the specific site, respectively) reveals that the percentage of respondents who replied affirmatively to both questions was only 27.42 per cent. This indicates that a minority of respondents were well informed about the WfW Programme. The Worcester site deviated from this trend, in that almost half of the respondents (45.41 per cent) knew about the Programme.

Table 8.5: Proportions of respondents knowledgeable of the WfW Programme

Variable	Classes		Sites		
		All sites	**Port Elizabeth**	**Underberg**	**Worcester**
Familiarity with WfW - RSA	Yes	45.05%	44.22%	40.15%	53.14%
	No	54.95%	55.78%	59.85%	46.86%
	Total	**100.00%**	**100.00%**	**100.00%**	**100.00%**
Familiarity with WfW - Site	Yes	41.50%	42.80%	23.17%	60.87%
	No	58.50%	57.20%	76.83%	39.13%
	Total	**100.00%**	**100.00%**	**100.00%**	**100.00%**
Main Objectives	Person knows 2 or more aims	9.07%	4.87%	9.65%	17.87%
	Person knows 0 - 2 of the aims	90.93%	95.13%	90.35%	82.13%
	Total	**100.00%**	**100.00%**	**100.00%**	**100.00%**
Understanding	Excellent	13.24%	10.34%	6.56%	28.50%
	Good	30.24%	33.27%	25.10%	29.47%
	Average	31.60%	35.09%	31.27%	23.67%
	Poor	16.16%	16.63%	21.24%	8.70%
	Very poor	8.76%	4.67%	15.83%	9.66%
	Total	**100.00%**	**100.00%**	**100.00%**	**100.00%**

Further indication that respondents are generally poorly informed about the WfW Programme is highlighted by the fact that only nine per cent could name more than two of the Programme's objectives (see Table 8.5). However, the majority of respondents were rated as having an average or above understanding of the research question after completion of the survey.

The age of respondents ranged from 16 to 82 and the average respondent was about 38 years old (see Table 8.6). Despite having the oldest respondent, Underberg had the lowest mean respondent age (34). Port Elizabeth had the oldest mean respondent age (38).

Table 8.6: Statistics of selected explanatory variables

Statistics	All sites	Port Elizabeth	Underberg	Worcester
Age (Years)				
Mean	38.12826	39.25355	36.79845	37.11594
Standard deviation	13.41832	13.44178	13.9367	12.53717
Minimum	16	19	16	18
Median	36	38	34	36
Maximum	82	78	82	68
Household size				
Mean	3.968717	4.227181	4.174419	3.89372
Standard deviation	2.203873	1.964396	2.511569	1.762145
Minimum	1	1	1	1
Median	4	4	4	4
Maximum	15	12	15	10
Income (R)				
Mean	73524.5	82505.07	53527.13	76618.36
Standard deviation	105128.8	109937	94241.41	103475.6
Minimum	0	0	0	0
Median	26250	47500	8750	26250
Maximum	750000	750000	750000	750000
Worth of fixed property (R)				
Mean	355656.9	329107.5	336337.2	441062.8
Standard deviation	621969.6	521647.4	625678.5	806525.9
Minimum	0	0	0	0
Median	75000	75000	25000	75000
Maximum	3000000	3000000	3000000	3000000
Education (Years)				
Mean	11.67727	12.24239	10.4845	11.80676
Standard deviation	3.343093	3.083784	3.757192	3.010314
Minimum	5	5	5	5
Median	12	12	12	12
Maximum	18	18	18	18
Understanding*				
Mean	2.769552	2.720081	3.151163	2.415459
Standard deviation	1.136816	1.01149	1.158801	1.254643
Minimum	1	1	1	1
Median	3	3	3	2
Maximum	5	5	5	5

* Scale:

Excellent	Good	Average	Poor	Very Poor
1	2	3	4	5

The mean household size for all the sites combined was four. A minimum household size of one was recorded at every site. The largest household size of fifteen was found at the Underberg site and the second largest at the Port Elizabeth site (twelve). The reported household sizes are consistent with information obtained from the 2001 Census. For example, the mean household size for Port Elizabeth was found to be 4.227181, while the average household size for Port Elizabeth, according to the 2001 Census was 4.28 (Stats SA, 2003).

The mean income level was found to be R73 524.50 for all the sites combined. The Underberg site had the lowest mean income level (R53 527.13), and the Port Elizabeth site the highest mean income level (R82 505.07). The median income was substantially lower for all the sites combined, and for the separate sites. For all the sites combined, as well as for the Worcester site, the median income level was R26 250. The median income provided a better reflection of the central tendency in income levels at the sites, and was more in line with average income levels in the various provinces, as determined in the 2001 Census. The 2001 Census found the median annual income of working adults aged 15 – 65, in the four wards surrounding the Port Elizabeth Driftsands site, to be R44 938.08.

The average worth of fixed property differed between sites. At the Port Elizabeth and Worcester sites, the median property value was R75 000, while it was R25 000 at the Underberg site.

It was hypothesised that the respondents' education levels and knowledge of the national WfW Programme would be positively correlated, since people who have achieved a higher educational qualification would be expected to be more aware of the ecological benefits resulting from the removal of alien vegetation. The relationship between education levels and knowledge of the WfW Programme is reported in Table 8.7.

Table 8.7: Relationship between education level and knowledge of the national WfW Programme – for the three sites (959 respondents)

Level of knowledge	Less than Grade 12	Grade 12	Tertiary	Total
Person knows none of the aims	19.40%	19.71%	12.3%	51.41%
Person knows 1 of the aims	7.09%	8.13%	7.51%	22.73%
Person knows 2 of the aims	3.02%	6.47%	7.30%	16.79%
Person knows 3 or more of the aims	0.42%	3.13%	5.53%	9.07%
% of entire sample	29.93%	37.43%	32.64%	100.00%

The data shows that the majority of respondents were poorly informed about the objectives of the WfW Programme, but the respondents' education levels and knowledge of the Programme's objectives do exhibit a positive correlation (see Figure 8.3).

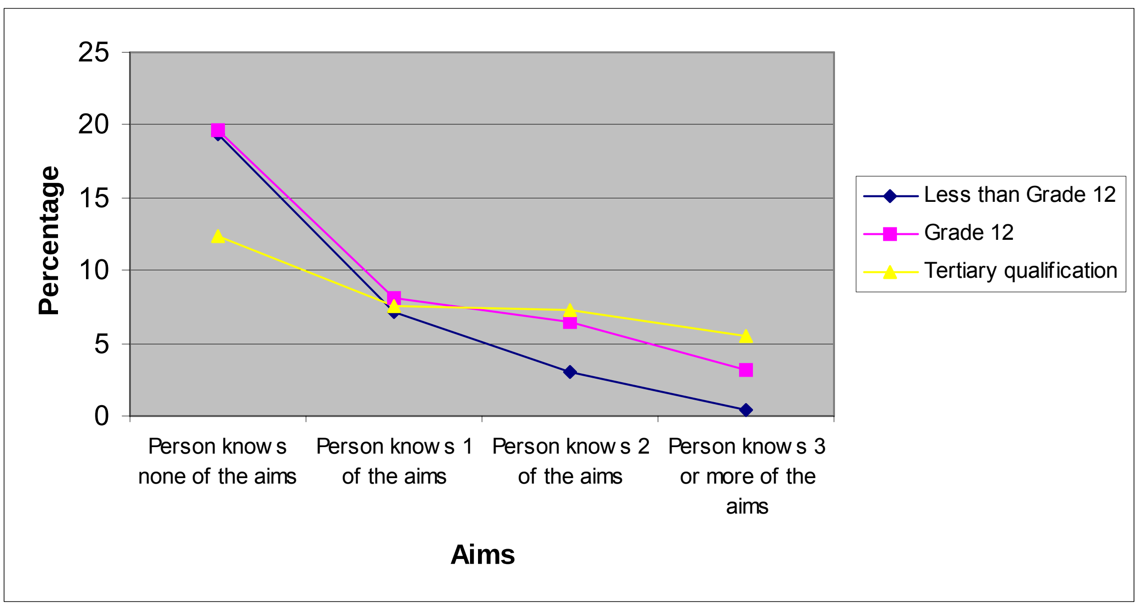


Figure 8.3: Relationship between education level and knowledge of the WfW Programme's objectives

The finding of a positive relation between knowledge of the objectives of the WfW Programme and WTP for alien plant removal is significant. In order to persuade people to be willing to pay for the WfW Programme it will be necessary, *inter alia*, to educate people about the Programme's objectives.

8.3 THE SAMPLE WTP FOR THE NATIONAL WFW PROGRAMME

The willingness of respondents to pay towards the preservation of indigenous vegetation through continued WfW activities at a national level is shown in Tables 8.8 and 8.9.

Table 8.8: The WTP per Rand for the national WfW Programme

Site	Sample size	Mean WTP (R)	Standard deviation of WTP (R)	Minimum WTP (R)	Median WTP (R)	Maximum WTP (R)
Port Elizabeth	493	41.53	48.96	0	27.5	200
Underberg	259	31.44	43.36	0	15	200
Worcester	207	42.18	46.57	0	22.5	150
All sites	959	38.22	47.33	0	22.5	200

The average WTP ranged from R31.44 to R42.18. Worcester respondents had the highest WTP. This finding could be explained in terms of the positive correlation that has been shown to exist between knowledge of the objectives of the WfW Programme and WTP for alien plant removal (see Figure 8.3). At the Worcester site, 20.77 per cent of respondents were willing to pay between R51 and R100, while a further 9.66 per cent were willing to pay up to R200 annually for the national WfW Programme. Despite having the highest mean WTP for the national WfW Programme (R42.18), Worcester's mean WTP for the national Programme was less than its mean WTP for the local WfW Programme of R50.43 (see Table 8.10). Our first reaction to this finding was that it was a contradiction, but the survey team argued otherwise. They argued that the town relies heavily on the surrounding agricultural areas for both direct[20] and indirect employment. For this reason, the respondents' were more willing to contribute to an initiative that improved their employment options than a general one, i.e. they

[20] Schroeder (2002:44) reports that 41 per cent of employed people in the Breede River Valley Municipality work in agriculture.

were paying for a combined good – vegetation rehabilitation plus improved employment opportunities.

The lowest average WTP was recorded at the Underberg site. The median WTP amounts are also reported in Table 8.7. The median is a measurement of central tendency and is computed where half of the observations lie above the median and the other half of the observations lie below the median (Gujarati, 2003:320). The median WTP amounts ranged from R15 to R27.50. Worcester had the highest median of all the sites, namely R27.50. This median is nearer to its average than the median of the other sites and suggests that there were less unusually high or low bids at the Worcester site than there were at the other sites.

The general impression given by the results was that the majority of respondents were willing to pay a significant sum of money to secure the preservation of indigenous vegetation.

A breakdown of the WTP measured at the three sites for the national WfW Programme is shown in Table 8.9 and Figure 8.4.

The majority of respondents (78 per cent) were prepared to pay a levy towards the preservation of indigenous vegetation through continued WfW activities. The highest percentage of zero WTP or zero bids was made at the Underberg site, where close to 29 per cent of all the bids were zero (see Table 8.9 and Figure 8.4). The lowest percentage of zero WTP bids were made at the Worcester site (see Table 8.9).

Table 8.9: Respondents' sample WTP per payment class for the national WfW Programme

Payment class (in Rands)	All sites		Port Elizabeth		Underberg		Worcester	
	Number	%	Number	%	Number	%	Number	%
0	211	22.00%	103	20.89%	75	28.96%	33	15.94%
0-2	3	0.31%	0	0.00%	0	0.00%	3	1.45%
2-5	54	5.63%	21	4.26%	14	5.41%	19	9.18%
5-10	76	7.92%	33	6.69%	24	9.27%	19	9.18%
10-20	93	9.70%	52	10.55%	19	7.34%	22	10.63%
20-25	75	7.82%	35	7.10%	28	10.81%	12	5.80%
25-30	52	5.42%	34	6.90%	12	4.63%	6	2.90%
30-40	64	6.67%	33	6.69%	21	8.11%	10	4.83%
40-50	68	7.09%	34	6.90%	14	5.41%	20	9.66%
50-60	61	6.36%	40	8.11%	13	5.02%	8	3.86%
60-70	24	2.50%	17	3.45%	6	2.32%	1	0.48%
70-80	28	2.92%	17	3.45%	3	1.16%	8	3.86%
80-90	22	2.29%	9	1.83%	6	2.32%	7	3.38%
90-100	42	4.38%	16	3.25%	7	2.70%	19	9.18%
100-200	66	6.88%	34	6.90%	12	4.63%	20	9.66%
200+	20	2.09%	15	3.04%	5	1.93%	0	0.00%

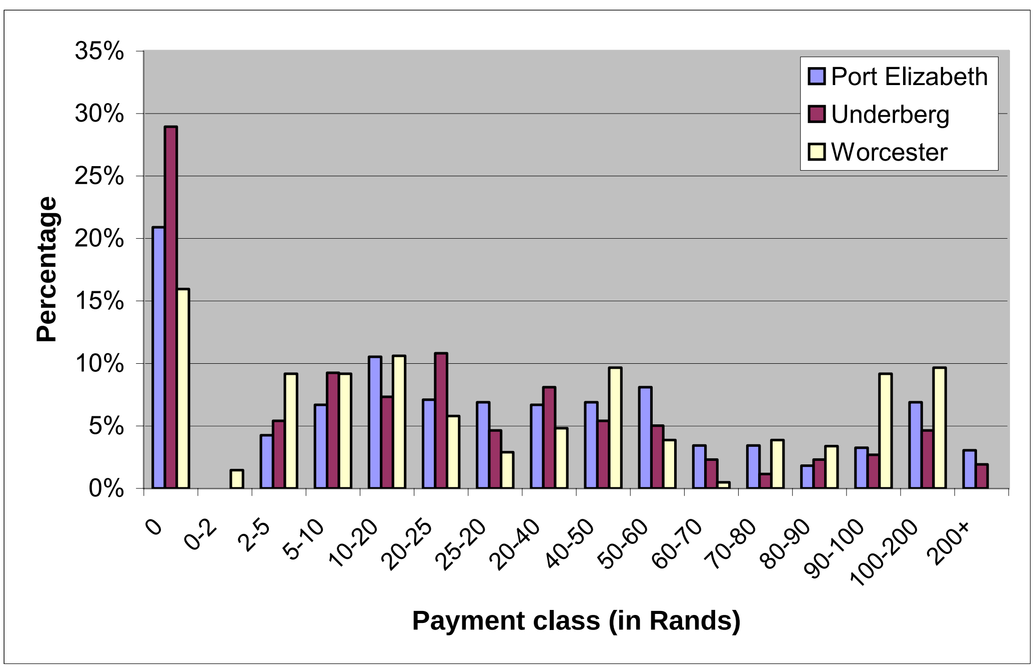


Figure 8.4: Respondents' sample WTP per payment class for the national WfW Programme

8.4 THE SAMPLE WTP FOR THE LOCAL WFW PROGRAMME

The average WTP per site is described in Table 8.10 below.

Table 8.10: The average WTP per site (in Rands)

Site	Sample size	Mean WTP (R)	Standard deviation of WTP (R)	Minimum WTP (R)	Median WTP (R)	Maximum WTP (R)
Port Elizabeth	493	29.32	43.80	0	15	200
Underberg	259	21.03	37.06	0	7.5	200
Worcester	207	50.43	51.04	0	35	150
All sites	959	31.10	45.08	0	15	200

The mean WTP at the Port Elizabeth and Underberg sites was lower than the mean WTP for all the sites combined (see Table 8.10). The mean WTP for the Worcester area was found to be the highest. More than half of the respondents at the Worcester site (53.14 per cent) were familiar with the WfW Programme in South Africa while 60.87 per cent knew about the activities of the local Worcester WfW Programme (see Table 8.5). This contrasts with 45.05 per cent of the respondents at the combined sites level who knew about the national WfW Programme (at all 3 sites), and 41.5 per cent who were familiar with the WfW Programme in their area.

The mean WTP was the lowest in the Underberg area; an expected result as the community is poor, and the unemployment rate high (approximately 31 per cent). The 2001 Census indicates that the age dependency ratio in the Underberg area is high (nearly 42 per cent) (Stats SA, 2003). The age dependency ratio is the ratio of the combined child population (0 – 14 years) and the aged population (over 65 years) to the intermediate age population (15 – 64 years).

The median WTP amounts are also reported in Table 8.10. These amounts ranged from R7.5 to R35; with the lowest median bid being at the Underberg site.

A breakdown of the WTP measured at the three sites is provided in Table 8.11 and Figure 8.5. As was the case with the WTP question for the national WfW Programme, the vast majority of respondents (75.9 per cent) were prepared to pay a levy towards the preservation of indigenous vegetation through continued WfW activities in their regions. Approximately, 41.29 per cent of respondents indicated that they were prepared to pay between R1 and R25, while 13.34 per cent were prepared to pay between R26 and R50, and 13.45 per cent were willing to pay between R51 and R100 a year. Only 13 respondents (1.36 per cent) indicated that they were prepared to pay a levy of more than R200 annually (see Table 8.11).

Table 8.11: Respondents' sample WTP per payment class at the three sites

Payment class (in Rands)	All sites		Port Elizabeth		Underberg		Worcester	
	Number	%	Number	%	Number	%	Number	%
0	231	24.09%	131	26.57%	77	29.73%	23	11.11%
0-2	18	1.88%	6	1.22%	11	4.25%	1	0.48%
2-5	100	10.43%	53	10.75%	25	9.65%	22	10.63%
5-10	106	11.05%	50	10.14%	38	14.67%	18	8.70%
10-20	117	12.20%	59	11.97%	36	13.90%	22	10.63%
20-25	55	5.74%	30	6.09%	12	4.63%	13	6.28%
25-30	36	3.75%	20	4.06%	15	5.79%	1	0.48%
30-40	42	4.38%	27	5.48%	8	3.09%	7	3.38%
40-50	50	5.21%	18	3.65%	8	3.09%	24	11.59%
50-60	39	4.07%	24	4.87%	7	2.70%	8	3.86%
60-70	19	1.98%	11	2.23%	2	0.77%	6	2.90%
70-80	16	1.67%	14	2.84%	0	0.00%	2	0.97%
80-90	23	2.40%	12	2.43%	3	1.16%	8	3.86%
90-100	32	3.34%	6	1.22%	4	1.54%	22	10.63%
100-200	62	6.47%	21	4.26%	11	4.25%	30	14.49%
200+	13	1.36%	11	2.23%	2	0.77%	0	0.00%

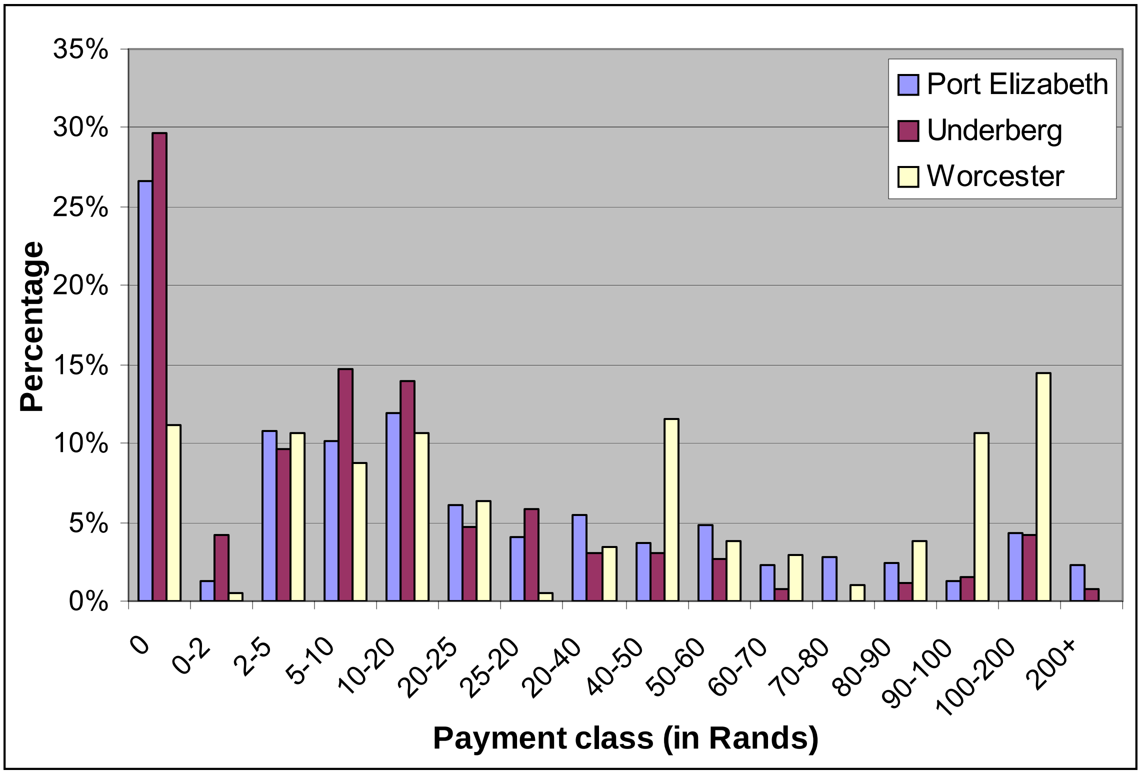


Figure 8.5: Respondents' sample WTP per payment class at the three sites

The highest proportion of zero WTP or zero bids were made at the Underberg site (see Table 8.11 and Figure 8.5). Due to the generally low income per capita, those respondents who were willing to pay towards the preservation of indigenous vegetation at this site were only willing to pay small amounts. For example at this site 28.57 per cent said they could pay up to R10 annually, 13.9 per cent could only afford to pay R20 annually and a further 13.9 per cent were prepared to pay up to R25 (see Table 8.11).

8.5 DISTINGUISHING PROTEST BIDS FROM GENUINE ZERO BIDS

An important step in analysing responses to contingent valuation questionnaires is to check these questionnaires for validity. The two principal categories of responses sometimes deemed invalid and excluded are protest bids of zero and implausibly high bids. Protest bids of zero refer to a situation where a respondent indicates that his / her WTP is zero, not because he has no value for the environmental good or service in question, but because he / she objects to some aspect of the survey. Common objections include a rejection of the contingent valuation market, concern about some attribute of the scenario, the mode of payment (i.e. income tax), and the survey instrument (personal interviews) (Caporossi, 2004:47). Outliers, on the other hand are WTP values that are large when compared to the respondent's income and / or the availability of substitute goods. The presence of outliers may indicate strategic behaviour, or that the respondent has failed to consider his / her budget constraint with due care (McDonald, 2001).

Although the most frequently used approach when dealing with invalid responses is to discard these observations (protest bids of zero and outliers) Carson (1991) notes that this is incorrect from a statistical point of view. Protest bidders are identified from legitimate zero bidders by examining the reasons why respondents refuse to pay for the environmental good or service. Protest bidders were identified in this survey as respondents who indicated that they lacked confidence in the government or municipality to collect and use the levies for the Programme and / or who stated that they already paid enough to the government or municipality. Outliers were identified by the number of standard deviations the response was away from the mean WTP statistic. For the purpose of this study outliers were defined to be those WTP responses that were more than three standard deviations above the mean WTP.

8.5.1 THE NATIONAL WFW PROGRAMME

Of the 959 questionnaires, 748 stated a positive WTP for the preservation of indigenous vegetation, while 211 stated a zero WTP. Respondents who indicated that they did not support the initiative were asked to select from a list of reasons in order to enable the researcher to identify protest zero bids from genuine zero WTP.

An analysis of the zero or protest bids is shown in Table 8.12.

Table 8.12: Zero or Protest Bids for the national WfW Programme

Users' reasons for zero bid	Port Elizabeth	Underberg	Worcester
Cannot afford the levy	37	21	6
Get no or negligible value out of the WfW Programme	6	2	6
Lack of confidence in the government to collect and use levies collected for the use mentioned	4	4	8
Already pay enough to the government	35	13	7
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)	3	1	1
I prefer alien vegetation over natural vegetation	6	12	0
Other	4	10	3
Lack of confidence in the government and Already pay enough to the government	0	3	1
Already pay enough to the government and I do not feel responsible for the vegetation of the area	2	2	1
Cannot afford the levy and Lack of confidence in the government and Already pay enough to the government	0	2	0
Already pay enough to the government and other	0	2	0
Cannot afford the levy and I prefer alien vegetation	0	1	0
Cannot afford the levy and Get no or negligible value out of the WfW Programme and Lack of confidence in the government and Already pay enough to the government	0	2	0
Cannot afford the levy and Already pay enough to the government	4	0	0
Lack of confidence in the government and Already pay enough to the government and I do not feel responsible for the vegetation of the area	1	0	0
Cannot afford the levy and Already pay enough to the government and other	1	0	0

Note: Respondents were allowed to offer more than one reason.

Of the 211 stated zero bids, 118 were identified as genuine zero bids. In 75 cases the zero bids were interpreted as protest bids. There were 18 cases where it was unclear whether the zero bid should be interpreted as a genuine or a protest bid. Although these bids may affect the logistic regression and WTP estimates, the data were not deleted from the sample based on an assumption that valuable information may be lost.

A lack of confidence in the government and an inability to afford the levy / tax were the two main reasons given by most respondents for unwillingness-to-pay.

8.5.2 THE LOCAL WFW PROGRAMME

There were 231 respondents who registered a zero WTP for WfW Programme in their region. Of these 231 zero bids, 129 were identified as genuine zero bids. In 88 cases the zero bids were interpreted as protest bids, but there were 14 cases where it was unclear whether the zero bid should be interpreted as a genuine or a protest bid. The data were not deleted from the sample based on an assumption that valuable information may be lost.

Table 8.13 below provides a breakdown of the reasons why respondents where unwilling to pay for the preservation of indigenous vegetation through the continued activities of the WfW Programme at the three sites.

Table 8.13: Zero or Protest Bids for the three sites

Users' reasons for zero bid	Port Elizabeth	Underberg	Worcester
Cannot afford the levy	34	26	6
Get no or negligible value out of the WfW Programme	5	1	3
Lack of confidence in the municipality to collect and use levies collected for the use mentioned	17	3	4
Already pay enough to the municipality	44	11	2
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)	8	4	2
I prefer alien vegetation over natural vegetation	6	11	0
Other	8	10	3
Lack of confidence in the municipality and Already pay enough to the municipality	0	6	1
Already pay enough to the municipality and I do not feel responsible for the vegetation of the area	1	1	2
Cannot afford the levy and Lack of confidence in the municipality and Already pay enough to the municipality	0	1	0
Already pay enough to the municipality and other	0	1	0
Cannot afford the levy and I prefer alien vegetation	0	1	0
Cannot afford the levy and Get no or negligible value of the WfW Programme and Lack of confidence in the municipality	0	1	0
Cannot afford the levy and Already pay enough to the municipality	6	0	0
Cannot afford the levy and Get no or negligible value of the WfW Programme	1	0	0
Lack of confidence in the municipality and Already pay enough to the municipality and I do not feel responsible for the vegetation of the area	1	0	0

Note: Respondents were allowed to offer more than one reason.

Almost 29 per cent of those respondents who indicated that they were unwilling to pay anything stated that they could not afford to pay any levy due to financial constraints. This figure rose to 33.77 per cent in the case of respondents from Underberg. One of the reasons given for the zero bid was a preference of alien vegetation over indigenous vegetation. More than 14 per cent of the Underberg respondents and 4.58 per cent of Port Elizabeth respondents stated that they were unwilling to contribute to the Programme because of this reason. A common rationale among these specific respondents was that although they realised that indigenous vegetation was important from a conservationist perspective, alien vegetation was more useful to them as firewood and building material. These findings are mirrored in a study conducted by de Neergaard *et al*. (2005).

Port Elizabeth respondents, in particular, felt that they already paid enough to the municipality, as 33.59 per cent cited this reason for being unwilling to contribute to the Programme. A lack of confidence in the municipality accounted for 10.39 per cent of all the zero bids.

8.6 GENERATING PREDICTIVE WTP MODELS AND ASSESSING VALIDITY / GOODNESS OF FIT USING THE OLS AND TOBIT MODELS

Regression models were used in this study to analyse the data gathered at the three WfW sites. Regression models in which the dependent variable is measured by a “yes” or “no” or present or absent response are known as dichotomous, or dummy dependent variable models (Gujarati, 2003:298). They are applicable in a wide variety of fields and are used extensively in survey or census-type data.

One type of analysis is the generation of predictive models and the other is testing for validity. The tests for the validity of the WTP results involve regressing the WTP variables on the other variables expected to influence WTP, and on which information had been collected. These analyses were conducted in order to determine whether the WTP bids were consistent with economic expectations as formulated in terms of other information supplied by the respondents. The statistical models employed for these purposes, namely the OLS and Tobit models, will be briefly described below.

(a) OLS models

OLS models use a least square estimation procedure. They define the best-fitted straight line that relates a dependent variable to several independent variables where the sum of squares of the residuals (SSR) is minimised (Bowerman and O'Connell, 1990).

(b) Tobit models

The Tobit model is known as a censored regression model, that is, a model in which the value of the dependent variable is not available for all observations (Gujarati, 2003:616). The parameters of this model are estimated using the Maximum Likelihood procedure. The Tobit model involves estimating the parameters in such a manner that the probability of observing the given dependent variable is as high as possible (Gujarati, 2003). The Tobit model is preferred to the OLS model for predictive purposes as it only predicts rational (non-negative) WTP values.

8.6.1 WTP ESTIMATES AND THE FITTING OF WTP FUNCTIONS

Observations of the dependent variable were drawn from two sets of information in order to estimate WTP functions for the three WfW sites. Firstly, mid-point WTP values were calculated for both the national WfW Programme and for the WfW activities present at the site. These values were used to fit OLS models to explain the WTP variations. The same data were fitted using a Tobit model, but the dependent variable in this case was restricted to non-negative values. The partial coefficients of OLS and Tobit models measure the changes of WTP per unit change in each explanatory variable.

Three aspects relevant to the validity of the predicted WTP are:

- The sign of the coefficient estimated should be as expected in terms of economic theory.
- Key coefficients in the complete model should be significant.[21]
- The best-fit model to the data should meet certain requirements.

The descriptions of the explanatory variables selected for the purpose of carrying out regression analyses are listed in Table 8.14. Their expected relationships with household WTP are also shown. The explanatory variables were both of a qualitative and of 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 quantitative variables, the mid-point value was taken from each category assigned, for example, income.

[21] In fitting the statistical model to the data that was collected for the three sites, p-values (i.e., the probability values) were calculated. These p-values are used to determine whether the independent variables are statistically significant.

Table 8.14: Description of selected variables in the multiple regression analysis and expectations of the signs of their coefficients

Variable name	Description			Predicted sign in regression model
Dependent variables				
WTP	Amount household would pay to prevent the possible future event of an increase in alien vegetation up to a point where indigenous vegetation would be totally compromised: the amount was taken from the mid-point of each category in both the national and site-specific scenario			
Levy WTP				
Independent variables				
Race	0 1	= =	If respondent belongs to African racial group Otherwise	+
Gender	0 1	= =	If gender of respondent is male Otherwise	-
Res	0 1	= =	If respondent uses site as a tourist Otherwise	+ or -
WFWP	0 1	= =	If respondent knows about the activities of the national WfW Programme Otherwise	-
Alien WW	0 1	= =	If respondent knows about the activities of the local WfW Programme Otherwise	-
Informed	0 1	= =	If respondent is well-informed regarding the aims of the WfW Programme Otherwise	-
Age			Age of respondent	+ or -
House No.			Number of people making up the respondent's household	+ or -
Educ Level			Highest education level attainment of respondent	+
Income			Gross annual pre-tax income of respondent	+
House Val			Approximate worth of any land and / or property owned by the respondent at current prices	+
Understand			Respondent's understanding of the research question after the completion of the survey	+ or -

Reasons for the predicted sign in the multiple regression model are described below.

Race: It was expected that non-African respondents would be willing to pay more towards the preservation of indigenous vegetation than African respondents as they would be expected to have more income at their disposal.

Gender: Female-headed households were expected to have less disposable income available for payment towards the preservation of biodiversity through WfW clearing activities, as these households typically have only one breadwinner, as opposed to male-headed households, where the wife may also contribute to the income.

Res: It was expected that permanent residents would have a stronger desire than visitors to pay for the preservation of indigenous vegetation as their frequency of use would be higher. However, it was argued that visitors might be wealthier than the permanent residents of the area and would thus be willing to pay more towards the protection of the environmental resource than residents, simply because their budgets allowed for this.

WFWP: Respondents with prior knowledge of the national WfW Programme were expected to pay more than uninformed respondents, because of their understanding of the connection between indigenous vegetation and the health of the ecological system.

Alien WW: Respondents with prior knowledge of the activities of the WfW Programme in their region were expected to pay more than uninformed respondents.

Informed: Respondents with a good knowledge of the WfW Programme's objectives were expected to pay more than uninformed respondents.

Age: Middle-aged respondents were expected to earn more than younger or older respondents and were thus expected to be more inclined to pay for the preservation of biodiversity. However, it was expected that younger African respondents would be willing to pay more towards the Programme than their older counterparts, as they would be expected to have attained higher education levels and would therefore be more knowledgeable of the connection between indigenous vegetation and the health of the ecological system.

House No.: It was expected that for every additional member making up the household the WTP would increase. However, it was argued that low-income earners' WTP for the preservation of indigenous vegetation would decline for each additional household member, especially if these members were not economically active.

Educ Level: Respondents who had attained higher education levels were expected to be more inclined to pay for the preservation of biodiversity, as they would be expected to have more income and knowledge at their disposal.

Income: Respondents with higher annual incomes were expected to be willing to contribute more towards the protection of the relevant environmental resource than low-income earners, simply because their budgets allowed for this.

House Val: Respondents owning more expensive properties or houses were expected to be in a better position to pay for the preservation of indigenous vegetation.

Understand: The higher the rating assigned to the respondent following the completion of the survey, the higher the respondent's WTP was expected to be.

The significance of each variable was tested using the null hypothesis. The p-values were used to determine whether to reject the null hypothesis or not. The p-value shows the lowest significance level at which a null hypothesis can be rejected (Gujarati, 2003:136). A significance level of between 5 per cent and 10 per cent ($0.05<p<0.10$) indicates that a variable is weakly significant. A level of significance of between 1 per cent and 5 per cent ($0.01<p<0.05$) indicates that a variable is significant and a significance level of 1 per cent ($p<0.01$) or less indicates that a variable is highly significant. In this study, only variables with a significance level between 0 per cent (0.00) and approximately 10 per cent (0.10) were retained in the reduced models. Log-likelihood ratio tests were used to determine the goodness of fit of the Tobit models, as well as to determine preference between the complete and reduced Tobit models. The nested test was used to determine the preference between the complete and reduced OLS models.

Alternative probability models (Logit and Probit) were also fitted to the data but they were not found to add information that could not be determined from the OLS or Tobit models.

8.6.1.1 Port Elizabeth Driftsands

(a) Estimate of WTP based on the national WfW Programme

The results of fitting the OLS and Tobit models to data based on the willingness of respondents to pay towards the preservation of indigenous vegetation through continued WfW activities at a national level are shown in Tables 8.15 and 8.16.

Table 8.15: The fit of the WTP function for Port Elizabeth Driftsands (national WfW Programme) using OLS and Tobit models – complete model

Dependent variable: WTP								
Model: Complete model								
Method	**Least squares**				**ML - Censored normal**			
	OLS				**Tobit**			
	Coefficient	**Std. Err.**	**t-Statistic**	**p-Value**	**Coefficient**	**Std. Err.**	**z-Statistic**	**p-Value**
Constant	-1027.925	1693.323	-0.607	0.544	118.920	25.439	4.675	0.000
Race	6.875	4.876	1.410	0.159	5.739	5.885	0.975	0.329
Gender	-4.209	4.400	-0.957	0.339	-2.970	5.333	-0.557	0.578
Res	-5.276	8.156	-0.647	0.518	-1.843	9.908	-0.186	0.852
WFWP	-6.226	4.769	-1.306	0.192	-9.016	5.774	-1.562	0.118
Alien WW	-8.143	4.715	-1.727	0.085	-8.608	5.700	-1.510	0.131
Informed	3.345	10.611	0.315	0.753	8.177	12.796	0.639	0.523
Age	-0.652	0.172	-3.784	0.000	-0.954	0.212	-4.494	0.000
House No.	-3.083	1.149	-2.682	0.008	-4.130	1.432	-2.884	0.004
Educ Level	-1.487	0.863	-1.723	0.085	-1.929	1.045	-1.847	0.065
Income	0.032	0.023	1.377	0.169	0.046	0.028	1.639	0.101
House Val	0.008	0.005	1.502	0.134	0.008	0.006	1.290	0.197
Understand	-1.398	2.537	-0.551	0.582	-3.848	3.071	-1.253	0.210
R^2	0.082				0.075			
Adjusted R^2	0.059				0.050			
Log-likelihood					-2212.76			
F-statistic (12.480)	3.58878							
p-Value (F-statistic)	0.00004							

The following features stand out with respect to the fit of the complete OLS and Tobit models:

- All the variables with statistical significance of less than or equal to 10 per cent (0.1) have negative coefficients.
- Variables with a statistical significance of less than 10 per cent in the OLS model are the knowledge of the local WfW Programme (*Alien WW*), *Age*, number of people making up a household (*House No.*) and education (*Educ Level*).
- In the case of the Tobit model, the statistically significant variables are *Age*, number of people making up a household (*House No.*) and education (*Educ Level*).
- Ten out of the twelve explanatory variables in both the OLS and Tobit models yielded expected results (see Table 8.14).

The coefficient of determination, R^2, is a summary measure that tells the researcher how well the sample regression line fits the data (Gujarati, 2003:81). The higher the R^2 the better is the fit of the model to the data. The R^2 of the OLS model is 0.082, which means that 8.2 per cent of the variation in WTP in the sample was found to be due to differences in the independent variables (Table 8.15). Since the size of R^2 can be affected by the number of independent variables in the model (even if many of the variables have no explanatory power) it is desirable to adjust for the number of variables. The adjusted R^2 was found to be 0.059.

The likelihood ratio test determines whether the model, which includes the variables of interest, tells the researcher more about the response variable than the model that fails to include these variables. The likelihood ratio test is based on the difference in the log-likelihood functions for the complete and reduced models. Since the maximum likelihood estimation procedure maximises the log-likelihood function, dropping variables usually results in a smaller log-likelihood (Potgieter, 2004). The question that must be answered is whether the reduction in the log-likelihood is large enough to conclude that the omitted variables are significant.

The likelihood ratio test statistic is given as:

$$\text{Likelihood ratio} = -2\,(L_R - L_C) \tag{8.1}$$

where:
L_R = the log-likelihood value of the reduced model.

L_C = the log-likelihood value of the complete model.

The rejection region at the 5 per cent level of significance is given as:

$$\text{Likelihood ratio} \geq \chi^2_{0.05}(v) \tag{8.2}$$

where:
v = the number of parameters tested.

The complete Tobit model and reduced Tobit model yielded log-likelihood values of -2212.76 and -2223.65, respectively. The log-likelihood ratio statistic value for the comparison of the complete and reduced Tobit models was calculated to be 21.78. This statistic is greater than the χ^2 (chi-square) value corresponding to the upper 5 per cent significance level with eight degrees of freedom, namely 15.507. The complete Tobit model is therefore the preferred one, as the null hypothesis cannot be rejected. There is sufficient evidence to infer that at least one variable that was omitted from the reduced model contributes significant information for the prediction of WTP.

In order to determine which of the complete or reduced OLS models was statistically preferable the null hypothesis was tested that all the coefficients of variables excluded in the reduced model were equal to zero. The test statistic (F-statistic) (Mendenhall and Sincich, 1996) used for this purpose was:

$$F = \frac{(SSE_R - SSE_C)/(k-g)}{SSE_C/(n-(k+1))} \qquad (8.3)$$

where:

SSE_R = the sum of squared errors for the reduced model.

SSE_C = the sum of squared errors for the complete model.

$k - g$ = the number of parameters specified in the null hypothesis.

$k + 1$ = the number of parameters included in the complete model.

n = the sample size.

The F-statistic value of 1.9722 was found to be higher than the critical value of 1.9577. For this reason the null hypothesis was rejected and it was thus deduced that the complete model was the preferred one for predictive purposes.

The variables of the complete model, with significance levels of close to or less than 10 per cent were used in the reduced OLS and Tobit models (see Table 8.16). The results from these models yielded an improved statistical significance for the *Alien WW* and *House No*. variables.

Table 8.16: The fit of the WTP function for Port Elizabeth Driftsands (national WfW Programme) using OLS and Tobit models – reduced model

Dependent variable: WTP								
Model: Reduced model								
Method	**Least squares**				**ML - Censored normal**			
	OLS				**Tobit**			
	Coefficient	**Std. Err.**	**t-Statistic**	**p-Value**	**Coefficient**	**Std. Err.**	**z-Statistic**	**p-Value**
Constant	1296.050	456.888	2.837	0.005	75.979	16.267	4.671	0.000
Alien WW	-11.992	4.475	-2.680	0.008	-	-	-	-
Age	-0.526	0.164	-3.201	0.001	-0.666	0.201	-3.305	0.001
House No.	-3.525	1.119	-3.149	0.002	-4.662	1.415	-3.296	0.001
Educ Val	-0.075	0.723	-0.103	0.918	0.304	0.886	0.343	0.732
R^2	0.0522				0.033519			
Adjusted R^2	0.0444				0.025597			
Log-likelihood					-2223.65			
F-statistic (12.480)	6.71490							
p-Value (F-statistic)	0.00002							

The following features stand out with respect to the fit of the reduced OLS and Tobit models (see Table 8.16):

- The significance level for the variable that shows whether a respondent is knowledgeable about the local WfW Programme (*Alien WW*) is 0.8 per cent (p=0.008). The coefficient is negative, as expected, and indicates that knowledgeable respondents would pay R11.99 more per annum than respondents who are unaware of the Programme's local activities.
- The significance level for the *Age* variable is 0.001 in both the reduced OLS and Tobit models. The coefficient in both models is negative and suggests that respondents would be WTP between R0.53 and R0.67 less towards the national Programme as they become older. This result is typical of CVM studies (Blaine and Smith, 2006).
- For every additional member included in a family the WTP decreased by R3.53 in the reduced OLS model, and by R4.66 in the reduced Tobit model. One plausible explanation for this result is that as the number of children and / or individuals over the age of 65 increases in a home, the household's budget constraint limits the respondent's WTP.

The adjusted R^2 for the reduced OLS model was found to be 0.0444. This means that the explanatory variables in the reduced model only provide an explanation for 4.44 per cent of the variation in the WTP data.

(b) Estimate of WTP based on the local WfW Programme

The results of fitting the OLS and Tobit models to the data generated for the local scenario are shown in Tables 8.17 and 8.18.

Table 8.17: The fit of the WTP function for Port Elizabeth Driftsands (local WfW Programme) using OLS and Tobit models – complete model

Dependent variable: Levy WTP								
Model: Complete model								
Method	**Least squares**				**ML - Censored normal**			
	OLS				**Tobit**			
	Coefficient	**Std. Err.**	**t-Statistic**	**p-Value**	**Coefficient**	**Std. Err.**	**z-Statistic**	**p-Value**
Constant	-260.454	1523.124	-0.171	0.864	84.994	24.359	3.489	0.001
Race	7.779	4.386	1.774	0.077	6.521	5.608	1.163	0.245
Gender	-4.296	3.958	-1.085	0.278	-1.713	5.083	-0.337	0.736
Res	7.726	7.337	1.053	0.293	17.131	9.753	1.757	0.079
WFWP	-3.392	4.290	-0.791	0.430	-4.335	5.526	-0.784	0.433
Alien WW	-5.547	4.241	-1.308	0.192	-5.027	5.447	-0.923	0.356
Informed	-1.112	9.545	-0.116	0.907	1.656	12.226	0.135	0.892
Age	-0.434	0.155	-2.802	0.005	-0.652	0.202	-3.221	0.001
House No.	-2.747	1.034	-2.657	0.008	-4.624	1.389	-3.328	0.001
Educ Level	-1.882	0.776	-2.426	0.016	-2.559	0.997	-2.566	0.010
Income	0.042	0.021	2.005	0.046	0.058	0.027	2.164	0.030
House Val	0.005	0.005	1.202	0.230	0.005	0.006	0.795	0.427
Understand	-0.602	2.282	-0.264	0.792	-3.642	2.932	-1.242	0.214
R^2	0.072419				0.059463			
Adjusted R^2	0.049229				0.033937			
Log-likelihood					-2053.66			
F-statistic (12.480)	3.12291							
p-Value (F-statistic)	0.00027							

The adjusted R^2 for the complete OLS model (Table 8.17) is 0.0492, meaning that the explanatory variables in the complete model give a 4.9 per cent explanation of the WTP figure. Despite this poor fit, eleven out of the twelve explanatory variables in both the OLS and Tobit models yielded expected results (see Table 8.14).

Both the complete and reduced OLS and Tobit models have p-values that are statistically significant at the 1 per cent level of significance (p<0.01).

Variables with statistical significance of less than or equal to 10 per cent and reflecting positive coefficients in the OLS and Tobit models are *Race* and *Income*. Variables with statistical significance less than or equal to 10 per cent and reflecting negative coefficients are *Age*, the number of people making up the household (*House No.*) and education (*Educ Level*).

Table 8.18: The fit of the WTP function for Port Elizabeth Driftsands (local WfW Programme) using OLS and Tobit models – reduced model

Dependent variable: Levy WTP								
Model: Reduced model								
Method	**Least squares**				**ML - Censored normal**			
	OLS				**Tobit**			
	Coefficient	**Std. Err.**	**t-Statistic**	**p-Value**	**Coefficient**	**Std. Err.**	**z-Statistic**	**p-Value**
Constant	-873.937	422.639	-2.068	0.039	61.167	17.786	3.439	0.001
Race	9.286	4.166	2.229	0.026	-	-	-	-
Res					15.106	9.609	1.572	0.116
Age	-0.351	0.147	-2.392	0.017	-0.514	0.194	-2.647	0.008
House No.	-2.784	1.032	-2.698	0.007	-5.141	1.355	-3.795	0.000
Educ Level	-1.476	0.699	-2.112	0.035	-1.665	0.904	-1.843	0.065
Income	0.055	0.020	2.810	0.005	0.079	0.025	3.193	0.001
R^2	0.0580				0.041998			
Adjusted R^2	0.0483				0.03017			
Log-likelihood					-2057.39			
F-statistic (12.480)	6.00							
p-Value (F-statistic)	0.0000							

The log-likelihood ratio test was used to determine preference between the complete and reduced Tobit models. The log-likelihood ratio statistic value was 7.46. As this statistic was smaller than the critical value corresponding to the upper 5 per cent significance level with six degrees of freedom, namely 12.5916, the null hypothesis that the variables omitted in the reduced model are equal to zero could not be rejected and it was thus deduced that the reduced Tobit model was the preferred model.

Using the nested test, in which the complete and reduced OLS models are compared, the F-statistic value of 1.0651 was found to be lower than the critical value of 2.0287. For this reason the null hypothesis could not be rejected and it was deduced that the reduced OLS model was preferred to the complete OLS model.

The following features stand out with respect to the fit of the reduced OLS and Tobit models (see Table 8.18):

- The significance level for the education variable (*Educ Level*) is 3.5 per cent (p=0.035) in the case of the reduced OLS model. Surprisingly, the coefficient is negative and suggests that for every extra year of education respondents at the Port Elizabeth site complete, their WTP for the national WfW Programme decreases by R1.48. The results from the reduced Tobit model suggest that for every extra year of education respondents complete their willingness to contribute decreases by R1.67 per annum. One possible reason for the inverse relationship between WTP and education postulated by du Plessis (2003) is that respondents with higher educational levels are better equipped to understand their budget constraint, and would thus be more realistic in their valuation of indigenous vegetation. An alternative reason for this inverse relationship could flow from the Programme's goal of investing in South Africa's most marginalised social sectors. Respondents with lower education levels may have been overstating their willingness to contribute to the preservation of indigenous vegetation in an attempt to improve their employment options.
- The *Income* variable has a significance level of 0.5 per cent in the reduced OLS model and a significance level of 0.1 per cent in the reduced Tobit model. As expected, the coefficient is positive. The reduced OLS model

suggests that for every additional R100 a respondent earns per year his / her WTP will increase by R5.50. Extra income earned also has a positive effect on the WTP of respondents in the reduced Tobit model. For every additional R100 a respondent earns per year his / her WTP increases by R7.90.

- The number of people making up the household (*House No.*) variable shows a significance level of 0.7 per cent in the reduced OLS model, while it has a significance level of 0 per cent in the reduced Tobit model. The coefficient in the reduced OLS model is negative and suggests that for every additional person in the household respondents' WTP decreases by R2.78. The results presented in the reduced Tobit model suggest that respondents' WTP decreases by R5.14 for every additional household member.
- The *Race* variable has a significance level of 2.6 per cent in the reduced OLS model. Its coefficient is positive and suggests that non-African respondents would be WTP R9.29 more towards the preservation of indigenous vegetation through continued WfW activities at a local level than respondents from the African race group.

The adjusted R^2 for the reduced OLS model was found to be 0.0483, meaning that the explanatory variables in the reduced model give a 4.83 per cent explanation of the variation of the WTP data.

(c) Comparative observations made for the preferred Tobit models[22] testing the Port Elizabeth data

For both the national and the local scenarios the variables of *Age*, *House No*. and *Educ Level* were highly significant in determining WTP. WTP was similar for both scenarios and positively related to income. This finding is consistent with expectations (see Table 8.14). Age was a highly significant statistical variable

[22] Since the Tobit models are preferred for estimations, only these models will be discussed.

with older African respondents having a lower WTP to preserve indigenous vegetation for both scenarios. As expected (see Table 8.14) the number of people making up a household was also statistically significant and showed that respondents with bigger households have a marginally lower WTP than smaller households. It was surprising that respondents with higher education levels had a lower WTP. One possible reason for this inverse relationship is that respondents with lower education levels were overstating their WTP in order to ensure that the WfW Programme continues its operations, thereby providing much needed employment opportunities to these individuals. Residents were expected to have a higher WTP and this was confirmed by the data that shows residents would be WTP more to preserve indigenous vegetation at the local site than visitors.

However, the fact that the explanatory variables could only provide such a small explanation of the variation of the WTP data in each model reduces confidence in the data gathered at the Port Elizabeth site. Reasons for the disappointing level of confidence could include, amongst others, too small a sample size and information accuracy problems. Notwithstanding these problems, there is correlation between the statistical findings for the Port Elizabeth site and what was expected. Furthermore, poor bid function fits are not abnormal in studies of this nature.

8.6.1.2 Worcester

(a) Estimate of WTP based on the national WfW Programme

The results obtained by fitting the WTP function to the OLS and Tobit models at the Worcester site are presented in Table 8.19.

Table 8.19: The fit of the WTP function for Worcester (national WfW Programme) using OLS and Tobit models – complete model

Dependent variable: WTP								
Model: Complete model								
Method	**Least squares**				**ML - Censored normal**			
	OLS				**Tobit**			
	Coefficient	**Std. Err.**	**t-Statistic**	**p-Value**	**Coefficient**	**Std. Err.**	**z-Statistic**	**p-Value**
Constant	999.153	1740.334	0.574	0.567	40.320	33.957	1.187	0.235
Race	17.680	9.154	-1.931	0.055	18.139	10.230	1.773	0.076
Gender	13.544	6.726	-2.014	0.045	14.154	7.621	1.857	0.063
Res	-16.068	12.985	1.237	0.217	-16.068	14.929	-1.076	0.282
WFWP	2.276	8.413	-0.270	0.787	-0.219	9.404	-0.023	0.981
Alien WW	-15.134	8.389	1.804	0.073	-18.384	9.457	-1.944	0.052
Informed	7.128	9.782	-0.729	0.467	11.742	11.006	1.067	0.286
Age	-0.003	0.276	-0.011	0.991	0.031	0.312	0.099	0.921
House No.	1.463	1.954	0.749	0.455	1.660	2.205	0.753	0.451
Educ Level	1.104	1.430	0.772	0.441	0.847	1.626	0.521	0.602
Income	-0.010	0.038	-0.265	0.791	-0.028	0.044	-0.637	0.524
House Val	-0.006	0.005	-1.172	0.243	-0.010	0.006	-1.734	0.083
Understand	-6.946	3.116	-2.229	0.027	-9.168	3.544	-2.587	0.010
R^2	0.107478				0.093068			
Adjusted R^2	0.052271				0.03198			
Log-likelihood					-958.168			
F-statistic (12.480)	1.94680							
p-Value (F-statistic)	0.03115							

The results of fitting the Tobit model to data obtained in the survey of the Worcester area gave an R^2 value of 0.093 and an adjusted R^2 value of 0.032. This implies that the independent variables provide an explanation for 3.2 per cent of the variation in users' WTP to prevent the possible future event of an increase in alien vegetation up to a point where indigenous vegetation would be totally compromised. The adjusted R^2 for the complete OLS model was found to be 0.0679. This means that 6.79 per cent of the variation in WTP data was found to be due to differences in the independent variables in the OLS model compared to the 3.2 per cent in the case of the Tobit model (see Table 8.19). The signs of only seven of the coefficients in the OLS model accord with expectations, while eight do so in the case of the Tobit model (see Table 8.14).

The significant independent variables in both the OLS and Tobit models are *Race*, *Gender*, the respondent's knowledge about the activities of the local WfW Programme (*Alien WW*) and the respondent's understanding of the research question after the completion of the survey (*Understand*). In addition, the approximate worth of any land and / or property owned by the respondent's household at current prices (*House Val*) was found to be a significant independent variable in the Tobit model.

The results obtained by fitting the WTP function to the reduced OLS and Tobit models are presented in Table 8.20.

Table 8.20: The fit of the WTP function for Worcester (national WfW Programme) using OLS and Tobit models – reduced model

Dependent variable: WTP								
Model: Reduced model								
Method	**Least squares**				**ML - Censored normal**			
	OLS				**Tobit**			
	Coefficient	**Std. Err.**	**t-Statistic**	**p-Value**	**Coefficient**	**Std. Err.**	**z-Statistic**	**p-Value**
Constant	1813.322	1036.867	1.749	0.082	46.400	11.915	3.894	0.000
Race	18.185	7.753	-2.346	0.020	19.391	9.081	2.135	0.033
Gender	13.423	6.363	-2.110	0.036	14.112	7.327	1.926	0.054
Alien WW	-14.226	7.311	1.946	0.053	-17.685	8.403	-2.105	0.035
House Val	-	-	-	-	-0.011	0.005	-2.117	0.034
Understand	-5.207	2.670	-1.950	0.053	-7.781	3.187	-2.441	0.015
R^2	0.086				0.08209			
Adjusted R^2	0.0679				0.05455			
Log-likelihood					-959.76			
F-statistic (12.480)	4.75134							
p-Value (F-statistic)	0.00110							

The reduced Tobit model was found to be more appropriate for prediction purposes than the complete Tobit model as the χ^2 critical value with upper 5 per cent significance level and seven degrees of freedom has a value of 14.07, which is greater than the log-likelihood ratio statistic of 3.184.

The reduced OLS model was preferred to the complete OLS model on account of the failure to reject the null hypothesis using the nested test. In the nested test, in which the complete and reduced OLS models are compared, the F-statistic value of 0.5837 was lower than the critical value of 1.9864.

The following results stand out:

- The *Race* variable has a significance level of 5.5 per cent in the reduced OLS model. Its coefficient is positive, as expected, and suggests that non-African respondents will be WTP R18.19 more towards the preservation of indigenous vegetation through continued WfW activities at a national level than respondents from the African race group. The *Race* variable has a significance level of 7.6 per cent in the reduced Tobit model and suggests that non-African respondents will be WTP R19.39 more than African respondents to preserve indigenous vegetation.
- Female respondents are willing to contribute R13.42 more in the reduced OLS model and R14.11 more in the reduced Tobit model than male respondents.
- The coefficient indicating respondents' knowledge about the activities of the local WfW Programme (*Alien WW*) in the reduced OLS and Tobit models is negative. The reduced OLS model suggests that these respondents' WTP is R14.13 less than respondents who do know about the activities of the local WfW Programme.

(b) Estimate of WTP based on the local WfW Programme

The results of fitting the OLS and Tobit models to the data generated for the local Worcester WfW Programme are shown in Tables 8.21 and 8.22.

Table 8.21: The fit of the WTP function for Worcester (local WfW Programme) using OLS and Tobit models – complete model

Dependent variable: Levy WTP								
Model: Complete model								
Method	**Least squares**				**ML - Censored normal**			
	OLS				**Tobit**			
	Coefficient	**Std. Err.**	**t-Statistic**	**p-Value**	**Coefficient**	**Std. Err.**	**z-Statistic**	**p-Value**
Constant	1895.135	1895.318	1.000	0.319	12.873	35.205	0.366	0.715
Race	12.754	9.969	-1.279	0.202	14.122	10.668	1.324	0.186
Gender	14.662	7.325	-2.002	0.047	16.234	7.896	2.056	0.040
Res	2.380	14.142	-0.168	0.867	8.344	15.653	0.533	0.594
WFWP	16.677	9.163	-1.820	0.070	15.036	9.778	1.538	0.124
Alien WW	-26.787	9.136	2.932	0.004	-30.494	9.837	-3.100	0.002
Informed	-1.289	10.654	0.121	0.904	3.375	11.453	0.295	0.768
Age	0.299	0.301	0.994	0.322	0.336	0.323	1.041	0.298
House No.	-0.612	2.128	-0.288	0.774	-0.565	2.290	-0.247	0.805
Educ Level	1.828	1.558	1.173	0.242	1.649	1.684	0.979	0.328
Income	-0.018	0.041	-0.433	0.666	-0.026	0.044	-0.594	0.552
House Val	0.000	0.005	0.010	0.992	-0.002	0.006	-0.324	0.746
Understand	-5.260	3.394	-1.550	0.123	-7.195	3.663	-1.964	0.050
R^2	0.11863				0.11327			
Adjusted R^2	0.06411				0.05354			
Log-likelihood					-1011.6			
F-statistic (12.480)	2.17588							
p-Value (F-statistic)	0.01427							

The following features stand out with respect to the fit of the complete OLS and Tobit models:

- Variables with a statistical significance of less than 10 per cent in the OLS model are the gender of the respondent (*Gender*), knowledge of the national WfW Programme (*WFWP*) and knowledge of the local WfW Programme (*Alien WW*).
- In addition to the variables that were found to be statistically significant in the OLS model, the respondent's understanding of the research question after completing the survey (*Understand*) is significant in the Tobit model.

- Nine out of the twelve explanatory variables in the OLS model yielded expected results, while eight variables yielded plausible results in the Tobit model (see Table 8.14).

The adjusted R² for the complete OLS model was found to be 0.0641. This means that the explanatory variables in the OLS model provide an explanation for 6.41 per cent of the variation in the WTP data.

The results obtained by fitting the WTP function to the reduced OLS and Tobit models are presented in Table 8.22.

Table 8.22: The fit of the WTP function for Worcester (local WfW Programme) using OLS and Tobit models – reduced model

Dependent variable: Levy WTP								
Model: Reduced model								
Method	**Least squares**				**ML - Censored normal**			
	OLS				**Tobit**			
	Coefficient	**Std. Err.**	**t-Statistic**	**p-Value**	**Coefficient**	**Std. Err.**	**z-Statistic**	**p-Value**
Constant	412.782	1053.891	0.392	0.696	62.912	9.514	6.613	0.000
Gender	12.877	7.058	-1.825	0.070	16.471	7.678	2.145	0.032
WFWP	13.182	8.230	-1.602	0.111	-16.393	7.896	-2.076	0.038
Alien WW	-22.459	8.422	2.667	0.008	-	-	-	-
Understand	-	-	-	-	-7.917	3.090	-2.562	0.010
R^2	0.04902				0.06185			
Adjusted R^2	0.03497				0.04328			
Log-likelihood					-1016.4			
F-statistic (12.480)	3.48792							
p-Value (F-statistic)	0.01672							

In order to determine preference between the complete and reduced Tobit models the log-likelihood ratio test was used. The log-likelihood ratio test statistic value was 9.6. This statistic is smaller than the critical value corresponding to the upper 5 per cent significance level with eight degrees of freedom, namely 15.5073. For this reason the null hypothesis that the variables omitted in the reduced model are equal to zero cannot be rejected and the reduced Tobit model was preferred to the complete Tobit model.

In an application of the nested test to check whether the complete or reduced OLS model was preferable it was found that the critical value of 1.92839 was greater than the F-statistic value of 0.42632. For this reason the null hypothesis could not be rejected and it was thus deduced that the reduced OLS model was the preferred one.

The following features stand out with respect to the fit of the reduced OLS and Tobit models (see Table 8.22):

- Female respondents are willing to contribute R12.88 more in the reduced OLS model and R16.47 more in the reduced Tobit model than male respondents.
- The variable representing the knowledge a respondent possesses of the national WfW Programme (*WFWP*) was incorporated into both the reduced OLS and Tobit models. The *WFWP* variable was, however, found to be insignificant in the reduced OLS model.
- As expected, the coefficient of the *WFWP* variable in the reduced Tobit model is negative. The negative coefficient of the variable suggests that respondents who do not know about the activities of the national WfW Programme have a WTP that is R16.39 less than respondents who do know about the activities of the national WfW Programme.
- The coefficient indicating respondents' knowledge about the activities of the local WfW Programme (*Alien WW*) in the reduced OLS model is negative. The findings presented in the reduced OLS model suggests that these respondents' WTP is R22.46 less than respondents who do know about the activities of the local WfW Programme.

The adjusted R^2 for the reduced Tobit model was found to be 0.04328. This means that 4.33 per cent of the variation in WTP in the sample was due to differences in the explanatory variables.

(c) Comparative observations made for the preferred Tobit models testing the Worcester data

As expected (see Table 8.14), it was found that respondents who knew about the activities of the local WfW Programme would pay more towards the preservation of indigenous vegetation through continued WfW operations. It was found that the better the respondent's understanding of the research question was after completion of the survey the more the respondent was willing to contribute to preserve indigenous vegetation. Race was a statistically significant variable for the national scenario. Non-African respondents were expected to have a higher WTP and this was confirmed by the data.

Male respondents were expected to have a higher WTP. However, it was found that female respondents were willing to pay more towards the preservation of indigenous vegetation in both scenarios. One possible explanation for this inverse relationship stems from the WfW Programme's target of ensuring that 60 per cent of wages go to women (DWAF, 2004:2). As noted in Section 8.3 the survey team argued that respondents were more willing to contribute to an initiative that improved their employment opportunities than a general one.

As was the case in Port Elizabeth, the explanatory variables in each model could only provide a small explanation of the variation of the WTP data. This reduces confidence in the data gathered in Worcester. For example, the adjusted R^2 for the complete Tobit model based on the willingness of respondents to pay towards the preservation of indigenous vegetation through continued WfW activities at a national level was only 0.03198 (see Table 8.19), while the adjusted R^2 for the local scenario was 0.5354 (see Table 8.21). Furthermore, there is limited correlation between the statistical findings for the Worcester site and what was expected *a priori*. Reasons for the disappointing level of confidence could include, amongst others, too small a sample size and strategic bids.

8.6.1.3 Underberg

(a) Estimate of WTP based on the national WfW Programme

The results obtained by fitting the complete OLS and Tobit models to the data for the national WfW Programme are shown in Table 8.23.

Table 8.23: The fit of the WTP function for Underberg (national WfW Programme) using OLS and Tobit models – complete model

Dependent variable: WTP								
Model: Complete model								
Method	**Least squares**				**ML - Censored normal**			
	OLS				**Tobit**			
	Coefficient	**Std. Err.**	**t-Statistic**	**p-Value**	**Coefficient**	**Std. Err.**	**z-Statistic**	**p-Value**
Constant	-205.491	1819.057	-0.113	0.910	29.151	29.036	1.004	0.315
Race	13.452	8.770	-1.534	0.126	15.738	11.621	1.354	0.176
Gender	-4.302	5.183	-0.830	0.407	-5.050	6.786	-0.744	0.457
Res	13.420	7.194	-1.866	0.063	22.240	9.827	2.263	0.024
WFWP	-0.497	5.797	-0.086	0.932	-6.688	7.571	-0.883	0.377
Alien WW	-23.552	6.765	3.481	0.001	-27.410	8.797	-3.116	0.002
Informed	-10.498	9.653	1.088	0.278	-9.144	12.622	-0.724	0.469
Age	-0.124	0.203	-0.610	0.543	-0.407	0.268	-1.515	0.130
House No.	0.718	1.058	0.679	0.498	0.273	1.396	0.195	0.845
Educ Level	1.013	0.950	1.066	0.287	1.462	1.251	1.169	0.243
Income	-0.037	0.014	-2.633	0.009	-0.053	0.019	-2.744	0.006
House Val	0.007	0.005	1.293	0.197	0.010	0.006	1.489	0.137
Understand	-1.418	3.211	-0.441	0.659	1.177	4.246	0.277	0.782
R^2	0.196754				0.191559			
Adjusted R^2	0.157572				0.148662			
Log-likelihood					-1039.39			
F-statistic (12.480)	5.021459							
p-Value (F-statistic)	0.00000							

Features that stand out are:

- All the variables with statistical significance of less than or equal to 10 per cent (0.1) have a negative coefficient.
- Variables with a statistical significance of less than 10 per cent in the OLS model are the knowledge of the local WfW Programme (*Alien WW*) and *Income*.
- In the case of the Tobit model, the statistically significant variables are *Alien WW, Income* and the residential variable *(Res)*.
- The signs of eleven of the coefficients in both models accord with expectations (see Table 8.14).

The adjusted R^2 for the complete OLS model was 0.15757. This means that 15.76 per cent of the variation in WTP in the sample was due to differences in the explanatory variables. Hanley and Spash (1993) state that a model is well fitted if it has an adjusted R^2 value greater than 15 per cent. This model can thus be adjudged to be well fitted based on the statistical significance of the model.

The variables with statistical significance of 10 per cent or less were used in the reduced OLS and Tobit models (see Table 8.24). The log-likelihood ratio test was used to determine the preference between the complete and reduced Tobit models. The log-likelihood ratio statistic value was 19. The critical chi-square value at the 5 per cent level of significance with nine degrees of freedom is 16.919. The null hypothesis was thus rejected as 19 > 16.919. There is sufficient evidence to infer that at least one variable omitted from the reduced model contributes significant information for the prediction of WTP. The complete Tobit model was thus preferred for the estimation and prediction of WTP for the national WfW Programme at Underberg.

The complete OLS model was preferred to the reduced model due to a failure to reject the null hypothesis using the nested test. In the nested test, the F-test statistic value of 2.34708 was larger than the critical value of 1.91806.

It was expected that the income variable would be significant in explaining the WTP bids but fitting the data to the reduced OLS and Tobit models did not prove this to be the case. The only significant variable in the reduced models is respondents' knowledge of the local WfW Programme (*Alien WW*) (see Table 8.24).

Table 8.24: The fit of the WTP function for Underberg (national WfW Programme) using OLS and Tobit models – reduced model

Dependent variable: WTP								
Model: Reduced model								
Method	**Least squares**				**ML - Censored normal**			
	OLS				**Tobit**			
	Coefficient	**Std. Err.**	**t-Statistic**	**p-Value**	**Coefficient**	**Std. Err.**	**z-Statistic**	**p-Value**
Constant	-3132.344	987.325	-3.173	0.002	46.078	11.606	3.970	0.000
Res	4.662	6.798	-0.686	0.493	11.622	9.371	1.240	0.215
Alien WW	-35.925	6.096	5.893	0.000	-41.804	8.013	-5.217	0.000
Income	-0.012	0.013	-0.932	0.352	-0.025	0.018	-1.413	0.158
R^2	0.127781				0.123689			
Adjusted R^2	0.117519				0.109889			
Log-likelihood					-1048.89			
F-statistic (12.480)	12.45256							
p-Value (F-statistic)	0.00000							

The coefficient of the *Alien WW* variable is negative and, in the case of the reduced OLS model, suggests that respondents who are unaware of the local WfW Programme report a WTP figure that is R35.93 less than respondents who do know about the activities of the local WfW Programme. Respondents who are aware of the local WfW Programme are willing to contribute R41.80 more in the reduced Tobit model than respondents who are unaware of the Programme's activities in Worcester.

The adjusted R^2 for the reduced OLS model was found to be 0.11752. This means that 11.75 per cent of the variation in WTP in the sample was due to differences in the independent variables.

(b) Estimate of WTP based on the local WfW Programme

The results of fitting the OLS and Tobit models to the Underberg data generated for the local WfW Programme are shown in Tables 8.25 and 8.26.

Table 8.25: The fit of the WTP function for Underberg (local WfW Programme) using OLS and Tobit models – complete model

Dependent variable: Levy WTP								
Model: Complete model								
Method	**Least squares**				**ML - Censored normal**			
	OLS				**Tobit**			
	Coefficient	**Std. Err.**	**t-Statistic**	**p-Value**	**Coefficient**	**Std. Err.**	**z-Statistic**	**p-Value**
Constant	-1504.471	1545.438	-0.973	0.331	20.694	24.672	0.839	0.402
Race	8.839	7.450	-1.186	0.237	8.628	9.868	0.874	0.382
Gender	-0.389	4.404	-0.088	0.930	-0.773	5.750	-0.134	0.893
Res	11.807	6.112	-1.932	0.055	20.158	8.369	2.409	0.016
WFWP	4.141	4.925	0.841	0.401	0.718	6.425	0.112	0.911
Alien WW	-24.021	5.748	4.179	0.000	-27.354	7.463	-3.665	0.000
Informed	-7.975	8.201	0.972	0.332	-7.516	10.715	-0.701	0.483
Age	-0.030	0.173	-0.175	0.862	-0.243	0.228	-1.069	0.285
House No.	0.563	0.899	0.626	0.532	0.233	1.180	0.197	0.844
Educ Level	0.851	0.807	1.055	0.293	1.285	1.061	1.212	0.226
Income	-0.032	0.012	-2.741	0.007	-0.047	0.016	-2.870	0.004
House Val	0.004	0.004	0.952	0.342	0.007	0.005	1.298	0.194
Understand	-2.956	2.728	-1.084	0.280	-1.406	3.596	-0.391	0.696
R^2	0.206293			0.191955				
Adjusted R^2	0.167576			0.14908				
Log-likelihood				-996.401				
F-statistic (12.480)	5.328183							
p-Value (F-statistic)	0.00000							

Table 8.25 shows that the WTP variable was regressed on 12 other variables expected to influence WTP. The following features stand out with respect to the fit of the complete OLS and Tobit models:

- Variables with a statistical significance of less than 10 per cent in the OLS and Tobit models are the residential variable (*Res*), knowledge of the local WfW Programme (*Alien WW*) and *Income*.
- Ten out of the twelve explanatory variables in both the OLS and Tobit models yielded expected results (see Table 8.14).

The adjusted R^2 for the complete OLS model was found to be 0.1676. This means that the explanatory variables in the OLS model provide an explanation for 16.76 per cent of the variation in the WTP data. This model is thus adjudged to be well fitted, as the adjusted R^2 value is greater than 15 per cent.

The significant variables mentioned above were fitted in the reduced OLS and Tobit models as shown in Table 8.26.

Table 8.26: The fit of the WTP function for Underberg (local WfW Programme) using OLS and Tobit models – reduced model

Dependent variable: Levy WTP								
Model: Reduced model								
Method	**Least squares**				**ML - Censored normal**			
	OLS				**Tobit**			
	Coefficient	**Std. Err.**	**t-Statistic**	**p-Value**	**Coefficient**	**Std. Err.**	**z-Statistic**	**p-Value**
Constant	43.525	7.248	6.006	0.000	33.539	9.794	3.424	0.001
Res	4.951	5.741	0.862	0.389	11.338	7.921	1.431	0.152
Alien WW	-32.857	5.092	-6.383	0.000	-37.571	6.741	-5.573	0.000
Income	-0.012	0.011	-1.162	0.246	-0.025	0.015	-1.664	0.096
R^2	0.14849				0.133921			
Adjusted R^2	0.13848				0.120282			
Log-likelihood					-1003.42			
F-statistic (12.480)	14.82302							
p-Value (F-statistic)	0.00000							

The log-likelihood ratio test was used to determine the preference between the complete and reduced Tobit models. The log-likelihood ratio statistic value was 14.038. The critical chi-square value at the 5 per cent level of significance with nine degrees of freedom is 16.919. The null hypothesis was therefore not rejected as 14.038 < 16.919. There is insufficient evidence to infer that at least one variable omitted from the reduced model contributes significant information for the prediction of WTP. The reduced Tobit model was thus preferred for the estimation and prediction of WTP for the Underberg WfW Programme.

In an application of the nested test to check whether the complete or reduced OLS model was preferable it was found that the critical value of 1.91806 was smaller than the F-statistic value of 1.99050. For this reason the null hypothesis was rejected. It was thus deduced that the complete OLS model was the preferred one and should be used for predictive purposes.

The following features stand out with respect to the fit of the reduced OLS and Tobit models (see Table 8.26):

- It was expected that the residential variable (*Res*) would be significant in explaining the WTP bids but fitting the data to the reduced OLS and Tobit models did not prove this to be the case.
- The *Alien WW* variable has a significance level of 0 per cent in both the reduced OLS and Tobit models. The coefficient of the *Alien WW* variable is negative for both reduced models. The reduced OLS model suggests that respondents who do not know about the activities of the local WfW Programme have a WTP that is R32.86 less than respondents who do know about the activities of the local WfW Programme. According to the reduced Tobit model, respondents who are knowledgeable about the local WfW Programme have a WTP that is R37.57 higher than respondents who are unaware of the activities of the local WfW Programme.
- The *Income* variable has a significance level of 9.6 per cent in the reduced Tobit model. The reduced Tobit model suggests that for every additional R100 a respondent earns per year his / her WTP will decrease by R2.50.

In the reduced OLS model the adjusted R^2 value for the Underberg site was 0.1485 while the R^2 value was 0.1385, meaning that the explanatory variables in the reduced model gave a 13.85 per cent explanation of the WTP figure.

(c) Comparative observations made for the preferred Tobit models testing the Underberg data

The results reported in Table 8.23 and Table 8.26 show knowledge to be an important influence on WTP as respondents who knew about the activities of the local WfW Programme would pay more towards the preservation of indigenous vegetation through continued WfW activities. This variable shows that respondents would pay 27 per cent more to preserve indigenous vegetation at the local site. As expected, due to higher frequency of use by residents, the residential variable (*Res*) for both the national and the local scenarios shows that residents are WTP more than tourists.

The results reported in the Tobit models imply that the higher the respondent's income, the less he / she is willing to pay to conserve indigenous vegetation. As a number of the wealthier respondents had indicated that they owned farms which had been planted to Pine and Gum trees this result was not as surprising as first thought.

There is correlation between the statistical findings for the Underberg site and what was expected *a priori*. Furthermore, the overall bid function fits are within acceptable norms.

8.7 <u>THE PREDICTED WTP FOR THE WFW PROGRAMME</u>

The predicted mean and median WTP per site for both the local and national WfW Programme is described in Table 8.27 below. The Tobit models were preferred to the OLS models in estimating the WTP functions, because they avoided the problem of negative WTP predictions, by using censored data. In this study, complete Tobit models were preferred to reduced ones for the Port Elizabeth and Underberg national WfW Programme scenarios because of their superior predictive qualities. In all other cases, the reduced Tobit models were found to be more appropriate for predictive purposes.

Table 8.27: Predicted mean and median WTP using Tobit models

Site	Mean of predicted WTP (R)	Median of predicted WTP (R)
Port Elizabeth: National WfW Programme	44.14	43.24
Underberg: National WfW Programme	34.00	29.22
Worcester: National WfW Programme	44.77	44.99
Port Elizabeth: Local WfW Programme	32.91	32.82
Underberg: Local WfW Programme	24.87	21.12
Worcester: Local WfW Programme	53.16	52.79

Note: These values relate to the period from July 2005 to October 2005.

Differences between the mean and median predicted WTP at the three sites are evident (see Table 8.27). The predicted median WTP at the three sites varied from R21.12 for the local WfW Programme in Underberg to R52.79 for the local WfW Programme in Worcester. There are many possible reasons for the differences; one of which is differences in each site's characteristics, and another, respondents interpreting the questionnaire differently for different enumerators.

8.8 VALIDITY

Construct validity refers to how well a valuation method explains the values generated (Hanley and Spash, 1993:116). 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 (0.15) (Hanley and Spash, 1993).

- The reduced model contains the significant variables that it would be expected to.
- The signs of the coefficients in the reduced model accord with expectations (see Table 8.14).

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.

The validity ratings of the three WfW sites using the abovementioned criteria are summarised in Table 8.28.

Table 8.28: Sample validity rating

WfW project	Validity of the results
Port Elizabeth Driftsands: National Programme	Weak support
Port Elizabeth Driftsands: Site	Moderate support
Worcester: National Programme	Weak support
Worcester: Site	Weak support
Underberg: National Programme	Moderate support
Underberg: Site	Moderate support

These ratings vary from weak to moderate support. Three possible explanations for the lack of expectations-based support for the various scenarios are insufficiency of the sample sizes, poor sampling of the relevant population (see Chapter Six) and failure to tease out biases in the CVM studies (see Chapter Four).

8.9 RELIABILITY (REPEATABILITY) ISSUE

The repeatability test of a CVM model is that, when applied repeatedly in the same or very similar situations, the difference in results should be statistically insignificant between these applications (Hanley and Spash, 1993). This test could not be carried out because the applications were not repeated at the same sites, but different ones. However, similar results were found at the different sites.

8.10 CONCLUSION

This chapter proposed that the information problem with respect to the nature of the biodiversity benefit could be overcome by taking people's preferences towards indigenous vegetation as a proxy for their preferences towards biodiversity. Biodiversity, in terms of the WfW Programme, entails the facilitation of indigenous tree growth and improved ecosystem function through the eradication of alien vegetation.

Biodiversity is important for both moral and economic reasons. However, like everything else, promoting biodiversity is subject to budget constraints, and the costs associated with promoting it need to be weighed up against the benefits. The results of the contingent valuation studies performed at each site give insight into the potential value of the population's preference for indigenous vegetation.

The predicted mean and median WTP per site for both the local and national WfW Programme is described in Table 8.29 below. For the Port Elizabeth and Underberg national WfW Programme scenarios, complete Tobit models were preferred to reduced ones because of their superior predictive qualities. In all other cases, the reduced Tobit models predictive qualities were superior to those of the complete models.

Table 8.29: Predicted mean and median WTP

Site	Mean of predicted WTP (R)	Median of predicted WTP (R)
Port Elizabeth: National WfW Programme	44.14	43.24
Underberg: National WfW Programme	34.00	29.22
Worcester: National WfW Programme	44.77	44.99
Port Elizabeth: Local WfW Programme	32.91	32.82
Underberg: Local WfW Programme	24.87	21.12
Worcester: Local WfW Programme	53.16	52.79

Note: These values relate to the period from July 2005 to October 2005.

There are differences between the mean and median predicted WTP at the three sites (see Table 8.29). However, the difference between the predicted mean and median WTP is generally less than 10 per cent. The predicted mean and median WTP was highest at Worcester. This is consistent with the information shown in Tables 8.8 and 8.10.

Notable aspects of the results of the surveys at the Port Elizabeth, Underberg and Worcester sites are:

- The value of any houses and / or land owned by the household to which the respondent belongs had little influence on the WTP.
- Income was weakly positively correlated with the WTP in the Port Elizabeth local WfW Programme scenario.
- Education level and WTP were negatively correlated. One possible reason for this inverse relationship is that respondents with higher educational levels are better equipped to understand their budget constraints. Alternatively, respondents with lower educational levels may have been overstating their WTP towards the preservation of biodiversity through WfW clearing activities in a strategic attempt to ensure the continued existence of the Programme as this Programme is currently providing much needed employment to various townships within Port Elizabeth (Conservation Support Services, 2003).

- Age and WTP were negatively correlated at Port Elizabeth and Underberg. As mentioned previously, this could be as a result of lower levels of education amongst older African respondents.
- Knowledge of the WfW Programme was positively correlated to WTP.
- Non-African respondents were willing to pay more than African respondents.
- The WTP amount decreases in proportion with the number of members per household. Low levels of employment and high levels of poverty are associated with a high dependency on natural resources such as firewood for energy. Many respondents stated that they used alien vegetation for this purpose.
- More than 14 per cent of the Underberg respondents who registered a zero WTP for the WfW Programme stated that they were unwilling to contribute to the Programme because they preferred alien vegetation over indigenous vegetation. A common rationale among these specific respondents was that alien vegetation was more useful to them as firewood and building material.
- It appears as if respondents from both Port Elizabeth and Worcester were paying for a combined good, namely the local biodiversity benefit of the WfW Programme + local employment creation.
- The apparent existence of strategic bias is a problem if the CVM is used solely to value the biodiversity benefit of the WfW Programme. However, if the CVM is used to pick up non-water benefits that have not been captured elsewhere, and the employment benefit perception of lower-income earners and individuals with lower levels of education has not been, this strategic behaviour of Port Elizabeth and Worcester respondents is no longer a problem.

There was a lack of expectations-based support for the WTP predictions generated using the CVM. It is clear that people’s WTP to preserve biodiversity is influenced by many different factors and that much work still remains to be done in uncovering the relative importance of these factors.

CHAPTER NINE
CONCLUSIONS AND RECOMMENDATIONS

A contingent valuation study conducted by du Plessis (2003) on six representative WfW sites in the Eastern Cape (namely Port Elizabeth Driftsands, Albany, Kat River, Kouga, Pot River and Tsitsikamma) indicated that the biodiversity benefit attributable to the WfW Programme was substantial. The present study has criticised the du Plessis (2003) study on, amongst other things, the basis of the sample design utilised. However, despite these deficiencies it was concluded that the basic argument made by du Plessis (2003), namely that the biodiversity benefit is potentially a major economic benefit, remains valid.

The main objective of the present study was to provide policymakers and other stakeholders with information on what people are prepared to pay for the biodiversity preservation benefit of the WfW Programme in order to contribute more evidence in support of the proposition made by du Plessis (2003).

9.1 CONCLUSION ON VALUES

The primary objective of a contingent valuation study is to determine an estimate of the total WTP. The total WTP to preserve indigenous vegetation at the three WfW sites are calculated below based on the results reported in Chapter Eight. To calculate the total value that people would be WTP per annum to preserve indigenous vegetation, the median (rather than the mean) WTP per annum were multiplied by the total number of user households residing in the local municipal area in which the three sites are situated. The preference for using the median WTP figures was based on a desire to avoid bias induced by (possibly) large bid values in the upper tail of the distribution (Hanley and Spash, 1993). The calculations are shown in Table 9.1.

Table 9.1: The median and total value (benefit) of preference for indigenous vegetation over alien vegetation

Site	Local municipality	Estimate of number of households benefiting	Median of predicted WTP (R)*	Total WTP (R / annum)	WTP per hectare[23] (R / ha)
Port Elizabeth: National WfW Programme	Nelson Mandela Metropolitan Municipality	17 287	43.24	747 489.88	85.92
Underberg: National WfW Programme	Kwa Sani Municipality	1 200	29.22	35 064.00	30.25
Worcester: National WfW Programme	Breede Valley Municipality	10 441	44.99	469 740.59	75.22
Port Elizabeth: Local WfW Programme	Nelson Mandela Metropolitan Municipality	17 287	32.82	567 359.34	65.21
Underberg: Local WfW Programme	Kwa Sani Municipality	1 200	21.12	25 344.00	21.87
Worcester: Local WfW Programme	Breede Valley Municipality	10 441	52.79	551 180.39	88.26

* Values are estimated on the basis of Table 8.27. The values relate to the period July 2005 to October 2005.

There are considerable differences between the median WTP figures per hectare at the different sites. There are many possible reasons for the differences. As mentioned previously one possible reason is differences in each site's

[23] The per hectare per annum Rand value was calculated as the total WTP per annum divided by the size of the respective project site. The size of the project site, rather than the estimated size of untransformed land in the local municipality, was used to determine the per hectare per annum Rand value as the target population was drawn up on the assumption that individuals with a demand for the biodiversity services, available at the two urban sites, namely Port Elizabeth Driftsands and Worcester, would locate themselves at some stage in a given year within a 5-kilometre radius of these sites. Due to the rural nature of the Underberg site, it was assumed that individuals with a demand for the biodiversity services available at this site would locate themselves at some stage in a given year within a 15-kilometre radius of the site.

characteristics. Another possible reason for these differences is that respondents interpreted the questionnaire differently.

The values generated in Table 9.1 include very small non-user passive WTP amounts because very little could be determined about this demand. It is probable that there is a starting point bias towards zero built into the values because, for many respondents, this is what they have been paying for biodiversity preservation.

9.1.1 EXPECTED FINDINGS

(a) Sensitivity of results

It was expected that respondents would be WTP more for the more inclusive good, i.e. the national WfW Programme, than for the less inclusive good (i.e. the local WfW Programme). The results correspond with this expectation at the Port Elizabeth and Underberg sites, but not at the Worcester site.

(b) Size of user population

By definition the user population is an important determinant of total WTP value and the results shown in Table 9.1 confirm this. The Port Elizabeth and Worcester sites, adjacent to which large populations live, top the total WTP valuations, while the Underberg site is at the bottom of the list.

9.1.2 CONFIDENCE IN RESULTS

It has been repeatedly stressed in this dissertation that contingent valuation studies are subject to many biases and, for this reason, need to be subjected to tests for validity and reliability. The method and nature of these tests were described in Chapters Four, Five and Eight. Chapter Four indicated that the contingent valuation technique has considerable potential for error, while Chapter Five showed that the technique could be applied to valuing biodiversity.

Expectations-based tests indicated that the different scenarios valued scored differently under this test (see Chapter Eight). Moderate support was found for valuations of the Port Elizabeth: local WfW Programme, Underberg: national WfW Programme and Underberg: local WfW Programme. Little support was, however, found for valuations of the Port Elizabeth: national WfW Programme and Worcester national and local scenarios.
The reliability of the estimates could not be assessed because only one survey was conducted per site.

9.2 CONCLUSION ON THE APPROPRIATENESS OF APPLYING THE CVM TO VALUING BIODIVERSITY

Given that most of the respondents used the sites in a variety of different ways and that it was not possible to capture their WTP for most of these uses through any revealed preference mechanism, the application of the CVM was appropriate. It was recognised from the outset that many problems would be encountered (see Chapter Four).

As was expected, some inconsistencies were found, for example, the sign of the gender coefficient in Worcester and the income coefficient in the Underberg local Programme scenario. It was also noted that unavoidable strategic factors had crept into the responses of people interviewed at both the Port Elizabeth and Worcester sites. These respondents were overstating their willingness to contribute to the preservation of indigenous vegetation through continued WfW activities in an attempt to improve their employment options. This employment juxtaposition was not seen as a problem if the CVM was used as a device to pick up non-water benefit measures that have not been captured elsewhere.

However, these inconsistencies were not of a nature that suggested the CVM was an inappropriate valuation method.

9.3 RECOMMENDATIONS

(a) Decisions on where the WfW Programme must function should not be made based solely on the water benefit.

(b) The sample size for the Worcester survey was found to be too small both in terms of the approach taken by Cochran (1977) with respect to random sampling with continuous data and in terms of published tables. Future studies should ensure that the sample sizes for all sites be in line with those indicated by statistical theory.

(c) The training of the people undertaking the surveys is a crucial aspect of the process, as is the tailoring of the questionnaire to the people from whom responses are being sought. Questionnaires should ideally be administered in the home language of the respondent.

(d) Data inconsistencies were found in certain instances. Follow-up questions and observations made during the surveys determined some of the reasons for these inconsistencies. There is, however, scope for improving the questions included in the survey instrument so as to limit future inconsistencies.

(e) When the data gathered at the three sites was compared, inconsistencies were found to exist. It is recommended that people's WTP to preserve indigenous vegetation be compared with those generated using a different valuation technique, e.g. CM or travel cost.

(f) Based on the observations made by the enumerators it is recommended that resources continue to be committed to educating the public about the activities of the WfW Programme and the potentially devastating effect that increasing alien vegetation coverage could have on South Africa's biodiversity. Those respondents who were aware of the activities of the WfW Programme tended to make higher WTP bids than respondents who were unaware of the Programme.

(g) Only the costs of clearing alien vegetation were included in the du Plessis (2003) study. The costs of restoring indigenous vegetation were omitted. These costs will have to be included if the benefits attributable to restoring indigenous vegetation are to be included in a revised CBA.

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APPENDIX 1: QUESTIONS TO ASSESS CONTENT VALIDITY

A framework of questions that should be addressed when assessing the content validity of a questionnaire is described below (Bateman *et al*., 2002).

Issues of scenario design:

- Is the good / service offered clearly specified to and understood by respondents?
- Is the information provided sufficient and reasonable to describe the provision and payment scenario?
- Is the trade-off between money and the good / service plausible?
- Are substitutes and the consequences of non-payment adequately described?

Elicitation Issues:

- Is the chosen welfare measure appropriate (WTP and WTA)?
- Is the chosen survey format appropriate?

Institutional context:

- Are the methods of provision and related institutional arrangements plausible?
- Are the respondents likely to have an expectation of having to pay for the good if it is provided?
- Are respondents likely to feel that they are providing an input to the decision-making process?

Sampling:

- Has the correct population been identified and adequately sampled?

Survey format:

- Is the choice of survey mode appropriate?
- Is the survey administration and data preparation of a sufficiently high standard?
- Does the questionnaire design gather adequate data concerning variables that are likely to explain WTP, so as to permit construct validity testing (including the elicitation of attitude and response reason data)?

APPENDIX 2: BLUE RIBBONS' GUIDELINES

1. For a single dichotomous choice question (yes-no type) format, a total sample size of at least 1000 respondents is required. Clustering and stratification should be accounted for and tests for interviewer and wording biases are needed.
2. High non-response rates would render the survey unreliable.
3. Face-to-face interviewing is likely to yield the most reliable results.
4. Full reporting of data and questionnaires is required for good practice.
5. Pilot surveying and presenting are essential elements in any CVM study.
6. A conservative design more likely to underestimate WTP is preferred to one likely to overestimate WTA.
7. A WTP format is preferred.
8. The valuation question should be posed as a vote on a referendum, i.e., a dichotomous choice question related to the payment of a particular level of taxation.
9. Accurate information of the valuation situation must be presented to respondents, with particular care required over the use of photographs.
10. Respondents must be reminded of the status of any undamaged possible substitute commodities.
11. Time-dependent measurement "noise" should be reduced by averaging across independently-drawn samples taken at different points in time.
12. A "no-answer" option should be explicitly allowed in addition to the "yes" and "no" vote options on the main valuation question.
13. Yes and no responses should be followed by the open-ended question: "why did you vote yes or no?".

14. On cross-tabulation, the survey should include a variety of other questions that help to interpret the responses to the primary valuation question, i.e., income, distance to site, prior knowledge of the site, etc.

15. Respondents must be reminded of alternative expenditure possibilities, especially when "warm glow" effects are likely to be present, i.e., purchase of moral satisfaction through the act of charitable giving.

Source: Barbier, Acreman and Knowler (1997)

APPENDIX 3: WESTERN CAPE: DOMESTIC TOURISM PATTERNS

The Western Cape has been divided into ten tourism regions. The ten regions are:

1. West Coast (Dwarskersbos, Paternoster, Langebaan, Vredenburg)
2. Winelands (Wellington, Paarl, Stellenbosch, Franschoek)
3. Breede River Valley (Worcester, Ceres, Montagu, Tulbagh, Robertson)
4. Central Karoo (Beaufort Wes, Murraysburg, Laingsburg, Prince Albert)
5. Garden Route (Mosselbaai, Hartenbos, Knysna, George, Wildernis)
6. Klein Karoo (De Rust, Uniondale, Oudtshoorn, Calitzdorp)
7. Cape Metropole (Cape Town Central, South Peninsula, Blaauwberg)
8. Swartland and Sandveld (Elandsbaai, Piketberg, Malmesbury, Moorreesburg)
9. Olifants River Valley (Clanwilliam, Lutzville, Citrusdal)
10. Overberg (Gansbaai, Grabouw, Napier, Swellendam, Struisbaai)

Source: Rule *et al*. (2001)

APPENDIX 4: KWAZULU-NATAL: DOMESTIC TOURISM REGIONS

KwaZulu-Natal has been divided into twelve tourism regions. The twelve regions are:

1. Battlefields (Newcastle, Utrecht, Dundee, Estcourt, Ladysmith, Colenso)
2. Drakensberg (Bergville, Cathedral Peak, Giant's Castle)
3. Durban Central (Westville, Berea, Glenwood, Bluff, City Centre, Golden Mile)
4. Durban South (Isipingo, Amanzimtoti-Umkomaas)
5. Durban North (Umhlanga and Umdloti)
6. Durban Outer West (Kloof, Botha's Hill, 1000 Hills, Assegai, Waterfall, Cato Ridge)
7. North Coast-Dolphin Coast (Ballito, Zinkwazi and surrounding areas)
8. South Coast (areas south of Umkomaas-Scottburgh, Pennington, Hibberdene, Port Shepstone, Margate, Southbroom, Port Edward etc.)
9. Pietermaritzburg and Midlands
10. Zululand (Vryheid, Melmoth, Babanango, Eshowe, Mtunzini, Ulundi, Richards Bay, including the Hluhluwe-Umfolozi and Itala game reserves)
11. Maputaland (mostly northward from St Lucia to Kosi Bay and the Mozambique border, including the Greater St Lucia Wetland Park and the Tembe and Ndumo game reserves)
12. East Griqualand (Kokstad, Matatiele, Cederberg, Swartberg)

Source: Rule *et al*. (2001)

APPENDIX 5: AN EXAMPLE OF A QUESTIONNAIRE USED IN THE SURVEY

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

Conducted by the Department of Economics and Economic History, Nelson Mandela Metropolitan University, 2005

PORT ELIZABETH DRIFTSANDS

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 ____________________. I am conducting a survey in this area on behalf of the Nelson Mandela Metropolitan University. 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 the Eastern Cape
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 5 the least preferred)

	Most Preferred				Least Preferred
Commercial plantations of Wattle or Pine or Gum	1	2	3	4	5
Plants and trees that grow in the wild, but which were brought to South Africa from elsewhere, e.g. Australia, such as Wattle, Pine, Gum and Hakea	1	2	3	4	5
Grassy Fynbos	1	2	3	4	5
Dune Thicket	1	2	3	4	5
South and South-west Coast Renosterveld	1	2	3	4	5

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

- Grassy Fynbos is mainly found on sandy soils. Unlike in all other types of Fynbos, grasses (and grassy elements) are present in very high numbers in Grassy Fynbos. These grasses tend to replace the reed component, which occurs in other types of Fynbos. Furthermore, Grassy Fynbos is separated from other Fynbos types by the presence of small-leaved shrubs and succulents (i.e. plants that store water in their stems and / or leaves, e.g. Aloe species) that do not belong to the Protea family and hairy broad leaved flowering plants. Typical grasses that are present include Red Grass, Spear Grass, Giant Spear Grass and Velvet Signal Grass.
- Dune Thicket occurs on young sands, which are protected from fires, often by the dune landscape. Dominant trees and shrubs include: Coast Silver Oak, White Milkwood, Common Spike Thorn, Dune Crow-berry, Dune String

and Bush-tick Berry (Bitou). Vines and climbers are common. Dense Dune Thicket however, consists mostly of woody elements.

- South and South-west Coast Renosterveld mainly occurs on fine-grained soils such as clays and silts. Because all these soils are fertile, much of this vegetation type has been ploughed for wheat or other types of crops. The major difference between this and the other Renosterveld vegetation types is the high proportion of grasses. Renosterbos, a member of the Daisy Family, dominates this vegetation type. However, many other plant species belonging to the Daisy, Pea, Gardenia, Cocoa and Thyme Families also occur. All these shrubs are characterised by their small, tough, grey leaves. Grasses, particularly Red Grass, and seasonally active bulbs are also plentiful. The Protea, Erica and Reed families usually do not occur in South and South-west Coast Renosterveld, and if they do occur, they are not plentiful.

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 **<u>NATIONAL</u> 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

<table>
<tr><td rowspan="2">[ ] YES</td><td rowspan="2">→</td><td rowspan="2">If YES: Would you be willing to pay R_____ every year?</td><td rowspan="2">(check one)</td><td>[ ] YES</td></tr>
<tr><td>[ ] NO</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="2">[ ] NO</td><td rowspan="2">→</td><td rowspan="2">If NO: Would you be willing to pay R_____ every year?</td><td rowspan="2">(check one)</td><td>[ ] YES</td></tr>
<tr><td>[ ] NO</td></tr>
</table>

(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 PREVIOUS 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 Driftsands 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 Wattle, and Eucalyptus species to restore Dune Thicket, Grassy Fynbos and South and South-west Coast Renosterveld, the indigenous vegetation of this area.

- Dune Thicket occupies 0.3% of South Africa, with 17.7% of all South Africa's Dune Thicket established in the Eastern Cape. It is used for firewood.
- Grassy Fynbos occupies 0.5% of South Africa, with 96.7% of it growing in the Eastern Cape. This vegetation type makes poor grazing, but is attractive to look at.
- South and South-west Coast Renosterveld makes up 1.1% of South Africa, with the Eastern Cape contributing 13.3% of this. It is used for grazing.

14 HOW MANY TIMES PER YEAR DO YOU GO HIKING / VISITING THE DRIFTSANDS 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 **PORT ELIZABETH DRIFTSANDS WORKING FOR WATER PROGRAMME** purely because of your preference for Dune Thicket, Grassy Fynbos and South and South-west Coast Renosterveld 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 PREVIOUS 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 the municipality 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 the Department of Economics and Economic History at the Nelson Mandela Metropolitan University 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

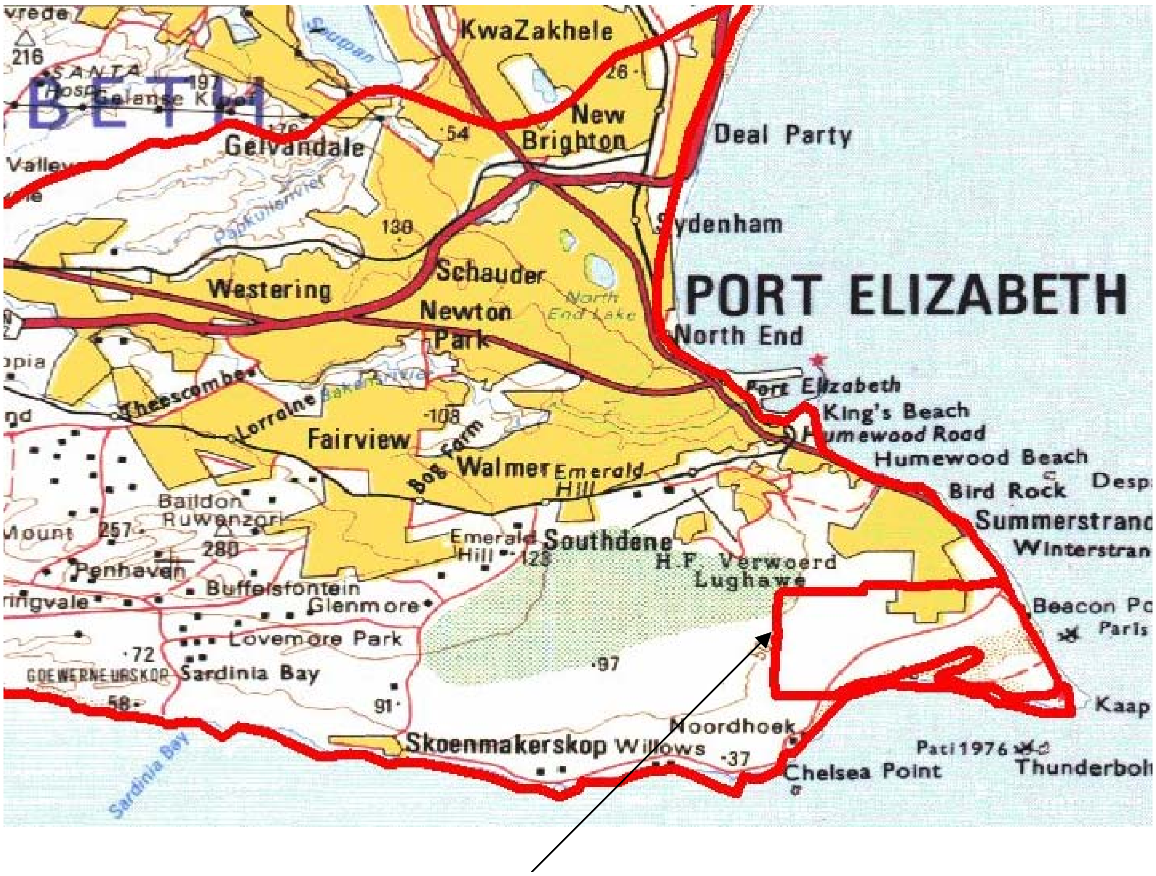
19.1	African
19.2	White
19.3	Coloured
19.4	Indian / Asian

20 GENDER OF RESPONDENT

20.1	Male
20.2	Female

Questionnaire compiled by members of the Department of Economics and Economic History, NMMU. Questions about this project may be directed to Prof SG Hosking, tel. 041-504 2205, email: Stephen.hosking@nmmu.ac.za.

APPENDIX 6: MAP SHOWN TO RESPONDENTS DURING THE PORT ELIZABETH SURVEY

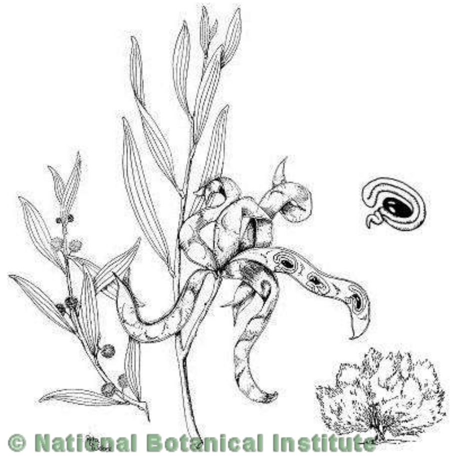


Port Elizabeth Driftsands WfW Project

Source: Conservation Support Services (2003)

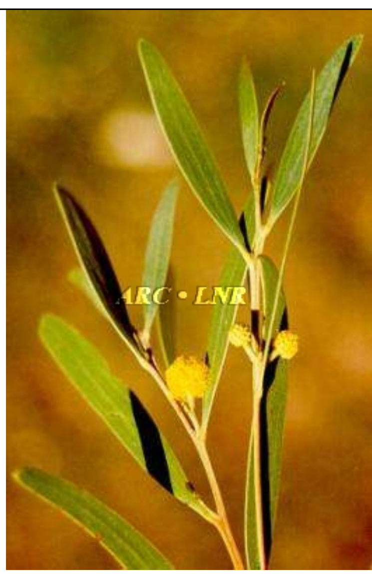
APPENDIX 7: PICTURES SHOWN TO RESPONDENTS DURING THE PORT ELIZABETH SURVEY: ALIEN VEGETATION

Red Eye (Afrikaans: Rooikrans)
Acacia cyclops



Plant

Leaves



Flowers

Fruit

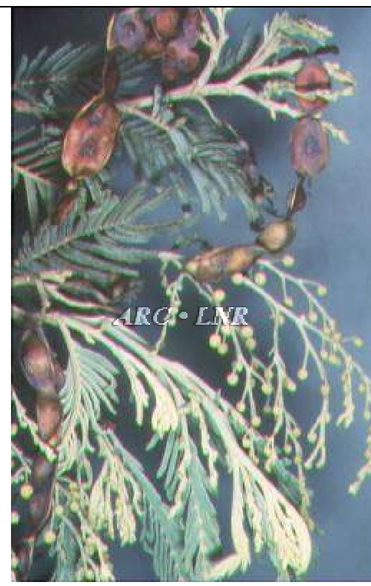
Source: http://www.agis.agric.za/agisweb/wip

Silver Wattle (Afrikaans: Silwerwattel)
Acacia dealbata

Plant

Leaves

Flowers

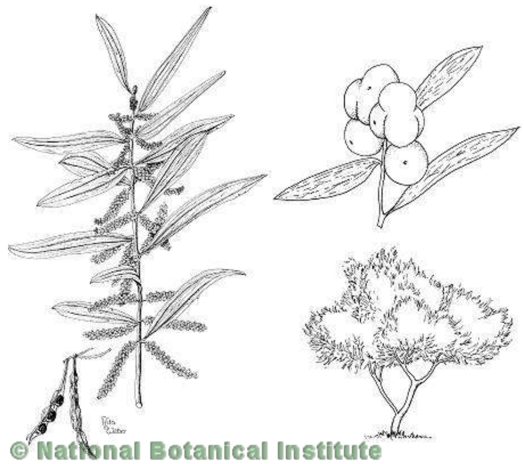


Fruit

Source: http://www.agis.agric.za/agisweb/wip

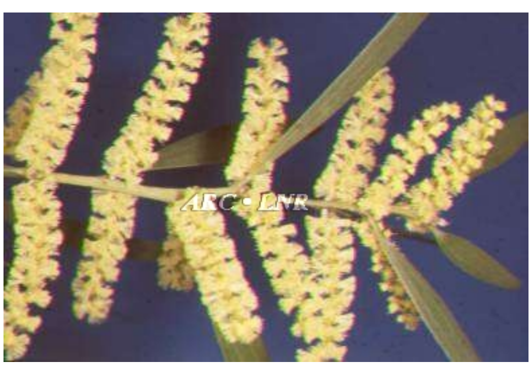
Long-leaved Wattle, Golden Wattle, Sydney Golden Wattle (Afrikaans: Langblaarwattel)

Acacia longifolia



Plant

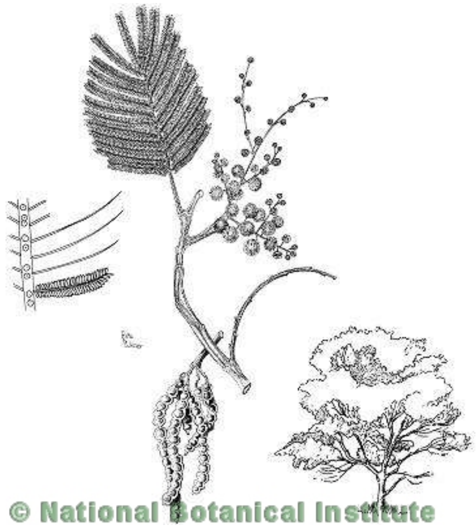
Leaves



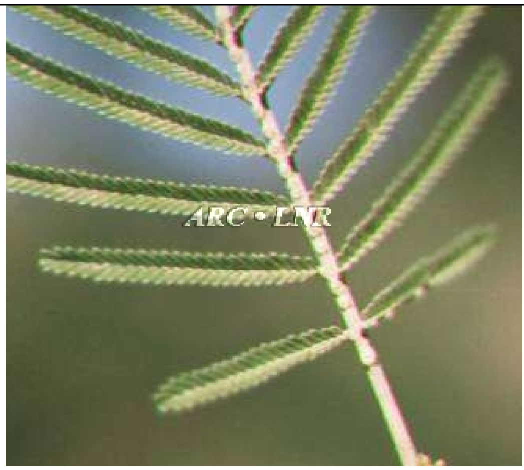
Flowers

Source: http://www.agis.agric.za/agisweb/wip

Black Wattle (Afrikaans: Swartwattel; Zulu: Uwatela)
Acacia mearnsii



Plant



Leaves

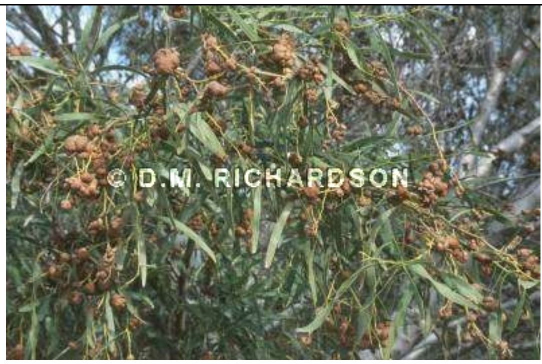
Flowers

Fruit

Source: http://www.agis.agric.za/agisweb/wip

Port Jackson, Port Jackson Willow, Golden Willow (Afrikaans: Goudwilger)
Acacia saligna

Plant



Leaves

Flowers

Fruit

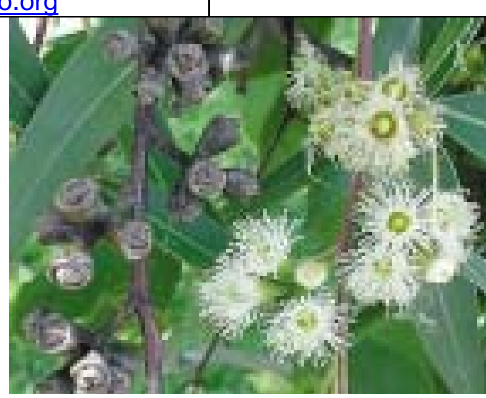
Source: http://www.agis.agric.za/agisweb/wip

Saligna Gum, Rose Gum (Afrikaans: Salignabloekom)
Eucalyptus grandis

Source: http://www.agis.agric.za/agisweb/wip

Plant
Source: www.fao.org

Leaves
Source: http://www.agis.agric.za/agisweb/wip

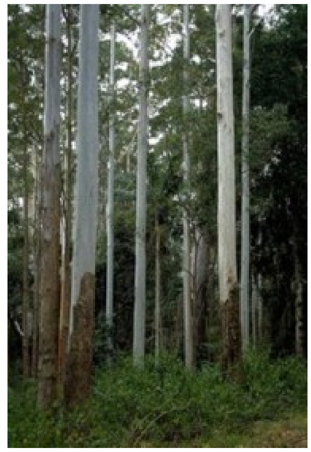


Flowers
Source:
www.durban.gov.za/eThekwini/Municipality/environment/documents_reports/alien/alien_plants_4

APPENDIX 8: PICTURES SHOWN TO RESPONDENTS DURING THE PORT ELIZABETH SURVEY: COMMERCIAL PLANTATIONS

Gum Plantations

Source: www.gtplantations.org/.../image_figure1.jpg



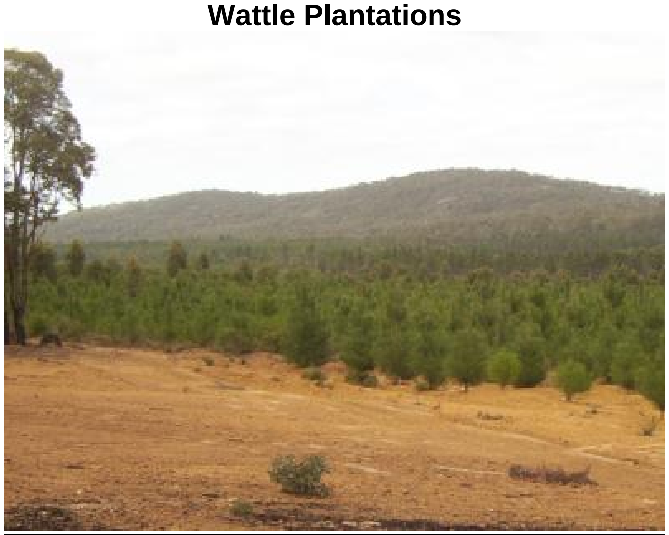
Source: users.bigpond.net.au/eagle33/places/tsv.htm

Pine Plantations

Source: www.sumtertimber.com/images/Pine-Plantation-1.jpg

Source: www.tarleton.edu/

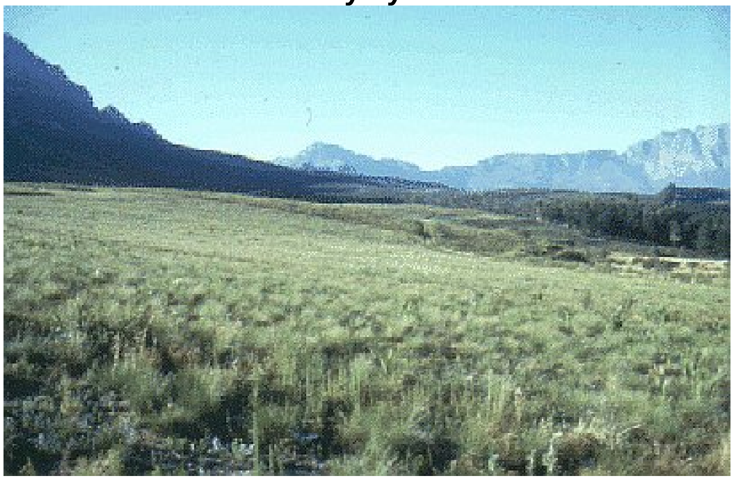
Wattle Plantations



Source: http://patrick.wattle.id.au/cameron/walks/mtcooke/0925.jpeg

APPENDIX 9: PICTURES SHOWN TO RESPONDENTS DURING THE PORT ELIZABETH SURVEY: INDIGENOUS VEGETATION

Grassy Fynbos



Source: www.botany.uwc.ac.za/presents/fynbos/24.htm

Red Grass (Afrikaans: Rooigras; Zulu: iNsinde.)
Themeda triandra

Source:
http://www.plantzafrica.com/planttuv/themedatri.htm

Spear Grass (Afrikaans: Assegaaigras)

Heteropogon contortus
Source:
www.krugerpark.co.za/images/PG00014A.jpg

Giant Spear Grass (Afrikaans: Bokbaardgras)

Trachypogon spicatus
Source: www.that.co.za/custom/grasses/giant.jpg

Velvet Signal Grass (Afrikaans: Fluweelsinjaalgras)

Brachiaria serrata
Source:
http://www.fao.org/ag/AGP/AGPC/doc/Gallery/safricapics/bracser.htm

Dune Thicket	
 Source: http://bgis.sanbi.org/STEP/vegetation.asp#slideshow	
  **Coast Silver Oak** (Afrikaans: Kusvaalbos; Zulu: umPhahla, umDali, isiPhaluga; Xhosa: umPhahla, umDali) ***Brachylaeana discolor*** Source: http://zoo.upe.ac.za/grysbok/tplants.htm	  **White Milkwood** (Afrikaans: Witmelkhout; Zulu: aMasethole-amhlope, uMakhwela-fingqane; Xhosa: aMasethole, umQwashu) ***Sideroxylon inerme*** Source: http://zoo.upe.ac.za/grysbok/tplants.htm

Dune String, Dune Gonna (Afrikaans: Seekoppiesgonna, Gonnabas; Zulu: uNyenyevu)
Passerina rigida
Source: http://zoo.upe.ac.za/grysbok/tplants.htm

Common Spike Thorn (Afrikaans: Gewone Pendoring; Zulu: uSala, iNgqwangane, isiBhubhu, isiHlangu; Xhosa: umQaqoba)
Maytenus heterophylla
Source:
www.plantweb.co.za/Plant_Pictures/Maytenus/Maytenus_heterophylla/thumbnails/Maytenus_heterophylla.jpg.jpg

Dune Crow-berry (Afrikaans: Duine-kraaibessie, Kraaibessie, Soettaaibos, Rosyntjiebos; Xhosa: umhlokotshane)
Rhus crenata
Source:
http://zoo.upe.ac.za/grysbok/tplants.htm

Bush-tick Berry, Bitou (Afrikaans: Bietou; Zulu: umTholombe; Xhosa: ulwAmfithi)
Chrysanthemoides monilifera
Source: http://zoo.upe.ac.za/grysbok/tplants.htm