Report No: P WMA
19/G10/00/2413/3

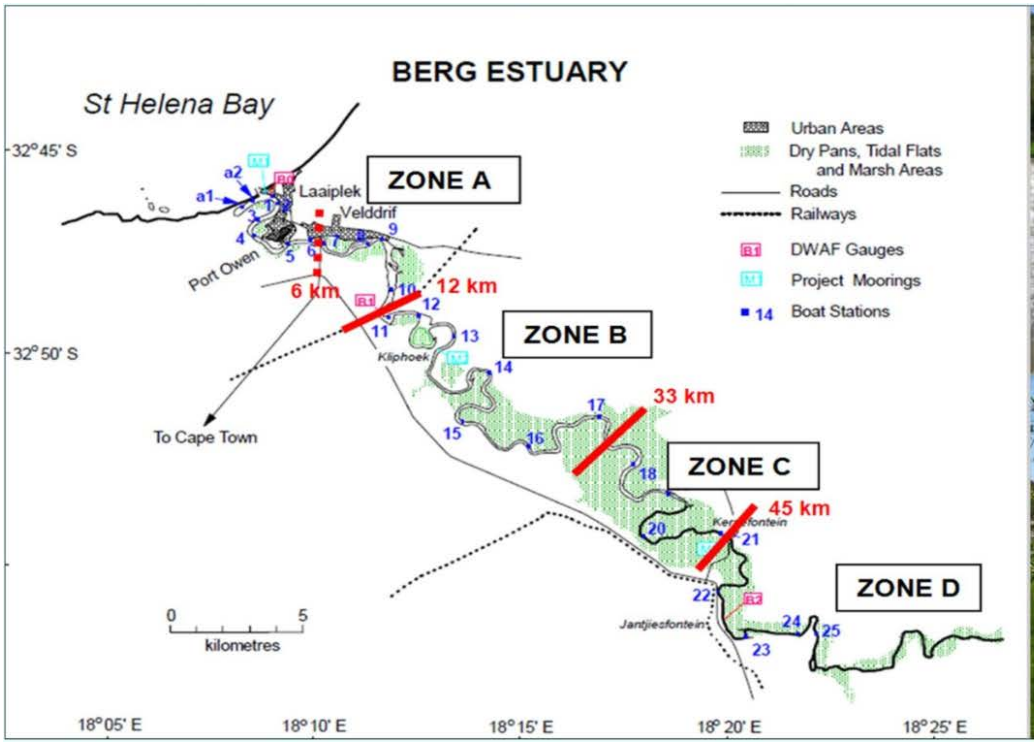
Department of Water Affairs
Directorate: Options Analysis

PRE-FEASIBILITY AND FEASIBILITY STUDIES FOR AUGMENTATION OF THE WESTERN CAPE WATER SUPPLY SYSTEM BY MEANS OF FURTHER SURFACE WATER DEVELOPMENTS

REPORT No.1 – VOLUME 3
Berg Estuary Environmental Water Requirements

APPENDIX No.I

Specialist Report - The Economic Value of the Berg River Estuary



June 2012

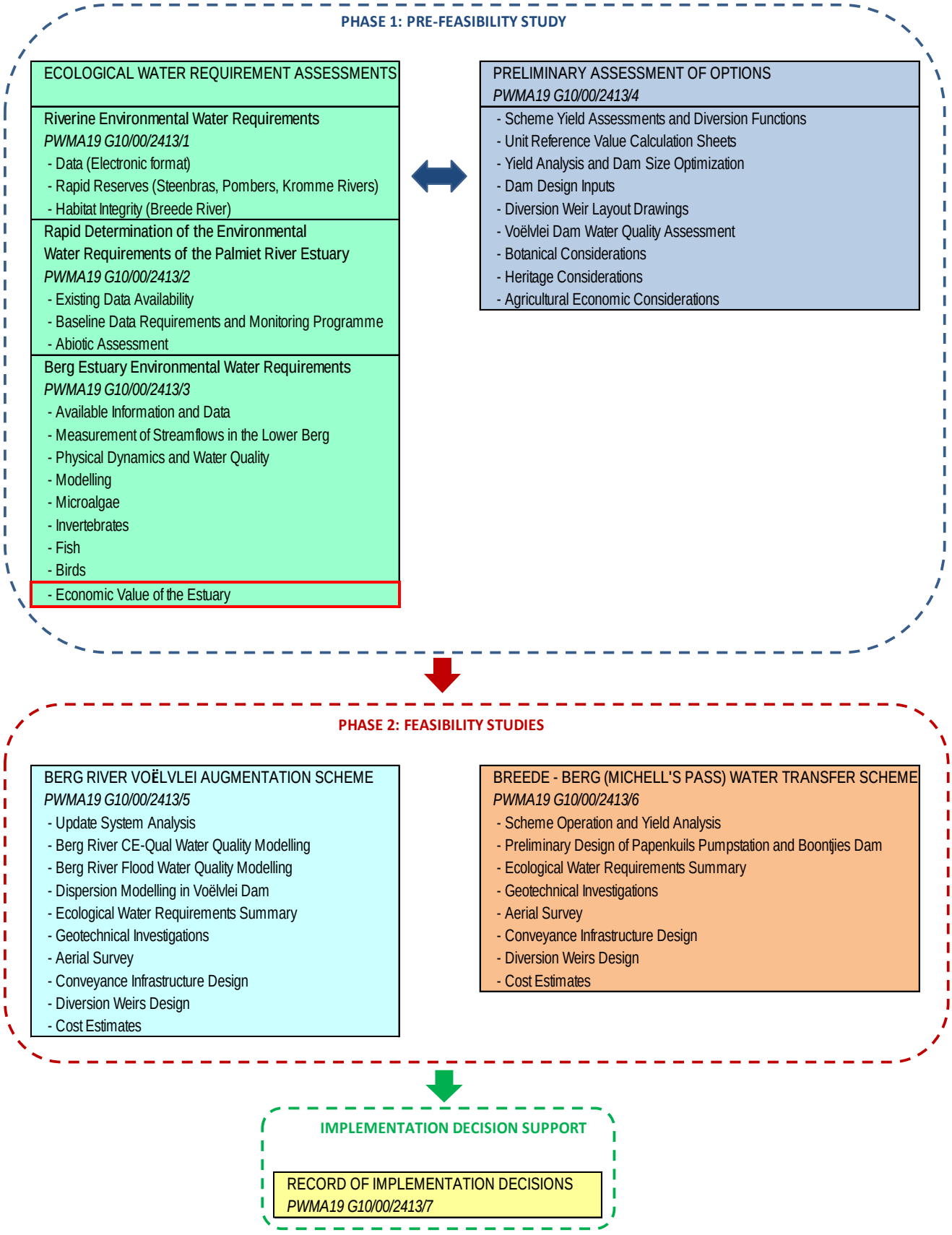
STUDY REPORT LIST

REPORT No	REPORT TITLE	VOLUME No.	DWA REPORT No.	VOLUME TITLE
1	ECOLOGICAL WATER REQUIREMENT ASSESSMENTS	Vol 1	PWMA19 G10/00/2413/1	**Riverine Environmental Water Requirements**
				Appendix 1: EWR data for the Breede River
				Appendix 2: EWR data for the Palmiet River
				Appendix 3: EWR data for the Berg River
				Appendix 4: Task 3.1: Rapid Reserve assessments (quantity) for the Steenbras, Pombers and Kromme Rivers
				Appendix 5: Habitat Integrity Report – Breede River
		Vol 2	PWMA19 G10/00/2413/2	**Rapid Determination of the Environmental Water Requirements of the Palmiet River Estuary**
				Appendix A: Summary of data available for the RDM investigations undertaken during 2007 and 2008
				Appendix B: Summary of baseline data requirements and the long-term monitoring programme
				Appendix C: Abiotic Specialist Report
		Vol 3	PWMA19 G10/00/2413/3	**Berg Estuary Environmental Water Requirements**
				Appendix A: Available information and data
				Appendix B: Measurement of streamflows in the Lower Berg downstream of Misverstand Dam
				Appendix C: Specialist Report – Physical dynamics and water quality
				Appendix D: Specialist Report – Modelling
				Appendix E: Specialist Report – Microalgae
				Appendix F: Specialist Report – Invertebrates
				Appendix G: Specialist Report – Fish
				Appendix H: Specialist Report – Birds
				Appendix I: Specialist Report – The economic value of the Berg River Estuary
2	PRELIMINARY ASSESSMENT OF OPTIONS		PWMA19 G10/00/2413/4	Appendix 1: Scheme Yield Assessments and Diversion Functions
				Appendix 2: Unit Reference Value Calculation Sheets
				Appendix 3: Yield Analysis and Dam Size Optimization
				Appendix 4: Dam Design Inputs
				Appendix 5: Diversion Weir Layout Drawings
				Appendix 6: Voëlvlei Dam Water Quality Assessment
				Appendix 7: Botanical Considerations
				Appendix 8: Heritage Considerations
				Appendix 9: Agricultural Economic Considerations

STUDY REPORT LIST (cntd)

REPORT No	REPORT TITLE	VOLUME No.	DWA REPORT No.	VOLUME TITLE
3	FEASIBILITY STUDIES	Vol 1	PWMA19 G10/00/2413/5	**Berg River-Voëlvlei Augmentation Scheme**
				Appendix 1: Updating of the Western Cape Water Supply System Analysis for the Berg River-Voëlvlei Augmentation Scheme
				Appendix 2: Configuration, Calibration and Application of the CE-QUAL-W2 model to Voëlvlei Dam for the Berg River-Voëlvlei Augmentation Scheme
				Appendix 3: Monitoring Water Quality During Flood Events in the Middle Berg River (Winter 2011), for the Berg River-Voëlvlei Augmentation Scheme
				Appendix 4: Dispersion Modelling in Voëlvlei Dam from Berg River Water Transfers for the Berg River-Voëlvlei Augmentation Scheme
				Appendix 7 - 12: See list under Volume 2 below
		Vol 2	PWMA19 G10/00/2413/6	**Breede-Berg (Michell's Pass) Water Transfer Scheme**
				Appendix 5: Scheme Operation and Yield Analyses with Ecological Flow Requirements for the Breede-Berg (Michell's Pass) Water Transfer Scheme
				Appendix 6: Preliminary Design of Papenkuils Pump Station Upgrade and Pre-Feasibility Design of the Boontjies Dam, for the Breede-Berg (Michell's Pass) Water Transfer Scheme
				Appendix 7: Ecological Water Requirements Assessment Summary for the Berg River-Voëlvlei Augmentation Scheme , and the Breede Berg (Michell's Pass) Water Transfer Scheme
				Appendix 8: Geotechnical Investigations for the Berg River-Voëlvlei Augmentation Scheme, and the Breede-Berg (Michell's Pass) Water Transfer Scheme
				Appendix 9: LiDAR Aerial Survey, for the Berg River-Voëlvlei Augmentation Scheme, and the Breede-Berg (Michell's Pass) Water Transfer Scheme
				Appendix 10: Conveyance Infrastructure Design Report, for the Berg River-Voëlvlei Augmentation Scheme, and the Breede-Berg (Michell's Pass) Water Transfer Scheme
				Appendix 11: Diversion Weirs Design for the Berg River-Voëlvlei Augmentation Scheme, and the Breede-Berg (Michell's Pass) Water Transfer Scheme
				Appendix 12: Cost Estimates for the Berg River-Voëlvlei Augmentation Scheme, and the Breede-Berg (Michell's Pass) Water Transfer Scheme
4	RECORD OF IMPLEMENTATION DECISIONS		PWMA19 G10/00/2413/7	

STUDY REPORT MATRIX DIAGRAM



ACKNOWLEDGEMENTS

PREPARED FOR THE WCWC JV BY:
Anchor Environmental Consultants
Suite 8, Steenberg House
Steenberg Office Park, Tokai
7945

AUTHORS:
J. Turpie, B. Clark, G. Wilson

REVIEWER:
C.A. Brown

LEAD CONSULTANT:
Anchor Environmental

EDITOR:
B. Clark

TABLE OF CONTENT

1 INTRODUCTION

South Africa has roughly 258 functioning estuaries along its approximately 3 100 km coastline. Many human activities undertaken in estuaries and their catchment areas impact directly on estuarine biodiversity and resource stocks, and different activities often conflict with one another through such impacts. If estuaries and their catchments are to be managed in an optimal sustainable way, it is necessary to understand the full economic value of the goods and services that they provide. This is generally assessed within a modified Total Economic Value framework, which includes subsistence, property, tourism, nursery, and existence value of estuaries (Turpie and Clark 2007).

Subsistence value is the value derived from subsistence fishers who harvest resources (e.g. fish, reeds, building material) from an estuary. Property value of estuaries is the premium paid for access to or views of estuaries and represents the value or willingness to pay for that amenity. Tourism value of an estuary is reflected in visitors' expenditure on travel to get to the estuary and accommodation at the site. The nursery value of an estuary is the value that a system contributes to marine fishery production through the provision of nursery habitat for commercially or recreationally valuable species. The existence value of estuaries is the feeling of satisfaction that their existence generates. People are willing to pay to maintain that feeling and this willingness to pay is used to reflect this value in monetary terms.

The recreational value of the Veldrif area is dominated by use of the estuary. The recreational use value of an estuary includes its aesthetic value, and is expressed in terms of (i) expenditure by visitors on trips to the estuary, and (ii) by investment in property with access to or views of the estuary, in the case of residents and holiday homeowners. This expenditure impacts on the broader economy, creating income for the tourism industry, the real-estate sector and other knock-on effects. Moreover, the existing expenditure may be less than users' actual willingness to pay for access to the estuary, with the differential being expressed as the aggregate consumers' surplus. From the users' perspective, total recreational use value in the sense of the total utility or wellbeing derived from the estuary includes this consumer surplus.

This report presents information on subsistence value, property value, visitor expenditure, nursery value of the system for fish, and existence value of the Berg estuary on the basis of existing information and a survey of user households in the area. The aim of the study was to ascertain the degree to which the estuary contributes to recreational and property values, and how these values might change due to predicted changes in the estuary characteristics under the different scenarios. These changes are ultimately linked to the changes in flow associated with the scenarios.

2 METHODS

This section provides details on the manner in which the user survey in Veldrif at the mouth of the Berg estuary was implemented and how the data were analysed.

2.1 OVERALL APPROACH

The recreational use value of the Berg Estuary was estimated in terms of the investment in property made by residents and the expenditure of visitors that was attributed to the estuary. Data were collected by means of a survey of estate agents and a questionnaire survey that was targeted at permanent residents, holiday homeowners and visiting users of the estuary.

The user survey was carried out during September 2009. A total of 498 households/groups were interviewed in the vicinity of the Berg Estuary, of which more than half were permanent residents and one third were visitors (Table 2.1). Interviews were conducted in English and Afrikaans and each took approximately 20-30 minutes.

Table 2.1 Sample size of the survey for the Veldrif (Laaiplek, Veldrif, Noordhoek, Port Owen) area.

Category	Sample size
Resident	269
Holiday homeowner	52
Visitor	177

Two valuation methods were used in combination in this study: hedonic pricing and conjoint valuation. Data were collected by means of a questionnaire survey of households conducted in the vicinity of the Berg Estuary. Two questionnaires were designed, one for property owners and one for visitors. The structure of the questionnaires was roughly as follows.

Property owners: permanent residents and holiday homeowners

- Household size
- Time spent in the area per year
- Contribution of different attractions/amenities to the attractiveness of the area
- Contribution of different activities to enjoyment of the estuary
- Frequency of visiting the estuary
- Boats and angling activities
- Description and value of property and role of estuary in investing in property
- Evaluation of scenarios of estuary condition (5 questionnaire versions)
- Impact of best and worst scenarios on use and property value
- Household income

Visitors

- Origin and group size
- Length of vacation at site and in SA
- Type and location of accommodation
- Trip expenditure
- Contribution of different attractions/amenities to the attractiveness of the area
- Contribution of different activities to enjoyment of the estuary
- Frequency of visiting the estuary
- Boats and angling activities

- Evaluation of scenarios of estuary condition (5 questionnaire versions)
- Impact of best and worst scenarios on use
- Household income

2.2 ESTIMATION OF USE AND APPRECIATION OF ESTUARY

To gauge the importance of the estuary respondents of the questionnaire survey were asked to estimate how much a variety of attractions, including the estuary, contributed to the attractiveness of the area. Respondents were also asked to indicate whether they participated in various activities (as a percentage) as well as to indicate the extent that these activities (fishing, bait collecting, boating, relaxing, walking, swimming, launching, and photography/art) contributed to their enjoyment of the area. Some respondents also indicated other activities in which they participated in while in the Veldrif area, but these other activities were excluded from this analysis, as the low-level response to any activity did not make the inclusion meaningful.

2.3 APPROACH TO PROPERTY VALUE AND HEDONIC PRICING

Property values associated with the natural environment are typically investigated using the Hedonic Pricing Method, which is a multivariate statistical technique that allows non-market valuation of the characteristics of a commodity rather than of the entire commodity itself (UNEP 1995). The method is based on the premise that a commodity, such as a house, can be defined as bundle of measurable characteristics or variables, such as size, location, and views, which together determine the total price of the commodity being investigated (Russell, 2001). This approach assumes it is possible to isolate the contribution of a given variable and thus estimate the relative proportion of the full price paid for a commodity that can be attributed to that given characteristic or variable. The general formula used in a hedonic valuation includes a suite of variables falling under four broad categories and is described by the equation (following Pearce and Turner, 1990):

Property price = f (property variables, neighbourhood variables, accessibility variables, environmental variables)

The hedonic pricing method assumes that consumers have access to the entire housing market and can differentiate among or between variables of a property and as such, there is a sufficiently wide variety of choices on all characteristics that no one is stuck in an indecisive situation (Kulshreshtha and Gillies, 1993, UNEP, 1995, Russell, 2001). It further assumes that the market is in or near equilibrium (Russell 2001). While these assumptions may not always hold true, it is accepted that this method provides a reasonable approximation of the actual values.

The permanent residents and holiday homeowners were asked information about their properties, including its location, distance from the coast or estuary, number of bedrooms and an approximate value of the property. Properties for which data were incomplete were excluded from the analysis.

The remaining data were analysed to establish the various attributes that contributed to property value in order to isolate the premium associated with the estuary. Information was obtained by using Google Earth on the number of houses in each of the main suburbs (Veldrif, Port Owen, Laaiplek and Noordhoek). The formula derived from the analysis of the data collected during the surveys was applied to these properties to derive a premium for the whole estuary, with the results extrapolated to determine a premium attributable to the estuary based on the number of properties along the estuary and the proportion of those with a water view.

The hedonic model was used to estimate the total value of the properties based on the total number of properties, the average size of the properties and the proportion of houses at different distances from the estuary in each suburb area. The 'basal price' without any coastal premium was estimated by applying the same model, except assuming that all properties were at a maximum distance from the estuary (5 km). This was subtracted from the current value to obtain the aggregate premium. This capital value was converted to an annual value by estimating the cost of capital (income to the financial sector) and the income to the property sector, based on estimated turnover rates and payments relating to the purchase of property.

2.4 ESTIMATION OF VISTOR EXPENDITURE

The expenditure by visitors to the Veldrif area was estimated based on the average expenditure reported in the surveys and estimated visitor numbers. Respondents were asked to indicate the total amount their group budgeted to spend during the entire trip, and were reminded to think about their expenditure on accommodation, tours, restaurants, entertainment and shops. They were also asked to indicate the degree to which visiting the Veldrif area was the reason for the trip, expressed as a percentage.

2.5 EVALUATION OF ALTERNATIVE SCENARIOS

Stated preference methods were used to estimate the potential impacts of environmental quality on recreational value. In this study, respondents were presented with four different scenarios and requested to rate them in terms of their relative appeal on a scale from zero (not at all appealing) to ten (it does not get any better). The most preferred and least preferred scenarios were then selected, and for each of these scenarios, property owners indicated what the effect on their property value would be while visitors indicated the affect on the amount of time they would spend in the Veldrif area.

3 ECONOMIC VALUE OF THE BERG ESTUARY

3.1 SUBSISTANCE VALUE

Information on subsistence fishing effort on the Berg estuary is available from two sources. Turpie and Clark (2007) evaluated subsistence use of all estuaries between the Orange and the Mdumbe using survey data collected as part of the Subsistence Fisheries Task Group assessment (Clark *et al.* 2002, Branch *et al.* 2002). These data were collected by a team of enumerators who were tasked with interviewing key informants knowledgeable regarding subsistence fishing activities in a series of eight regions spanning the South African coastline. Estimates of the total number of subsistence fishers in the area around the Berg estuary was available from Clark *et al.* 2002, while an estimate of the value of the annual subsistence catch from the estuary was derived by multiplying the average catch per resource (invertebrates and fish) caught fisher per annum by an estimate of the value for each as proffered by the fishermen themselves (data from Branch *et al.* 2002). Based on these data, Turpie and Clark (2009) estimated the subsistence value of the Berg estuary to be in the order of R600 000 per annum.

The second source of data is from the work of Hutchings *et al.* (2008) who undertook a survey of linefishing effort on the Berg estuary in the period December 2002 to November 2005. Recreational and subsistence anglers were differentiated through the gear that they used – recreational anglers generally fished with a rod and reel while subsistence fishers generally used handlines – and from information supplied by the anglers themselves. This study was concerned with linefish catch only, and did not include surveys of invertebrate (bait fisheries) or net (illegal gill netting). The total value of the subsistence fishery derived from this study can thus be considered a minimum estimate only. Hutchings *et al.* (2008) authors estimated that average annual subsistence line fishing effort (estimated by extrapolating from instantaneous counts of the number of fishers in each survey section) was in the order of 1 448 shore angler days for the period 2003-2005. Fishing effort was not consistent across all months, and peaked in summer, although fishers remained active for much of the year with low effort only observed during late winter (August-October). Catch-per-unit-effort (CPUE), catch (total number of fish per year), and catch value was estimated separately for the dominant species caught (Table 3.1). Catch value was calculated by multiplying the replacement value of the protein derived from the fish (assumed to be a constant R20/kg for all species) by the average mass of an individual fish in each species by the estimated total annual catch from Hutchings *et al*. (2008). Total value of the subsistence linefish catch from the Berg

Table 3.1 Catch-per-unit-effort (fish.angler^{-1}.hour^{-1}) and total annual catch by species for subsistence fishers on the Berg estuary, December 2002-November 2005 (from Hutchings *et al.* 2008).

Species	CPUE	Annual catch	Value per fish	Total catch value
Elf	1.158	7 846	R 6.00	R 47,076.00
Harder **	1.711	11 237	R 6.00	R 67,422.00
Carp **	0.296	2 688	R 40.00	R107,520.00
Barbel	0.017	158	R 30.00	R 4,740.00
White stump	0.017	109	R 8.00	R 872.00
Gurnard *	0.002	13	R 10.00	R 130.00
Other sp *.	0.006	48	R 6.00	R 288.00
All species	3.207	22 100		R228,048.00

estuary was estimated at R228 048 per annum. Given that this is a minimum estimate for the fishery as it include only line fishing effort (i.e. does not take account of net fish catch or invertebrates catches) it is likely that the true value lies somewhere between this and the value provided by Turpie and Clark (2008) – i.e. between R2228 000 and R600 000.

3.2 TOURISM AND RECREATIONAL USE AND VALUE OF THE BERG RIVER ESTUARY

3.2.1 Respondent Characteristics

Respondents were predominantly white and coloured, and permanent residents comprised the largest proportion of respondents followed by visitors and holiday homeowners (Figure 3.1). Whites were the highest number of respondents for all three categories interviewed, but comprised a relatively higher proportion of holiday homeowners while coloureds made up a relatively higher proportion of residents and visitors (Figure 3.2).

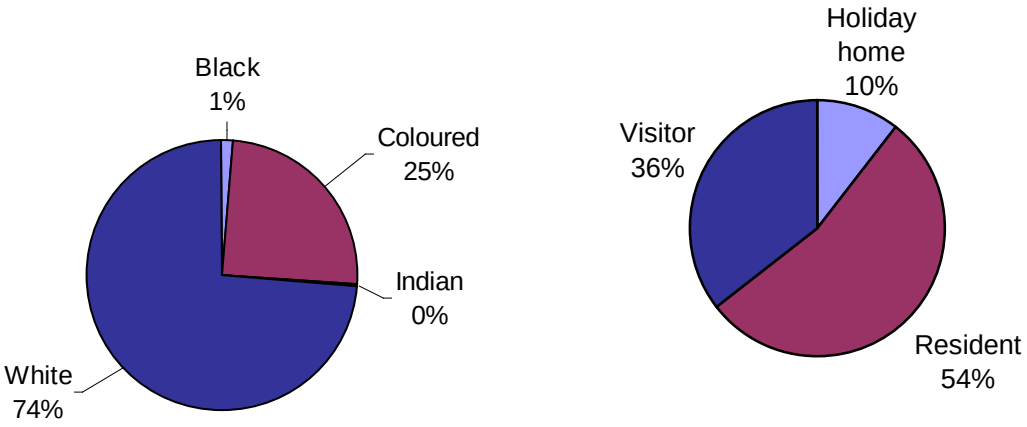


Figure 3.1 a) Racial composition of respondents (n = 472) and b) the type of respondent (n = 498).

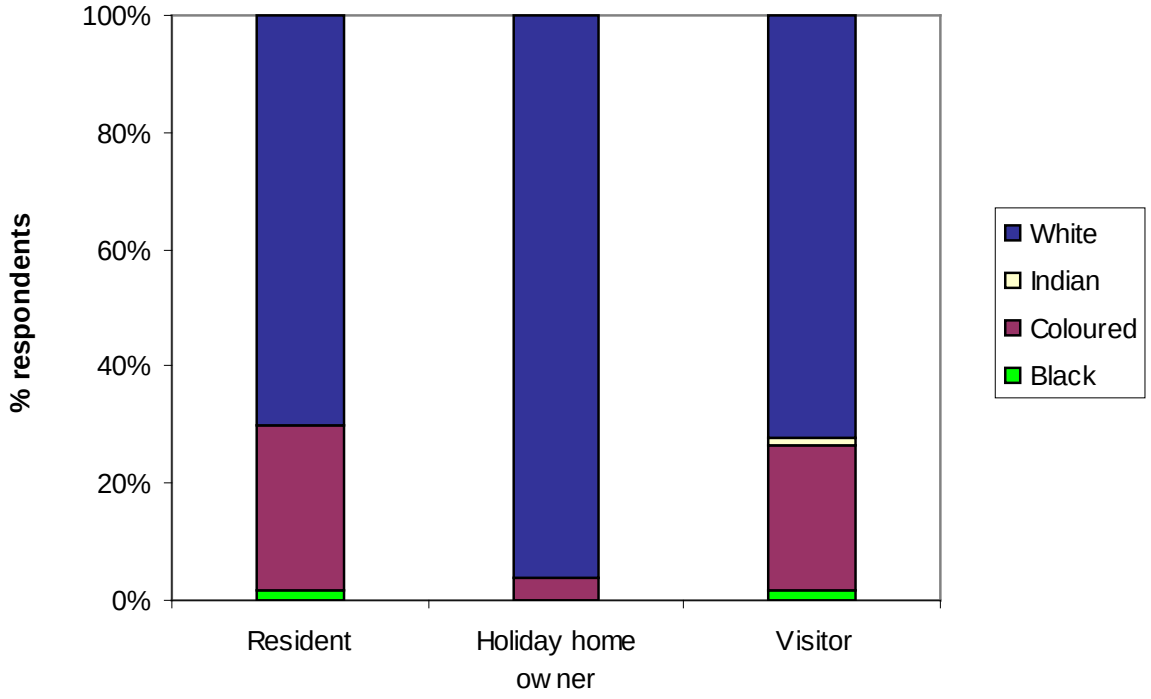


Figure 3.2 Race composition of types of respondents (n = 472).

The majority of the respondents (60%) earned less than R20 000 per month, with the remaining 40% earning more than R20 000 per month (Figure 3.3).

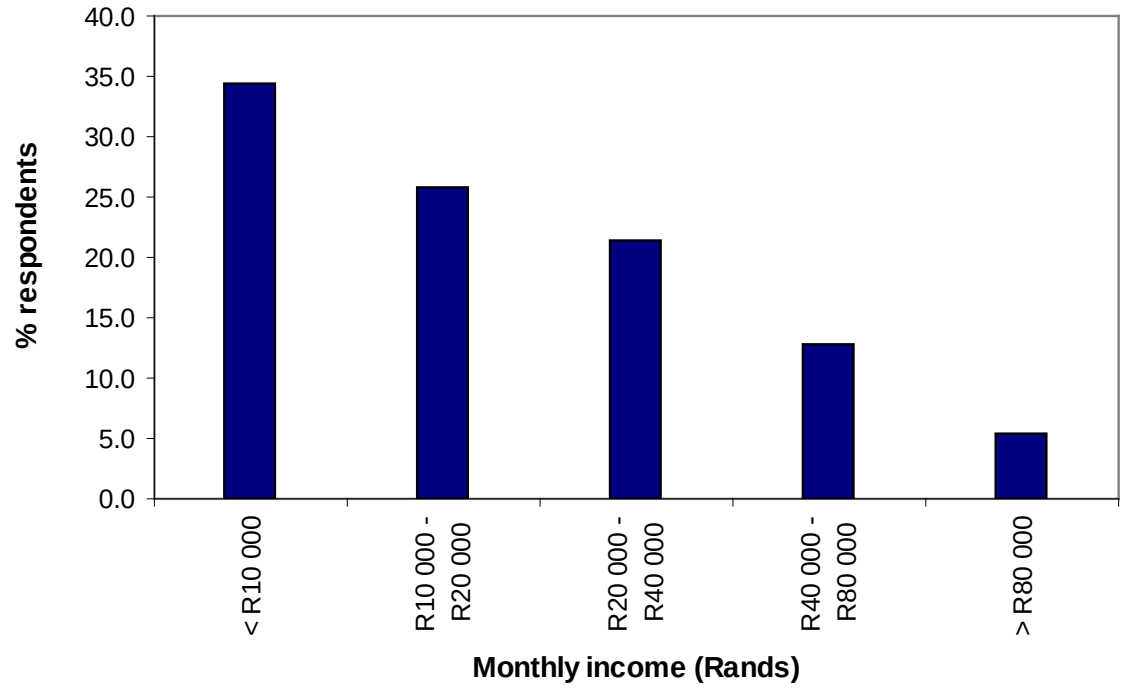


Figure 3.3 Percentage of respondents in each household income category (n = 438).

3.2.2 Overall numbers of users

Development around the Berg Estuary comprises of four main suburbs (Veldrif, Laaiplek, Noordhoek and Port Owen). Laaiplek is situated near the mouth of the estuary, closest to the beach, and has 353 properties (Figure 3.4). Port Owen, which is found on the estuary near the marina, has 270 properties, a large proportion of which are found on the marina system. Veldrif, which has 550 properties, is east of Laaiplek and Port Owen, further from the mouth but adjacent to the estuary. North of Veldrif is Noordhoek, the suburb furthest from the estuary, which has 820 properties. This gives a total of 2 017 properties, whose permanent or temporary residents may utilise the estuary to some degree.

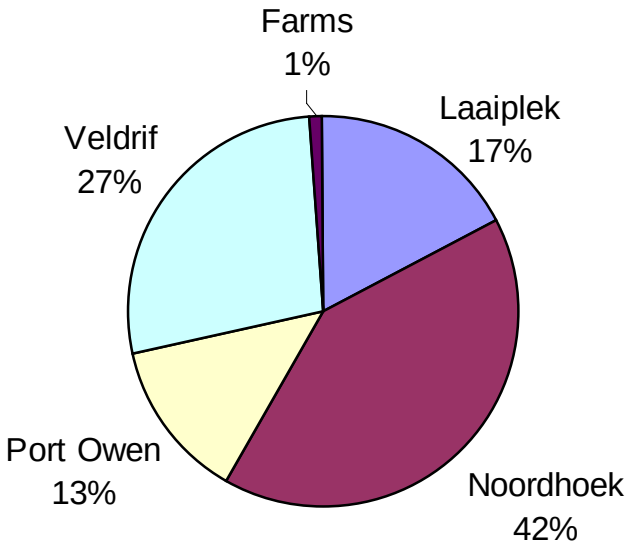


Figure 3.4 Percentage properties within each suburb surrounding the Berg Estuary

Permanent residents made up 54% of the respondents (n=498) in the sample, with holiday homeowners and visitors respectively 10% and 36% of the sample. Based on this study, we estimate that permanent residents occupy about 70% of properties (1 411). The total number of visitors to the estuary is unknown. Assuming 20% occupancy of the remaining properties, this equates to 226 100 household days, or nearly 840 000 visitor days per annum, based on average group size (Table 3.2). The latter includes both holiday homeowners and visitors. Resident households have an average of 3.24 occupants, compared with 3.59 for people occupying holiday homes. Based on this the resident population is roughly 4 570 residents in 1411 households.

Table 3.2 Household size for residents, holiday homeowners and visitors

	Adults	Children	Total
Resident	2.33	0.91	3.24
Holiday homeowner	2.59	1.00	3.59
Visitor	2.93	0.91	3.84

3.2.3 Use of the estuary

Permanent residents spent an average of 143 days visiting the estuary, while holiday homeowners and visitors visited for an average of 62 and 10 days per year, respectively (Table 3.3).

Table 3.3. Days visiting estuary per year

	Mean	SD
Resident	142.5	133.3
Holiday homeowner	61.7	81.4
Visitor	9.6	47.3

The coastal area (coast, beach, and ocean) contributes 30% of people's enjoyment of the Veldrif area, while the estuary alone contributes more than one third (35%), or as much as the other five attractions/amenities combined (Figure 3.5). A variety of activities are carried out on the estuary, with relaxing, walking and swimming being the most important (35%) (Figure 3.6). Fishing, bird watching and boating, all of which are potentially affected by changes in flow, make up 19%, 15% and 14% of estuary value, respectively.

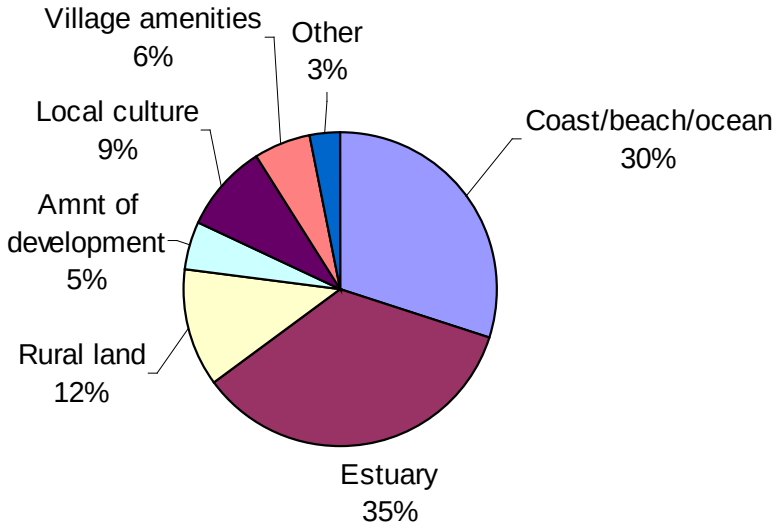


Figure 3.5. Average percentage contribution of different amenities to enjoyment of the area.

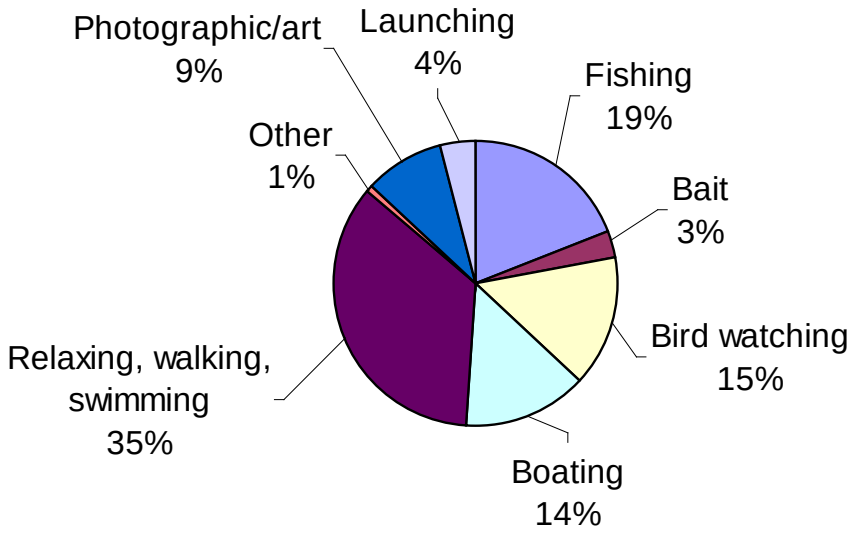


Figure 3.6 **Average percentage contribution of different activities to enjoyment of the estuary. Launching means using the estuary to get out to sea.**

A high proportion of households have boats, with more than 50% of residents and holiday homeowners using boats (Table 3.4), reflecting the high level of use of the estuary. Most of the boats are used either on the estuary or launched from the estuary.

Table 3.4 **Average number of boat days per year and the percentage of households/groups with boats**

	Avg. boat days per year		Percentage households/groups with boats	
	Non-powered	**Powered**	**Non-powered**	**Powered**
Residents	61.4	37.9	16.2	42.7
Holiday homeowners	43.4	86.2	24.5	65.3
Visitors	2.2	16.4	8.5	17

Table 3.5 shows the average length of trip for visitors staying in the Veldrif area, the average expenditure per person per day (pppd) for the trip, and the percentage reason for the whole trip away to come to the Veldrif area. The main types of accommodation for visitors were camping (23%), staying with friends (19%), cottages (19%) and bed and breakfasts (10%).

Table 3.5 Average length of trip to the Veldrif area, average expenditure (pppd) for total trip, and percentage reason for trip to come to the Veldrif area.

	Trip Length (days)	**Veldrif area as % reason for trip**	**Average Spent (R pppd)**	
			Accommodation	**Expenses**
Visitors	6.9	89%	R53	R85

3.2.4 Contribution of the estuary to property value

Information for a total of 264 properties was included in the analysis. Most respondents had properties on the estuary (44%, estuary frontage or canal frontage), while a large number of respondents had no water views (42%) (Figure 1-7). Only 14% of the respondents had houses with sea views.

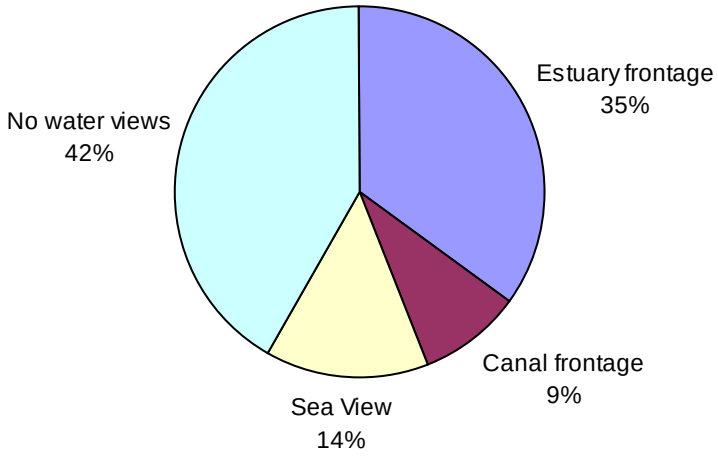


Figure 3.7 Property location in relation to the distance from the estuary and sea.

House prices are usually primarily linked to the size of the property, and this pattern was found in the Veldrif area (Figure 3.8). However, there is considerable variation within this trend.

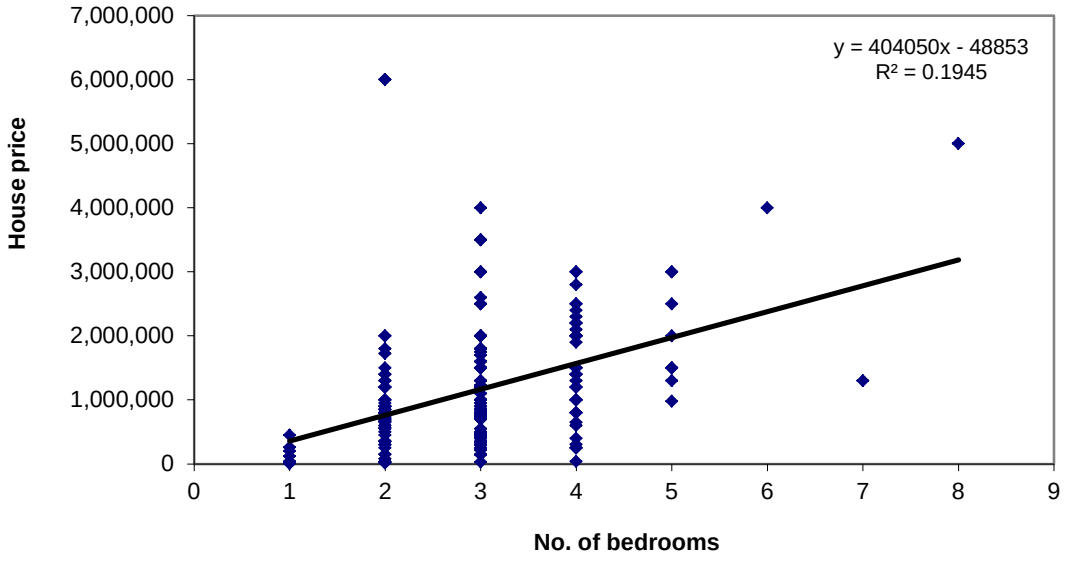


Figure 3.8 Variation of house price in relation to number of bedrooms.

The presence of water frontage makes a significant difference to the property value in the area, and houses with canal and estuary frontage had the highest average price (Table 3.6). Houses with canal and estuary frontage were worth about R1.7 million and R1.6

million on average respectively, more than double the average price of properties with no water frontage or view.

Table 3.6 Average prices of properties with canal or estuary frontage, sea views and with no water views (2009 Rands).

	Average	SD	Max	Min	n
Canal frontage	1,673,913	639,579	3,500,000	350,000	23
Estuary frontage	1,580,924	1,038,355	6,000,000	10,000	92
Sea view	1,426,838	967,393	4,000,000	10,000	37
No water view	731,717	731,717	6,000,000	8,000	112

There was a significant positive correlation between house price and distance to the estuary (Figure 3.9), but no significant correlation between house price and distance to the sea.

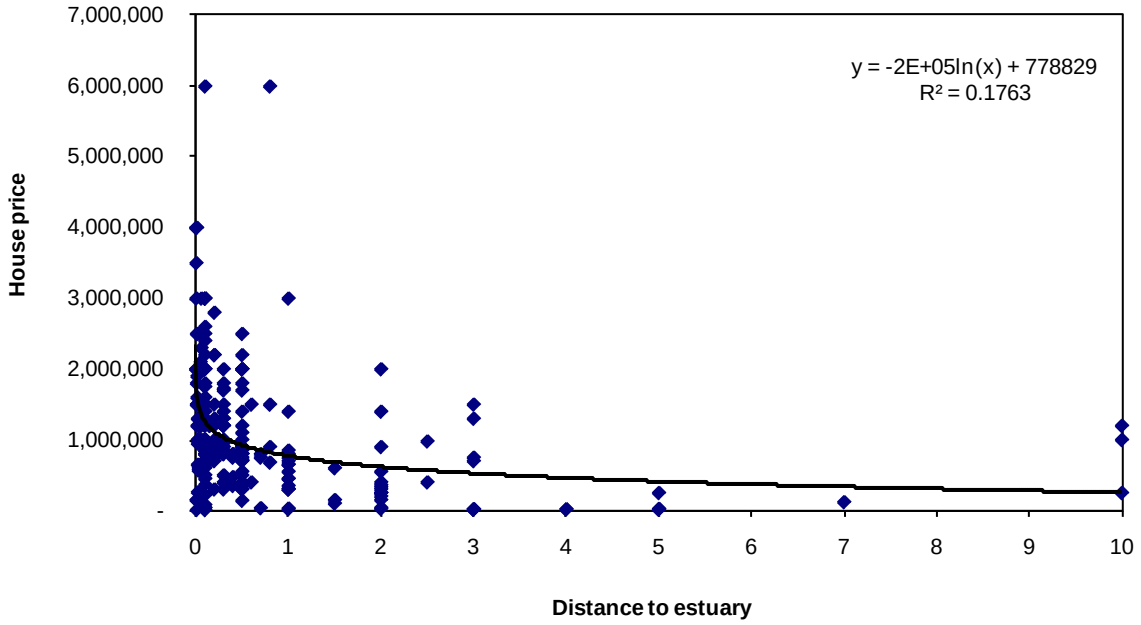


Figure 3.9 Relationship between house price and distance to the Berg Estuary

The hedonic pricing method was applied to determine the overall relationship between property values and a range of other variables. This provided a far stronger relationship than the individual relationships described above. The best-fit regression was obtained with the property size and property area, however the property areas is relative to its position in relation to the estuary and therefore distance to the estuary (km) was used instead.

Property value was modelled as follows (n = 318, r^2 = 0.24, P < 0.001):

Value = 83 115 + 394 248*B – 129 445*D……1

Where B = number of bedrooms and D = distance from the coast in kilometres. Based on this model, property in the Veldrif area was estimated to have a total capital value in the order of R1.8 billion, and the total premium associated with proximity to the Berg estuary

was estimated to be just under R900 million. This translates to an annual turnover of about R49 million in the financial and property sectors (Table 3.7).

Table 3.7 Estimated contribution of the estuary to economic output in the financial and property sectors

Suburb	Total Property Value (R millions)	Premium (R millions)	Cost of capital (R millions)	Annual inc to property sector (R millions)	Total turnover (R millions)
Farms	29	11	0.6	0.1	0.6
Laaiplek	376	160	8.0	1.1	9.1
Noordhoek	429	202	10.1	1.4	11.5
Port Owen	327	165	8.3	1.2	9.4
Veldrif	629	315	15.7	2.2	17.9
Total	**1 791**	**853**	**42.7**	**6.0**	**48.6**

Holiday homeowners spend on average 73 days in the area and spend an average of R85 per person per day on expenses. Visitors to the area spend on average R138 per person per day on expenses and accommodation. This estimated total expenditure by holiday homeowners and visitors to the area is some R52 million per annum. Given that the estuary contributes 35% of the value to the area, a total of R18.3 million of this visitor expenditure can be attributed to the estuary.

3.3 NURSERY AREA VALUES AND ESTIMATED CHANGES IN FISHERY VALUE UNDER DIFFERENT SCENARIOS

3.3.1 Introduction

One of the most important values of estuarine systems is their contribution to fisheries. Resident fish populations are exploited directly in estuarine recreational and subsistence fisheries. More importantly, though, estuaries provide nursery areas for numerous species of fishes that are exploited by recreational and commercial fishers operating in the inshore marine environment. These species are dependent on estuaries for the early stages of their growth.

3.3.2 Estuarine fish species harvested by commercial and recreational fishers, their distribution and dependence on estuaries

About 160 species of fish occur in South African estuaries, of which about 80 species are utilised in fisheries. Some 16 of these species occur in the Berg estuary. Of these, 8, 3, and 5 species fall into categories II to IV, respectively (Table 3.8). Of particular importance are the category II species, for which management of estuaries plays a crucial role in fisheries.

The catches of estuarine-associated fish species differ from west to east around the coast, following biogeographical changes from the Cool Temperate region on the west coast through to the Subtropical region north of the Mbashe River in the Transkei. Numbers of estuarine species in catches increase from west to east around the South African coast. Within regions, species composition of catches within estuaries also differs between estuaries of different types and sizes, with greater species richness associated with larger and permanently open estuaries (Turpie and Lamberth 2003).

Table 3.8 Major categories and subcategories of fishes which utilise southern African estuaries (Whitfield 1994)

Category	Description	Species
I	Estuarine species which breed in southern African estuaries. Ia. Resident species which have not been recorded spawning in marine or freshwater environments. Ib. Resident species which also have marine or freshwater breeding populations.	
II	Euryhaline marine species which usually breed at sea with the juveniles showing varying degrees of dependence on southern African estuaries. IIa. Juveniles dependent on estuaries as nursery areas. IIb. Juveniles occur mainly in estuaries, but are also found at sea. IIc. Juveniles occur in estuaries but are usually more abundant at sea.	Leervis, flathead mullet, white steenbras, Cape stumpnose, harder, elf, white stumpnose, kob
III	Marine species which occur in estuaries in small numbers but are not dependent on these systems.	Anchovy, sardine, streepie
IV	Freshwater species, whose penetration into estuaries is determined primarily by salinity tolerance. This category includes some species which may breed in both freshwater and estuarine systems.	sharptooth catfish, bluegill sunfish, Mozambique tilapia, carp, small-mouth bass

3.3.3 Nursery value of the Berg estuary

The Berg Estuary acts as a very important nursery area for inshore marine fish along the West coast. The affected fisheries in this region are primarily the recreational line fisheries, inshore commercial line and net fisheries, and inshore and estuarine subsistence fisheries.

Recreational shore and boat anglers on the West coast take an estimated annual catch of 115 and 407 tons per annum, respectively (Turpie and Lamberth 2003). Spear fishers take an estimated 19 tons. Commercial line and net fishers take a further 10 191 and 4 303 tons, respectively Fish that spend at least part of their life cycle in estuaries contribute up to 83% of the catch weight of these fisheries (Table 3.9).

Table 3.9 Percentage contribution of different categories of estuarine associated fish to the inshore marine fish catches in the southern Cape. All percentages in terms of biomass except recreational shore angling, in terms of numbers. Source: Turpie and Lamberth (2003).

	IIa	IIb	IIc	III	Total
Recreational shore	0.51	0.17	41.26	13.81	55.75
Recreational boat	0.02	<0.01	0.80	0.10	0.92
Recreational spear	0.05		0.09	0.09	0.23
Commercial boat	0.09	<0.01	0.80	0.10	0.91
Seine and gillnet	1.05	0.04	80.86	1.10	83.06

The value of these fisheries is described in detail in Turpie and Lamberth (2003). Along the West coast, the recreational fisheries are worth an estimated R6.2 million per annum and commercial fisheries are worth some R26.1 million (2005 Rands; Table 3.10). Fish that spend at least part of their life cycle in estuaries make up 52.3% of the combined value of these fisheries. Taking into account the degree to which different categories of

fish depend on estuaries, the value attributed to estuaries is more conservatively estimated at about 21.3% of overall value, or R745 million for the West coast (Table 3.10).

The above value is attributed to the combined nursery function of all the estuaries along the West coast. The relative contribution of the different estuaries is unknown, but the yields of the each estuary have been estimated on the basis of catch data (Turpie and Lamberth 2003). Based on the yields of the Berg relative to other West coast estuaries, which contributes about 79.7% of the total, the nursery value of the Berg estuary is estimated to be in the order of R8.1 million (2005 Rands).

Table 3.10 Percentage contribution of estuarine associated fishes to the total value of the inshore marine fishing sectors on the West coast, the total annual values of the fisheries, the amount and percentage of total which is comprised of estuary-associated species, and the contribution of estuaries to total fishery values. The latter is calculated on the basis of 100% of the value of Category Ia, Ib, IIa, Va and Vb species, 90% of the value of Category IIb species, and 30% of the value of Category IIc species. Category III species are not included in this value. Note, there is no measurable contribution in terms of category I, IV and V species. Based on Turpie and Lamberth, 2003. Values in 2005 Rands.

Value	Category				Total value	Estuary fish contribution		Value due to estuaries	
	IIa	IIb	IIc	III	R million	R million	%	R million	%
Recreational shore	0.60	0.03	18.05	2.24	105.70	22.12	20.92	6.39	6.0
Recreational boat	0.00	0.00	0.39	0.01	112.06	0.45	0.41	0.13	0.1
Recreational spear	0.12		0.06	0.12	7.24	0.02	0.30	0.01	0.1
Commercial boat	0.04	0.00	0.78	0.05	188.89	1.66	0.88	0.53	0.3
Seine and gillnet	3.89	0.02	72.90	1.86	11.92	9.37	78.67	3.07	25.8
Total West Coast					425.81	33.62	101.18	10.13	32.3
TOTAL RSA					**3,628.7**	**1,859.4**	**52.3**	**744.8**	**21.3**

3.4 EXISTENCE VALUE

Existence value (otherwise known as non-use value) is typically estimated using the Contingent Valuation Method (CVM). CVM is used to estimate the values associated with resources or products that do not currently fall under existing markets, and thus utilise a simulated market approach (Mitchell and Carson 1989, Garrod and Willis 1999). A 'stated preference' method, CVM elicits a stated willingness-to-pay (WTP) from respondents which is contingent on a hypothetical scenario coming about (Arrow *et al.* 1993). Turpie and Clark (2008) attempted develop estimates of existence values of all temperate estuaries in South Africa (Orange to the Mdumbi) using a combination of contingent valuation and conjoint valuation (choice modelling) methodology. Their estimates are based on a questionnaire survey of 605 respondents in the Western Cape from which overall willingness to pay for estuaries was estimated by extrapolating the above results (WTP for conservation x % allocation to estuaries) to the South African population. Results from this survey and earlier estimates of aggregate WTP for estuarine biodiversity, was disaggregated using a relationship between value and estuary characteristics based on a second survey of 125 respondents who were asked to score the 14 different estuaries used in the first survey in terms of their scenic beauty, independent estimates of which were available for all estuaries in the country. Existence

value of the Berg estuary calculated using this approach was estimated to be R176,452 per annum, which places it on the upper end of the spectrum of existence values for temperate estuaries in South Africa (Figure 3.10).

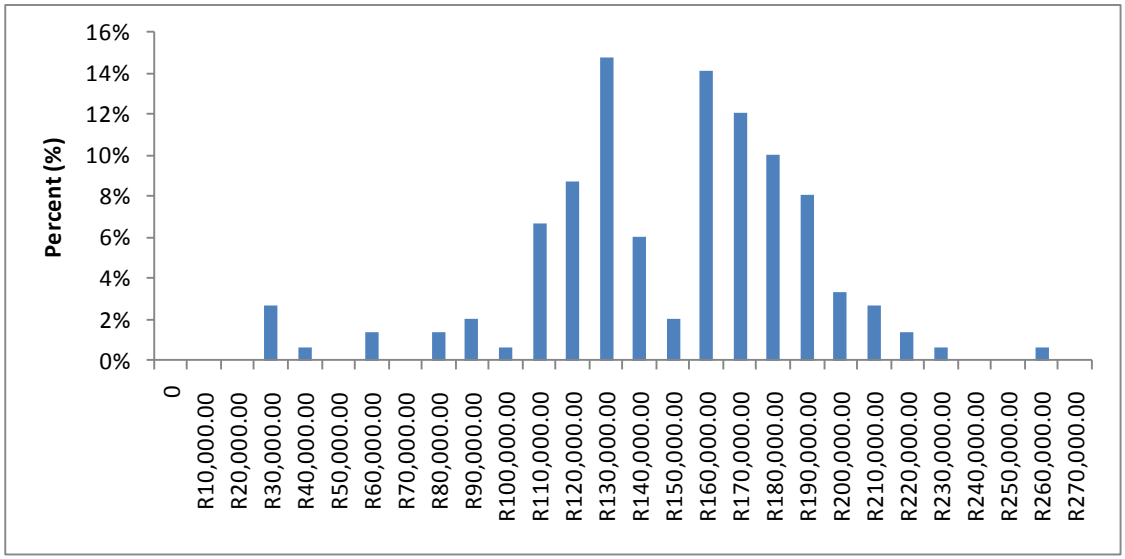


Figure 3.10 Frequency distribution for existence value of temperate estuaries in South Africa (Orange to Mdumbi) (Data from Turpie and Clark 2008).

3.5 TOTAL ECONOMIC VALUE OF THE BERG ESTUARY

Adding up all the components of value for the Berg estuary, as described above, allows for an estimate of total economic value of the system under present day conditions to be generated. The various components of value are summarised in Table 3.11 along with the estimate of total economic value. Total economic value of the Berg estuary is estimated to be R75.6 million, with by far the largest component of this value being derived from turnover in the property sector (R48.6 million), followed closely by visitor expenditure (R18.3 million) and nursery value (R8.1 million). Subsistence and existence value make relatively small contributions to total economic value. This places the Berg estuary firmly on the upper end of the value spectrum for temperate estuaries in South Africa (Figure 3.11).

Table 3.11 Summary of economic value of the Berg estuary

Component of value	**Value**
Subsistence value[11]	R 414,000
Property sector turnover	R 48,600,000
Visitor expenditure	R 18,300,000
Nursery value	R 8,100,000
Existence value	R 176,452
Total value	**R 75,590,452**

[1] Average of the values derived from Hutchings *et al*. (2008) and Turpie and Clark (2008)

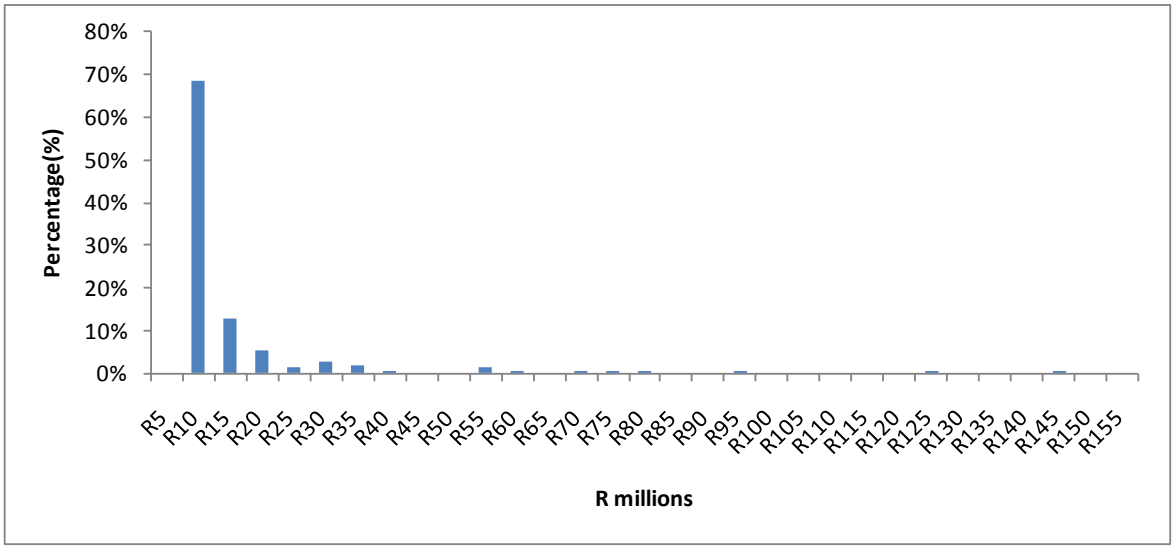


Figure 3.11 Frequency distribution of Total Economic Value for temperate estuaries in South Africa (after Turpie and Clark 2008).

4 IMPACTS OF ALTERNATIVE FLOW SCENARIOS ON ECONOMIC VALUE THE BERG ESTUARY

4.1 INTRODUCTION

Impacts of the various flow scenarios examined in this study on economic value of the Berg estuary was estimated only for turnover in the real estate sector, visitor expenditure, and the nursery value of the estuary, as these three components contributed more than 99% of the Total Economic Value of the estuary.

4.2 PROPERTY VALUE AND VISITOR EXPENDITURE

Respondents evaluated a series of hypothetical scenarios regarding the condition of the Berg Estuary. Note that these were not related to the scenarios assessed in the larger RDM study and were simply designed to tease out the relative influence of various attributes on total of economic of the estuary. These attributes included numbers of birds on the estuary, abundance of angling fish, reed bed area and intertidal salt marsh area. The scenarios presented and the scores for each are given in Table 4.1. The average score for the current status quo was 7.63. Having bird numbers and angling fish increase achieved the highest ratings (Table 4.1).

Table 4.1 Hypothetical scenarios presented to respondents and the average overall scores for each

Survey Version	Scenario	Birds	Angling fish	Reed beds	Intertidal Saltmarsh	Average Overall
		(Numbers)	(% change)	(ha)	(ha)	Score
1a - present	Status quo	12 000	1.00	900	140	7.63
1b		9 600	0.70	1170	70	4.23
1c		9 600	1.30	1170	140	6.30
1d		12 000	1.30	720	70	6.73
2a - present	Status quo	12 000	1.00	900	140	7.90
2b		12 000	0.70	1170	112	4.97
2c		15 600	1.30	1170	182	**8.37**
2d		15 600	0.70	720	182	6.01
3a - present	Status quo	12 000	1.00	900	140	7.63
3b		15 600	1.30	720	182	7.94
3c		8 400	1.30	720	182	6.43
3d		15 600	1.50	450	182	8.07
4a - present	Status quo	12 000	1.00	900	140	7.61
4b		13 200	1.00	720	182	7.22
4c		13 200	1.30	1170	112	7.89
4d		13 200	1.30	1170	182	8.13
5a - present	Status quo	12 000	1.00	900	140	7.16
5b		8 400	0.70	900	70	**3.70**
5c		12 000	1.30	450	182	6.56
5d		8 400	1.50	900	140	6.34

A model was constructed using the four variables in continuous form. Although the variance explained by the model was relatively low (Table 1-9), the model was highly significant ($P<0.001$). The co-efficient for all four variables were significant, with birds and angling fish being extremely significant (Table 1-9). Based on the rating analysis (Table 4.2), overall utility (on a scale of 0 to 10) can be expressed as follows:

Utility score = -0.46 + 0.006*Saltmarsh area (ha) + 2.35*Angling fish (% diff to present day) + 0.0003*Birds (numbers) + 0.0007*Reed bed area (ha).

Table 4.2 Summary of conjoint regression results for the Berg Estuary – all results combined – assuming the variables are continuous.

Multiple R	0.439	Standard error	2.181			
R square	0.193	Observations	1971			
Adjusted R square	0.192					
ANOVA	**df**	**SS**	**MS**	**F**	**Significance F**	
Regression	4	2238.25	559.56	117.66	0.00	
Residual	1966	9349.89	4.76			
Total	1970	11588.15				
	Coefficients	**Standard error**	**t stat**	**P-value**	**Lower 95%**	**Upper 95%**
Intercept	-0.463	0.436	-1.062	0.288	-1.319	0.393
Birds	0.000	0.000	10.320	0.000	0.000	0.000
Angling fish	2.351	0.204	11.533	0.000	1.951	2.751
Reedbeds	0.001	0.000	2.830	0.005	0.000	0.001
Saltmarsh	0.006	0.002	3.824	0.000	0.003	0.010

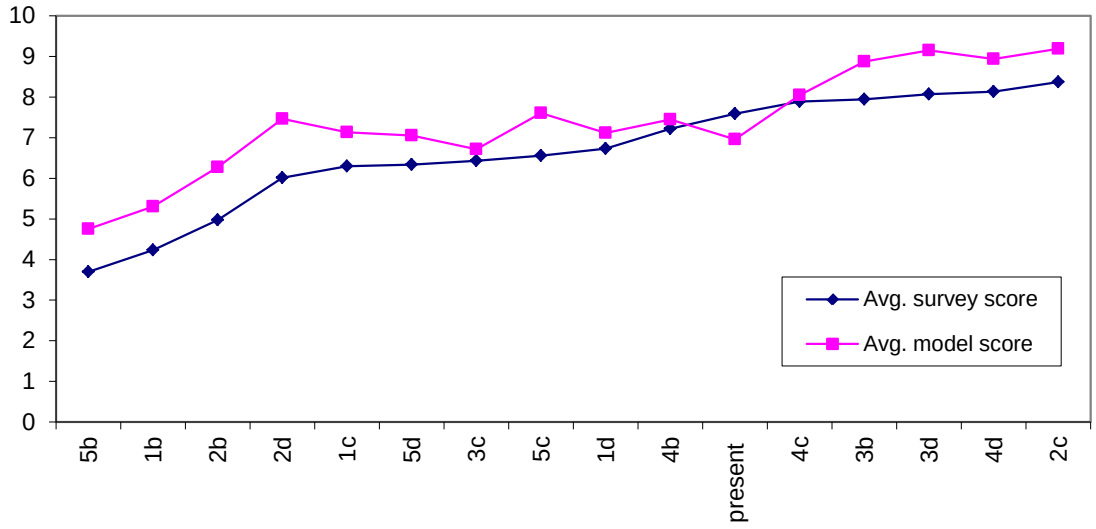


Figure 4.1. Average survey and scores allocated to the hypothetical 16 scenarios for the Berg Estuary

Many of the respondents indicated that if their preferred scenario occurred it would have a positive impact on either their property value, in the case of homeowners, or the amount of time spent in the area, in the case of visitors. 30% of permanent residents, 45% of holiday homeowners, and 21% of visitors indicated a positive impact (as opposed to no change). Property owners estimated an average increase in property value of 10% and visitors an average of 15% increase in the time spent in the area per unit increase in utility (Figure 4.2 and Figure 4.3). A larger percentage (33% of permanent residents, 58% of holiday homeowners, and 25% of visitors) indicated that if their least preferred scenario came about it would decrease property value, in the case of property owners, or decrease the amount of time spent in the area, in the case of visitors. Property owners estimated

an average decrease in property value of 11% and visitors an average of 21% decrease in the time spent in the area per unit decrease in utility (Figure 4.3 and Figure 4.3).

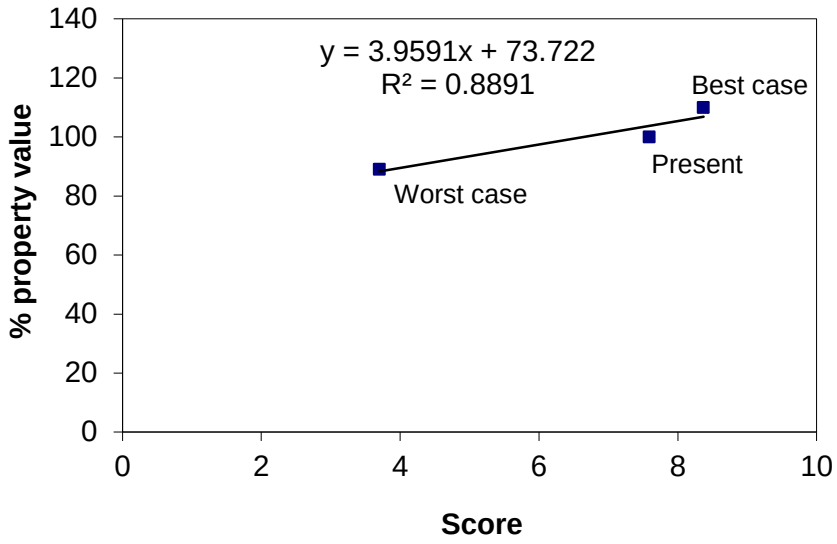


Figure 4.2 Change in property value in relation to change in utility score based on the condition of the estuary

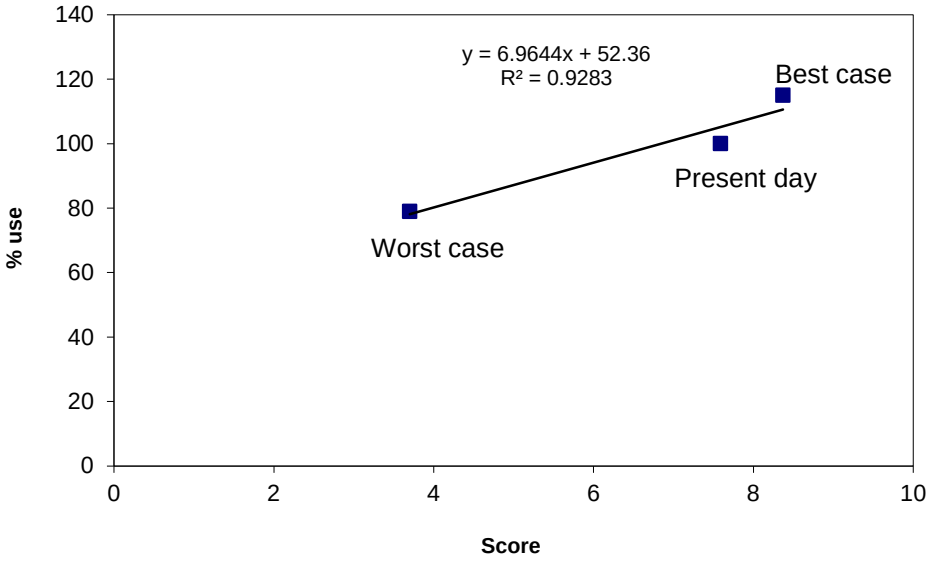


Figure 4.3 Change in use of the estuary in relation to change in utility score based on condition of the estuary.

Based on the above models, the various RDM Scenarios were evaluated in terms of their utility scores. The resultant scores range from 6.84 – 7.51, but only resulted in about a predicted 5% increase in the use of the estuary and an increase of R800 000 in estimated recreational turnover between the lowest (Sc 2/9) and highest (Sc 10) scoring scenarios (Table 4.3).

Table 4.3 Utility scores of the alternative scenarios, and predicted change in estuary use and value (R millions) under each scenario

Scenario	Modelled scenario score	Predicted use of the estuary relative to present	Estimated real estate turnover (R millions)	Estimated recreational turnover (R millions)
1	7.21	1.025	49.7	18.8
2	6.84	1.000	49.0	18.3
3	7.08	1.017	49.4	18.6
4	7.10	1.018	49.5	18.6
5	7.11	1.018	49.5	18.6
6	7.15	1.022	49.6	18.7
7	7.23	1.027	49.7	18.8
8	6.92	1.006	49.2	18.4
9	6.86	1.001	49.0	18.3
10	7.51	1.046	50.3	19.1

4.3 NURSERY VALUE

Estimated changes in the abundance of fish in each category under the various scenarios are provided in Section 4.3.4.2. According to these data, overall fish biomass in the Berg estuary has increased modestly (~14%) relative to the Reference condition. This was attributed to increased productivity in the estuary owing to higher nutrient inputs and associated increases in microalgae biomass that has benefited mainly the filter feeding species utilising the estuary. However, many of species important in inshore fisheries in the region are not filter feeding species and have not benefited in this manner. In fact, many of these species are very low relative to the Reference condition due mostly to anthropogenic influences operating both inside and outside the estuary. The most important of these influences is fishing which has decimated adult populations of these species. Changes in flow under the various future scenarios were nonetheless predicted to have some impact on the abundance of commercially and recreationally important fish species in the estuary, most of which were positive and were associated with an increase in saline (marine type) habitat in the estuary and increases in productivity in the system (increased phytoplankton and zooplankton abundance) (Sc2-Sc6 and Sc8), while increases in flow have the opposite effect (Sc 7 and 9) unless this is coupled with a concerted effort to reduce existing non-flow related anthropogenic impacts on the system (e.g. reduction in illegal gill net fishing and restoration of degraded habitats in the estuary, Sc 10) (Table 4.4).

4.4 SUMMARY OF IMPACTS OF ALTERNATIVE FLOW SCENARIOS ON PROPERTY VALUE, VISITOR EXPENDITURE AND NURSERY VALUE OF THE BERG ESTUARY

Contributions to the total estimated value of the Berg estuary from turnover in the real estate sector, recreational turnover, nursery value, and Total Economic Value (the sum of the other three) are presented in Table 4.5. Total estimated value for the Berg estuary at present is R75.0 million per annum. This value increases marginally under most of the future scenarios (aside from Scenario 9), due to increases in all components of value under these scenarios up a maximum of R78.6 million per annum under Scenario 10. Under Scenario 9, modest increases in real estate turnover are offset by the lack of any change in recreational utility and a reduction in nursery value. It should be noted that all of the changes in value are all very small relative to the overall value of the system (all

<5%), and should be treated with caution given that they are all less than the confidence limits surrounding these value estimates.

Table 4.4 Estimated change in the nursery contribution of the Berg Estuary to inshore marine fisheries under different scenarios and the impact on the overall West coast fishery value (2005 Rands)

	PD	SC1	SC2	SC3	SC4	SC5	SC6	SC7	SC8	SC9	SC10
Recreational shore	5.09	5.10	5.09	5.10	5.10	5.10	5.10	5.09	5.10	5.09	5.10
Recreational boat	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Recreational spear	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Commercial boat	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42
Seine and gillnet	2.45	2.45	2.45	2.45	2.45	2.45	2.45	2.45	2.45	2.45	2.45
Total Berg estuary	**8.07**	**8.86**	**8.38**	**8.50**	**8.81**	**8.69**	**8.81**	**8.07**	**8.81**	7.55	9.17
% Change		**10%**	**4%**	**5%**	**9%**	**8%**	**9%**	**0%**	**9%**	-7%	14%
Total West coast	**10.13**	**10.92**	**10.44**	**10.56**	**10.87**	**10.74**	**10.87**	**10.13**	**10.87**	**9.60**	**11.22**
% Change		**7%**	**3%**	**4%**	**7%**	**6%**	**7%**	**0%**	**7%**	**-5%**	**10%**

Table 4.5. Contributions to the total estimated value of the Berg estuary from turnover in the real estate sector, recreational turnover, nursery value, and Total Economic Value as estimated from this study for the Present Day (PD) and under the various future scenarios (Sc1-10). All values in 2005 Rands.

Scenario	Estimated real estate turnover (R millions)	Estimated recreational turnover (R millions)	Nursery value (R Millions)	Total Economic Value (R Millions)
PD	48.6	18.3	8.07	75.0
1	49.7	18.8	8.86	77.4
2	49.0	18.3	8.38	75.7
3	49.4	18.6	8.5	76.5
4	49.5	18.6	8.81	76.9
5	49.5	18.6	8.69	76.8
6	49.6	18.7	8.81	77.1
7	49.7	18.8	8.07	76.6
8	49.2	18.4	8.81	76.4
9	49.0	18.3	7.55	74.9
10	50.3	19.1	9.17	78.6

5 REFERENCES

Branch, G.M., May, J., Roberts, B., Russell, E., Clark, B. 2002. Case studies on the socio-economic characteristics and lifestyles of subsistence and informal fishers in South Africa. *South Africa Journal of Marine Science* **24**: 439-462.

Clark, B.M; Hauck, M; Harris, J.M; Salo, K. and Russel, E. 2002. Identification of subsistence fishers, fishing areas, resource use and activities along the South African coast. *South African Journal of Marine Science* **24**: 425-437.

Kulshreshtha, S.N., Gillies, JA, 1993. Economic valuation of aesthetic amenities. A case study of river view. Water Resources Bulletin 29: 257-267.

Pearce D.W., Turner R.K. 1990. Economics of Natural Resources and the Environment. Harvester Wheatsheaf London.

Russell C.S. 2001. Applying Economics to the Environment. Oxford University Press. New York.

Turpie, J.K. and Clark, B.M. 2007. The health status, conservation importance, and economic value of temperate South African estuaries and development of a regional conservation plan. Report to CapeNature.

Turpie J., Lamberth S., 2003. The role of estuaries in South African fisheries: Economic importance and management implications. African Journal of Marine Science 25: 131-157.

UNEP. (1995). Middle East Peace Multilateral Working Group on Water Resources. Training course on project design and appraisal tools for integrated environmental and economic assessment. Nairobi Kenya.

Whitfield, A.K. 1994. An estuary-association classification for the fishes of southern Africa. South African Journal of Science 90: 411-417.