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ANALYSIS

The existence value of biodiversity in South Africa: how interest, experience, knowledge, income and perceived level of threat influence local willingness to pay

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Abstract

South Africa is rich in biological diversity, but measures to conserve this heritage are under-funded and are of relatively low priority at national level. Part of the problem is that the social value of biodiversity is unknown, and thus the potential impact of a loss of biodiversity on social wellbeing is not recognised. Some of these threats, particularly climate change, are predicted to have major impacts on biodiversity within the next 50 years. This study investigates the public interest, experience and knowledge of biodiversity and uses contingent valuation methods to estimate its existence value, with emphasis on the internationally significant fynbos biome in the Western Cape. More than half of respondents classified themselves as actively or passionately interested in nature, and a high proportion had recently visited major nature reserves. Interest was correlated with knowledge, and both were positively correlated with willingness to pay (WTP) for biodiversity conservation, though WTP was constrained by income level. WTP for conservation was relatively high ($3.3 million per year for fynbos, $58 million for national biodiversity), and comparable with government conservation budgets. WTP increased dramatically (to up to $15 million and $263 million per year, respectively) when respondents were faced with the predicted impacts of climate change on biodiversity. The latter is probably a better estimate of the full existence value of biodiversity, since respondents were faced with absolute losses rather than, say, the reduction in species diversity.
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1. Introduction

South Africa is a biologically diverse country, containing seven major terrestrial biomes. Of these, the Fynbos Biome stands out in terms of its species richness and levels of endemism and rarity. The Fynbos Biome is the dominant component of the Cape Floristic Region, which is one of the world's 'hottest biodiversity hotspots' (Myers, 1990). This region, largely within the country's Western Cape province, attracts international interest in conservation programmes and is high on the agenda of South African scientists

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and conservationists. Yet national support for the conservation of this and other areas is dwindling in real terms as other social needs take precedent. Part of the reason for this is that little is known of the social value of the biodiversity of this region, nor, for that matter, of the country as a whole. Such understanding is not only important in deriving appropriate conservation strategies, but is crucial if biodiversity conservation is to compete with other issues for national funding (Edwards and Abivardi, 1998). Biodiversity is under threat from processes such as land conversion and invasion of exotic species, the protection from which require costly conservation programmes. However, these threats almost pale into insignificance compared with the more recently illuminated threat of global climate change on South African biodiversity, the prevention of which requires far more costly and complex action.

South Africa faces significant biophysical impacts due to climate change over the next 50 years (Kiker, 2000). One of the most startling predictions of the South African Country Study on Climate Change (Kiker, 2000) is that of the shrinkage in distribution of the country's existing biomes (Fig. 1), with more than half of South Africa's vegetation being replaced by unknown arid vegetation or desert. Such changes would be accompanied by a sizeable loss of species. Among the major casualties are Succulent Karoo and Nama Karoo biomes, with the former being lost over most of its range, and the Fynbos Biome, which may lose more than a third of its present range (Kiker, 2000).

There is a substantial and growing literature on the potential economic impacts of climate change. While climate change has both market and non-market impacts (e.g. Fankhauser and Tol, 1996, 1997), most research has concentrated on market impacts, such as agricultural impacts and the costs of sea-level rise (Fankhauser et al., 1998). Although research has increasingly started to address non-market impacts such as those relating to changes in human health, studies attempting to quantify the full social impacts of biodiversity loss in monetary terms are rare. The damage cost literature thus relies heavily on 'benefit transfer' (Fankhauser et al., 1998), if these values are considered at all.

This deficiency has usually arisen due to the inherent difficulties and controversies in valuing the more intangible non-market values associated with biodiversity. While market values, such as forestry or fisheries, are often articulated, the non-market values could be far higher. These non-market values include existence value, which, in its broad sense, is the utility that people derive from knowing of the existence of (features of) biodiversity, and from knowing that others and future generations also might be able to enjoy it. There have been very few estimates of the existence value of biodiversity at a large scale, especially at a national scale.

The existence value of biodiversity, although intangible, is often realised in the form of donations towards the conservation of biodiversity. Its magnitude can also be elicited in terms of willingness to pay (WTP) by means of stated-preference survey methods such as contingent valuation (e.g. Bower and Stoll, 1988; Mitchell and Carson, 1989; Carson et al., 1994; Stevens et al., 1997). Contingent valuation is prone to a number of biases that are the subject of extensive investigation (e.g. Ajzen et al., 1996; Carson et al., 1996; Cooper and Loomis, 1992; Herriges and Shogren, 1996). Embedding, where the same good is assigned a lower value if WTP for a good inferred from a more inclusive good is lower than if the particular good is evaluated on its own (Kahneman and Knetsch, 1992; Svedsäter, 2000), is one of the most important problems (Diamond et al., 1993; Schwarz, 1997). However, with careful design to circumvent these potential pitfalls, contingent valuation is deemed an acceptable method of measuring value (Arrow et al., 1993). Among the recommendations of Arrow et al. (1993) panel on contingent valuation, were that interviews should be face-to-face, the valuation question should be in a willingness-to-pay rather than willingness-to-accept format, and should be a referendum-type (yes–no) question, rather than open-ended. A willingness-to-pay format tends to yield a more truthful (lower) response than a willingness-to-accept format, but it does also imply that people have to pay to obtain the right to the

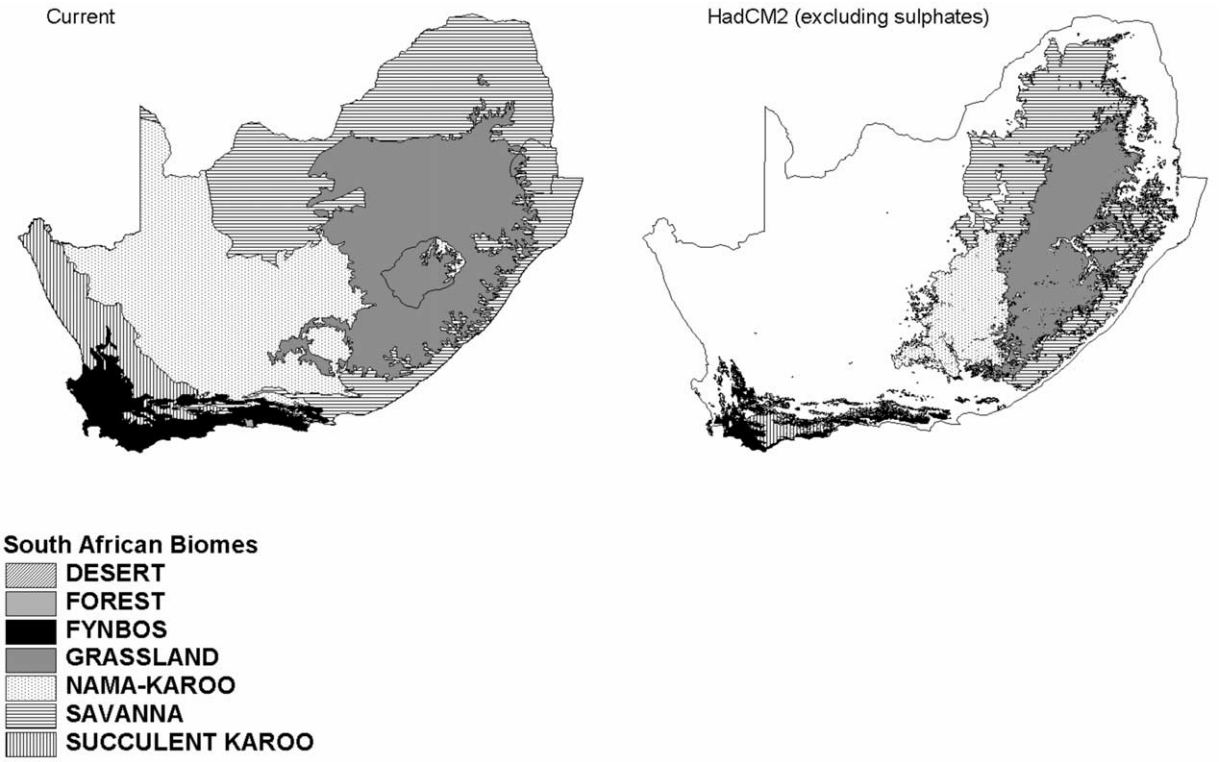

Fig. 1. Current and predicted future distribution of biomes in South Africa. The future scenario is based on climate changes brought on by an increase in the concentration of atmospheric carbon dioxide to 550 ppm.

climate currently observed (Fankhauser et al., 1998). Accurate information should be presented, and respondents should be reminded to consider their own budgetary constraints and expenditure preferences other than the issue in question.

This paper uses contingent valuation methods to estimate the local existence value of South African biodiversity, with emphasis on the Fynbos Biome. The study investigates South Africans' level of experience, interest in and knowledge of biodiversity, and compares WTP to protect biodiversity from 'normal threats' with WTP for protection from the threats associated with climate change.

2. Methods

This study used stated-preference methods to estimate the existence value of the vegetation that is predicted to be lost by 2050 due to climate change. A questionnaire was developed, pretested on ten colleagues, then tested on a sample of 30 respondents. Ten enumerators were selected for training from approximately 40 applicants on the basis of a test of their comprehension of a presentation on the background and purpose of the study. Eight of the enumerators were selected after the training process, and the work was carried out in two groups, each under the control of a supervisor.

2.1. Structure and content of the questionnaire

2.1.1. Interest in nature

Respondents were asked which of South Africa's National Parks they had visited, and whether they were members of any nature-related clubs such as the wildlife, hiking or angling clubs. They were then asked to rate their interest in nature as 'none', 'passive', 'active' or 'passionate'.

2.1.2. Experience of major protected areas and reaction to predicted vegetation changes

Respondents were asked how many times they had visited the West Coast National Park, De Hoop Nature Reserve and the Cedarberg Wilderness area in the last 2 years. They were then asked to predict their response to the predicted vegetation change in the areas they had visited in terms of how it would affect their visitation rate in future (a lot less, slightly less or no difference) as follows:

> "Suppose the vegetation of any of these parks was to become **desertified**, that is to say it wasn't the fynbos you see there now, but a much more **sparse** vegetation with **lots of open ground** and **not much variety** of plants. Given this situation, do you think you would visit any of these parks a lot less, slightly less, or would it make no difference to you? Bear in mind that the other features of these parks would remain the same".

2.1.3. Willingness to pay for biodiversity conservation in South Africa

This question was posed at the broadest possible level in order to counter embedding bias, as follows:

> "You may be aware that a number of things threaten South Africa's natural heritage, such as alien plants and developments, not just within parks or nature reserves, but even more so outside protected areas. We all know that our nature conservation agencies working both within and outside of nature reserves are struggling to find enough money to provide adequate protection against these threats. Many South Africans and foreigners make donations to nature conservation in South Africa in order to help ensure that some of South Africa's natural heritage will be preserved for their own and their children's benefit and even for the benefit of others. I am not about to ask you for a donation, but would like to ask how much you would be **willing** to pay **annually** towards nature conservation in SA as a whole. So, if the right type of payment facility was made available to you—this could be anything from someone coming round to collect, a donation sent to a society, or even a facility enabling easy transfer from your internet bank account, or whatever—and if you could influence how the money was spent, how much would you be willing to pay annually towards the conservation of South Africa's natural heritage? Please take a moment to think about this, and don't forget to consider that there are other things that you might wish to spend your spare cash on. We would like as realistic an estimate as possible, that is, an amount that you actually **would** pay".

If respondents gave a zero response, they were asked to explain their reasoning. Once the respondent's WTP was established, they were asked how they would like to see the money allocated among the different biomes of South Africa, including the marine areas. To assist respondents in this question, they were shown the first map in Fig. 1.

2.1.4. Familiarity with the local fynbos biome

Respondents were asked a series of questions to establish their familiarity with fynbos, in order of difficulty: (a) whether they had heard of it (b) whether they would be able to recognise it, (c) whether they could identify any fynbos species, and (d) whether they could identify different types of fynbos in different areas. Those that had heard of fynbos were then asked how many species they thought might exist in this Biome. This question was included because researchers often assume a far greater general knowledge of nature exists than generally is the case in reality, and in order to relate WTP for conservation and stated levels of interest to actual levels of knowledge. A knowledge score was assigned to each respondent on the basis of the level of familiarity with fynbos, such that respondents that had not heard of fynbos scored 0, those that responded in the affirmative to questions (a) to (d) scored accordingly up to 4, and those that were within 30% of the correct answer regarding fynbos species richness scored 5.

2.1.5. Response to predicted change in distribution of SA biomes

The issue of climate change was only introduced in the questionnaire at this stage, so that the above measures of existence value were not influence by a sense of impending loss. This part of the questionnaire also sought to determine the value of only the area of vegetation that stands to be lost according to the predictions of the country study. Although it is to be expected that the unit-value of a part of South Africa's natural heritage (estimated below) will not be the same as its unit value based on a value of the whole (estimated above), it provides a useful comparison and cross-check. The hypothetical situation differs quite markedly from the first WTP question. Respondents were first shown the second map in Fig. 1, and were given an explanation that this was the predicted effect of 'global warming'. They were first asked to what extent they were disturbed by this possibility, and if they were not concerned, they were asked why. If they were at all concerned, respondents were asked a hypothetical question as to their WTP to do something about it, as follows:

> ''Given this reality, even our best conservation efforts will not adequately preserve South Africa's natural heritage unless we, as a global society, manage to stop climate change. As you probably know, one of the main causes of global warming is excessive emissions of carbon from factories and cars etc, which creates a greenhouse effect. So the only way to prevent this huge loss of vegetation is to improve technology and behaviour so that we can reduce this pollution of the atmosphere.Now please imagine a situation where nature conservation agencies have plenty of money for on-the-ground conservation, and you did not need to make any donation towards the conservation agency as we asked about earlier. In this situation, we still stand to lose large areas of natural vegetation and large numbers of species due to global warming, but the areas remaining behind are well looked after. Faced with this situation, if you had a chance to help reduce climate change by reducing carbon emissions, for example by paying more for electricity or petrol, would you be in favour of such a policy? In this case the money raised could go towards improving technology or towards funding pressure groups to make governments adhere to international standards.Would you be in favour of such a policy?''

Those respondents that were in favour were then asked to choose one of three possible options in terms of different additional annual charges on their electricity bill that would lead to different levels of prevention of the predicted vegetation losses. Thus, the most expensive option would hypothetically prevent any loss, the intermediate option would lead to an intermediate loss, and a no payment option would lead to the loss as shown in the second figure. A range of five different top prices was given in different versions of the questionnaire, and the intermediate option was always half of the top option (Table 1). This was a closed-ended question which functioned as a double-bounded dichotomous choice question (see Hanemann et al., 1991) as follows: assuming that respondents responding positively to the preceding question would prefer the 100% option if it were cheap enough, then the first reaction was a yes–no reaction to the price of the 100% option. If this was a no, then the respondent was faced with the next choice, to make the loss half as bad by paying a smaller sum. Those finding either of these options higher than their WTP for those levels of conservation would then choose the zero-payment option. Following this, respondents were asked an open-ended question as to what their maximum WTP for the full conservation option would actually be.

2.1.6. Socio-economic data

The age group and race of respondents were noted by the enumerators. Respondents were asked their home town, their occupation and to indicate which of five household income brackets they fell into.

Table 1
Five different ranges of possible annual electricity surcharges associated with the prevention of climate change impacts on vegetation, given in different versions of the questionnaire

Result	Version 1	Version 2	Version 3	Version 4	Version 5
No loss of vegetation (100% prevention)	R1000	R500	R250	R100	R50
Intermediate loss	R500	R250	R125	R50	R25
Loss as predicted by country study	R0	R0	R0	R0	R0

R1 was equivalent to US$0.10 at the time of study.

2.2. Sampling strategy

The target population for the survey was that of income-earning (non poverty-stricken) households of the Western Cape. Respondents were selected randomly, and the final dataset was checked as to its representativeness of the population structure of the province. Within the main urban centre of the province, Cape Town, most respondents were interviewed on trains, where past experience has shown that people are usually particularly willing to participate since they are generally otherwise unoccupied. Only adults of 18 years or older were interviewed.

2.3. Population data

The Western Cape population was estimated to be 3 956 875 in the 1996 census, in 1 135 000 households. Based on a growth rate of 2.7% per annum, the estimated current population is 4 521 000, in 1 296 726 households. Taking into account that 18% of households in the province are poverty stricken, the target population and number of households in this study is estimated to be 3 700 000 people in 1 060 000 households. The South African population data and target population estimates are summarised in Table 2.

2.4. Estimation of changes in area of different biomes

Geographic Information System (GIS) coverages of the current extent of biomes and their predicted future extent under the Hadley 2CN climate model scenario were obtained from the National Botanical Institute. Areas were calculated in Arcview (Table 3).

2.5. Analysis

Spreadsheet data were checked for errors and then subjected to logical tests. Outlying, conflicting or nonsense responses were excluded.

WTP data obtained from open-ended responses were log-transformed in order to calculate the mean. Means were calculated for the whole sample and separately for each race group within the sample. Mean WTP was calculated from binary response data (choice of payment option for versions (bids) A–E) using a univariate binary response model. If a binary response was defined as $Y = 1$ if the individual accepted the bid and 0

Table 2
Estimated number of income-earning households in South Africa in 2001, by race group

	1996 Census	Estimated 2001 population	Estimated 2001 households	% unemployed	Estimated earning households
Black	31 127 631	35 562 992	10 189 969	43	5 808 282
Coloured	3 600 446	4 113 472	1 178 645	21	931 130
Asian	1 045 596	1 194 582	342 287	12	301 213
White	4 434 697	5 066 595	1 451 746	5	1 379 159
Unspecified	375 204	428 667	122 827	25	92 120
Total	40 583 573	46 366 307	13 285 475		8 511 904

Table 3
Estimated current and predicted future (2050) extent (ha) of the major vegetation Biomes in South Africa (source: National Botanical Institute)

Biome	Current area	Area remaining in 2050	% remaining in 2050
Desert	58 900	Not modelled	
Succulent Karoo	8 367 700	1 573 200	19
Nama-Karoo	36 205 900	8 218 800	23
Fynbos	7 139 800	2 897 900	41
Grassland	35 040 000	17 089 800	49
Savanna	40 714 400	33 874 200	83
Forest	56 400	Not modelled	
	127 526 700		

otherwise, then

$$P(\mathrm{Y}=1)=\pi(\mathrm{A})$$

where π (A) is a function of A representing the probability for accepting the bid A. The function was defined using a Logit Model, as follows:

$$\pi(\mathrm{A})=\frac{\mathrm{e}^{\beta_0+\beta_1\mathrm{A}}}{1+\mathrm{e}^{\beta_0+\beta_1\mathrm{A}}}$$

and

$$\ln\frac{\pi(\mathrm{A})}{1-\pi(\mathrm{A})}=\beta_0+\beta_1\mathrm{A}$$

The average WTP (μ) was then calculated as:

$$\mu=-\frac{\beta_0}{\beta_1}$$

The result was compared with that obtained from an open ended question on the same issue. Finally, estimates of the existence value of biodiversity based on the two types of questions—a hypothetical donation to conservation agencies versus a response to a climate change scenario—were compared. The viability of the results are discussed.

3. Results

3.1. Sample characteristics

The response rate was high (> 90%), and a total of 820 questionnaires were completed. Of these, six respondents were from outside the Western Cape and the questionnaires were eliminated from the analysis, leaving a sample of 814. About two thirds (568 or 69%) of the respondents were residents of the Cape Metropolitan Area, while the remainder were inhabitants of other towns and rural areas in the Western Cape. The proportion of CMA residents in the sample (69%) was exactly the same as proportion of the Western Cape population living in the CMA (1998) data: 3 035 500 in CMA; 4 390 000 in W Cape, Wesgro). Of respondents interviewed, 21% were 18–25 years old, 46% were 26–40, 26% were 41–60 and 5% were over 60.

A breakdown of respondents by race and income category is shown in Table 4. The racial composition of the sample was not significantly different from the racial composition of the Western Cape (1996) Census data; $X^2=4$, n.s.). Income data from this study cannot be compared properly with census data, because (a) 1996 census data are out of date and (b) 2001 census data are not yet published. However, the pattern of data collected in this study, when compared with the most comparable possible breakdown of 1996 census data, indicate that the sample data were highly representative, except for the intentional omission of the 18% of the population that are estimated to be living in poverty, and except for a possible slight overrepresentation of respondents in the highest income groups (Fig. 2).

Since the data were generally representative of the Western Cape population, results were analysed together for extrapolation at the provincial level. However, the racial composition differed

Table 4
Percentage of respondents of different race groups falling into each of five household monthly income categories, and the total number and percentage in each income and race category

Household monthly income	Black (%)	Coloured (%)	Asian (%)	White (%)	Total n	%
< $100	44	20	24	8	184	22.6
$1–300	40	42	43	22	297	36.5
$3–1000	14	32	24	40	242	29.7
$1–R3000	2	5	10	25	78	9.6
> $3000	0	0	0	5	13	1.6
Total n	182	403	21	208	814	
%	22.4	49.5	2.6	25.6		

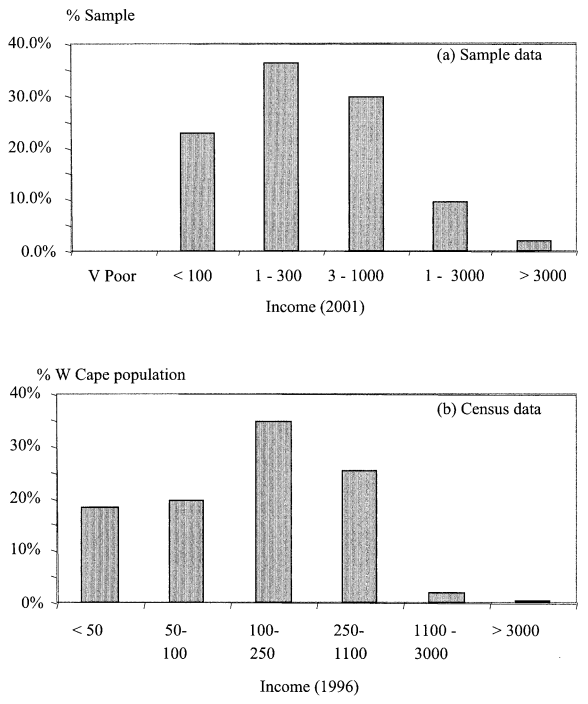

Fig. 2. Comparison of survey data and 1996 census data on monthly incomes (in US$). Note that the very poor category was not targeted in the survey.

from the national population, and thus results were extrapolated to this level by race group.

3.2. General awareness and interest in nature

Just over half (53%) of all respondents had visited at least one national park in South Africa, but only about 10% had visited more than four parks. Respondents had visited 1.5 parks on average. However, there was a strong racial skew in the number of national parks that respondents had visited, with the white respondents having visited about four times as many parks as other respondents, probably due to disparity of income between the groups. Indeed, the probability of a respondent having visited any national park in the country was significantly related to income (Fig. 3).

Some 14, 7 and 6% of respondents had visited the West Coast National Park, De Hoop Nature Reserve and the Cedarberg Wilderness Area, respectively, in the past 2 years, with 21% having visited any of the three. The highest frequency of trips was reported by respondents of 41–60 years old, and there was little difference among the rest. Trip frequency increased with income category 1–4 with 0.3, 0.7, 1.6 and 1.9 trips per 2 years, respectively, but was only 0.9 trips for the highest income bracket, though the latter was possibly an artefact of the smaller sample size of this category.

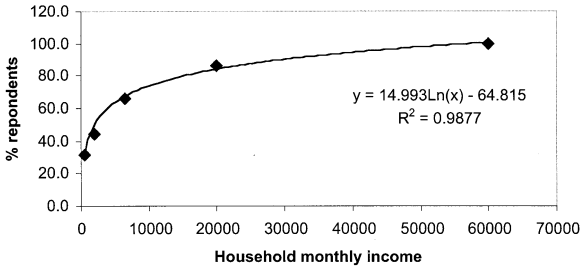

Fig. 3. Percentage of respondents having visited at least one National Park in South Africa in relation to household income (Rands per month).

Nearly 8% of respondents were members of any wildlife-related club, with botanical and hiking clubs being most common.

The majority of respondents classified their interest in nature as being passive (39%) or active (36%), while a small minority claimed to have no interest (10%) and 15% of respondents claimed to have a passionate interest in nature. Interest levels were related to income: while the majority of respondents in income categories 1 and 2 classed themselves as having a passive interest in nature, the majority of respondents in the higher income categories rated themselves as having an active interest in nature (Table 5).

3.3. Knowledge of fynbos

Despite its' being the dominant vegetation in the province, not all the respondents had heard of fynbos. A total of 72% had heard of fynbos, but less than half of respondents (41%) could recognise it, 22% could identify any fynbos species, and 15% could recognise different types of fynbos. There were also strong racial differences in the responses, with black respondents being far less familiar with fynbos than the other groups (Table 6). Some of these are likely to be overestimates.

When asked to estimate the number of species in fynbos vegetation, only seven respondents (1.2% of those that had heard of fynbos, 0.8% of all respondents) were within 15% of the correct answer of approximately 7000 species (Table 7). Only 6.6% of those that had heard of fynbos managed to guess the number of species within 50% of the correct answer. Of those that did hazard a guess, 90% of estimates were below half of the actual number of species, and 75% underestimated the number of species by a whole order of magnitude.

Knowledge scores were positively correlated with interest levels (Fig. 4).

3.4. Willingness to pay for nature conservation in South Africa

The majority of respondents (76%) were willing to pay an annual contribution towards the conservation of biodiversity in South Africa. Of those that were not, 57% gave inability to pay as their reason. The next most common reason (13%) was that the issue was not important to them and, related to this, a further 10% stated that they had other priorities. A significant proportion (11%) also believed that their tax contribution should cover this need. The remaining reasons (each $<$ 4% of responses) included that they felt they had paid their dues, conservation agencies were corrupt, conservation measures do not work, users should pay, and uncertainty about the future.

For respondents that had a positive WTP, the overall mean annual WTP for conservation in South Africa as a whole, calculated from log-transformed data, was \$10.4, with confidence limits of \$0.6 to \$195.2 ($n = 619$). There was no relationship between WTP and experience of protected areas (visitation rates to nature reserves or number of National Parks visited), but there was a positive correlation between WTP and both

Table 5
Number of respondents rating themselves as having different levels of interest in nature, separated by income category

Monthly income	Interest in nature				Total
	None	Passive	Active	Passionate	
$<$ \$100	29	78	52	24	183
\$1–300	35	122	96	43	296
\$3–1000	14	87	98	43	242
\$1–R3000	1	31	36	11	79
$>$ \$3000		4	7	2	13
Total	79	322	289	123	813
%	10	39	36	15	

Table 6
Respondents' knowledge about fynbos

	Black (%)	Coloured (%)	Asian (%)	White (%)	Total (%)
Heard of fynbos	45	74	81	91	72
Able to recognise it	27	36	29	63	41
Able to identify species	12	19	14	39	22
Able to identify different types	12	13	5	22	15

Table 7
Estimates of the number of fynbos species made by respondents that had at least heard of fynbos vegetation

Range of answer	Number of respondents	% respondents
No idea	83	14.1
1–10	118	20.1
11–50	93	15.8
51–500	156	26.6
501–1000	47	8.0
1001–6000	63	10.7
6001–8000[a]	7	1.2
8001–20 000	10	1.7
20 001–50 000	3	0.5
50 000+	7	1.2

[a] Correct.

stated level of interest in nature and knowledge levels (Fig. 5).

The above figures are partly due to the relative distribution of income categories within different interest groups. Indeed, the average amount (including zero bids) that people were willing to pay varied according to both income group and stated level of interest in nature (Fig. 6). Within each income category, people that were passionate about nature were prepared to pay a much higher amount per year than those in other groups, and there was not much difference in WTP between those who categorised themselves as having a passive or an active interest in nature (unlike in the comparison between interest groups alone).

If the mean WTP ($10.4) is extrapolated to 76% of the 1.06 million households in the Western Cape, provincial WTP for nature conservation in South Africa is estimated to be $8 378 240 per year. Assuming that all South Africans share similar sentiments to the Western Cape population, then, extrapolated separately by race group to an

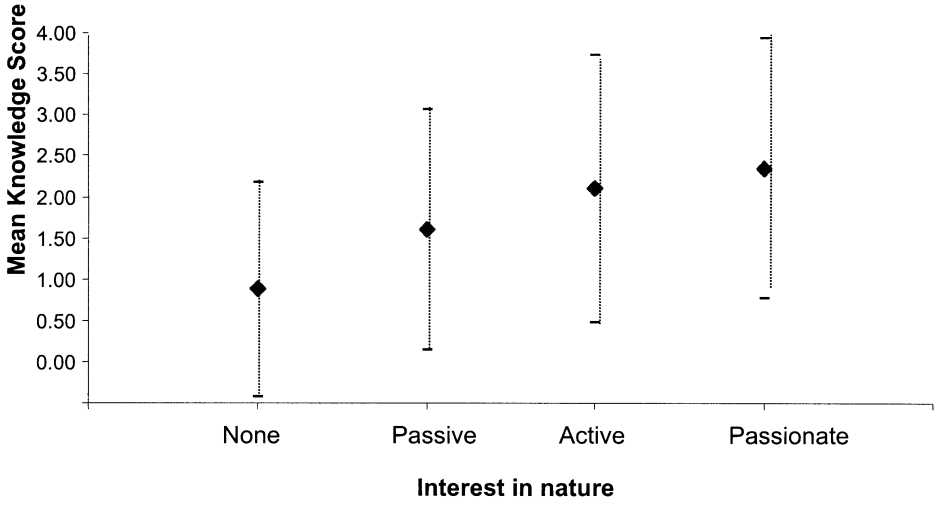

Fig. 4. Relationship between interest in nature and knowledge of fynbos, based on individual knowledge scores on a scale of 0–5.

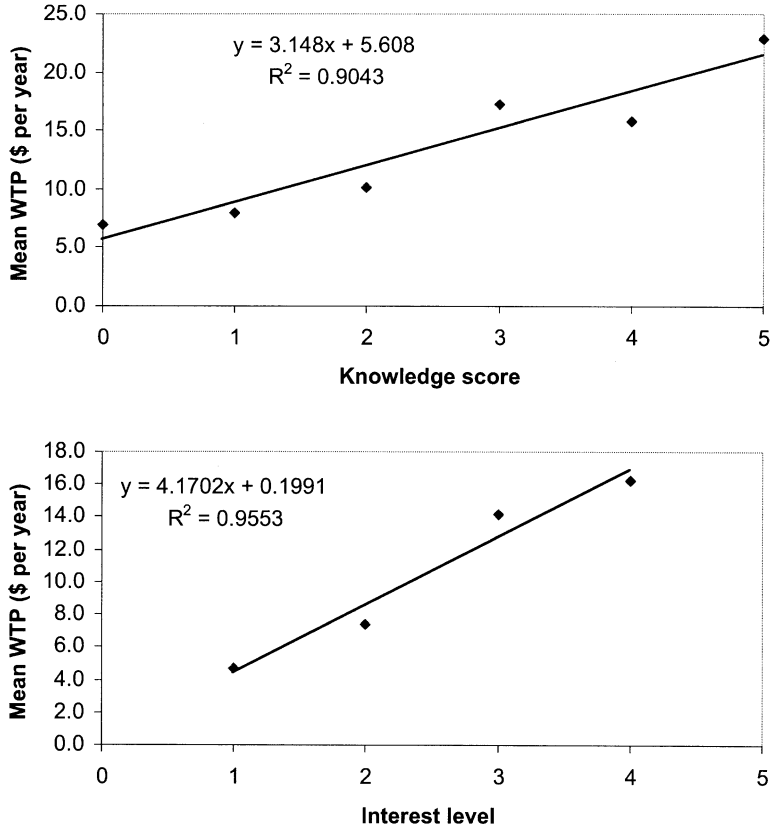

Fig. 5. WTP for nature conservation in South Africa in relation to (a) respondents' interest in nature and (b) their knowledge of fynbos (see text for explanation of scores).

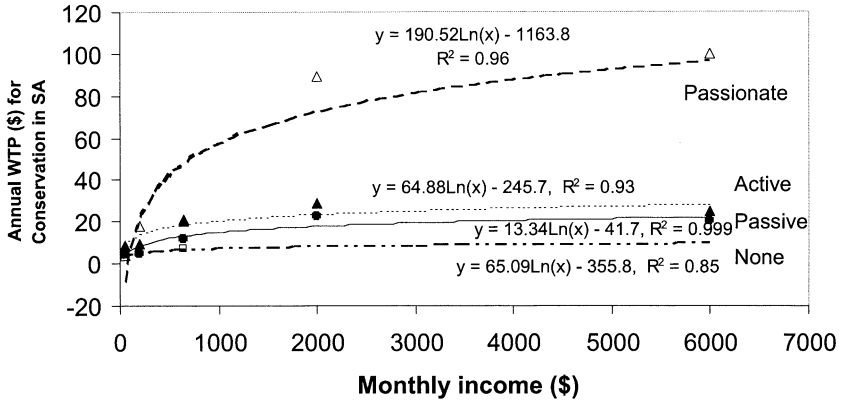

Fig. 6. Relationship between WTP for biodiversity conservation in South Africa as a whole and respondents' income and interest in nature. Values in Rands.

Table 8
Estimated total annual WTP by South Africans for nature conservation in South Africa as a whole, based on extrapolation of average WTP by race group given in the Western Cape (US$1 = approximately R10 in November 2001)

Extrapolate to RSA by race	Earning hh	% hh willing to contribute	Mean WTP hh^{-1} per year (US$)	Total WTP per year (US$)
Black	5 808 282	76	5.9	25 832 053
Coloured	931 130	78	9.5	6 926 057
Asian	301 213	55	7.0	1 161 714
White	1 379 159	79	21.1	23 034 958
Unspecified	92 120	76	10.4	728 116
Total	8 511 904			57 682 898

estimated 8.5 million income-earning households in South Africa, the total national WTP could be in the order of $58 million per year (Table 8).

3.5. Relative value of different biomes—a Western Cape perspective

Having given their overall WTP for biodiversity conservation, respondents were asked to allocate their donation among seven areas corresponding to the major biomes of South Africa, and the marine zone. Fynbos was allocated the largest share (Table 9), probably due its being located largely within the Western Province, and the marine and forest biomes were the next most popular targets for conservation. The preference for fynbos may not be because fynbos is more favoured than other vegetation types per se, but may stem largely from a loyalty towards conserving one's local heritage. It is probably reasonable to assume that a similar survey carried out in another province would find a bias towards the predominant biomes in that province.

Based on the above breakdown, the existence value of South Africa's different biomes to people in the Western Cape was estimated (Table 9). The total annual WTP for the conservation of Fynbos was estimated to be in the region of $3.3 million per year (Table 9), suggesting a that the existence value of fynbos in present terms is at least $84 million (at a 3% discount rate). Given the size of the fynbos biome as approximately 71 000 km^2, this represents a value of $0.46 ha^{-1} per year, which can be expressed as a present value of $10.88 ha^{-1} (3% discount rate).

3.6. Response to possible change in vegetation of Western Cape reserves

Respondents that had visited the West Coast National Park, the De Hoop Nature Reserve or the Cedarberg Wilderness area in the last 2 years generally felt that they would visit less often if the

Table 9
Western Cape population's WTP for biodiversity conservation in different biomes

	Current area (ha)	% Allocation	Total WTP by W Cape	$ ha^{-1} per year
Fynbos	7 139 800	39	3 265 564	0.46
Marine	2 480 000	19	1 590 916	0.64
Forest	56 400	15	1 255 986	22.27
Succulent Karoo	8 367 700	7	586 127	0.07
Nama Karoo	36 205 900	7	586 127	0.02
Grassland	35 040 000	7	586 127	0.02
Savanna	40 714 400	6	502 394	0.01
Total	122 864 400		8 373 240	

Values are also presented as values per ha per year, based on GIS data on the size of each biome; the marine zone is estimated to extend 8 km (5 nautical miles) out to sea.

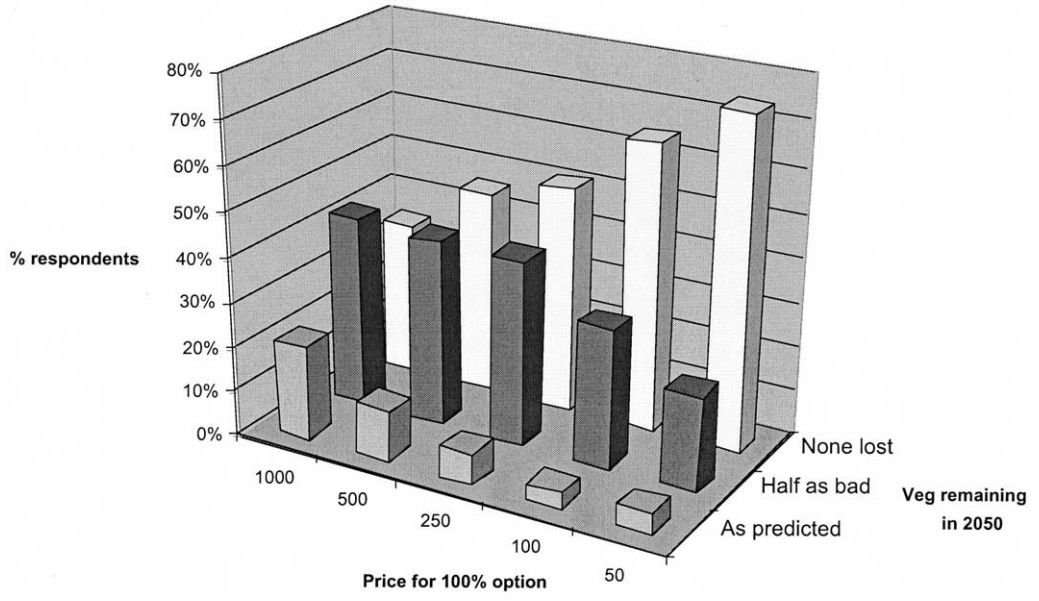

Fig. 7. Percentage of each respondent group given each different questionnaire version choosing each of the three hypothetical options given. The annual price (in Rands) of the 100% option (preventing any loss of vegetation) is indicated, and the price of the other two options are half this and zero, respectively. Data only include responses of those that stated upfront that they were in favour of such a policy ($n = 620$).

vegetation of these parks became desertified. Users of the West Coast National Park were most affected, with 43% stating that they would visit a lot less, while the majority of users of the other two said they might visit slightly less often. About 20–23% of users said it would not make a difference. All of these parks contain other geographic features—lagoon, vlei and coastal zone, and mountains, respectively, that are major attractions. It is difficult to predict with any accuracy how visitor numbers to these parks might change, as a new set of visitors could be attracted to the changed area for new reasons.

On the whole, respondents were very disturbed by the pictures they were shown of the predicted change in vegetation with climate change. This is reflected in the range of responses concerning their feelings on the matter: 60% of respondents said that they would be very disturbed by this reality, 21% said they would be disturbed 'quite a lot', and 10% would be 'slightly' disturbed. Only 8% of respondents were not concerned at all.

Reasons given by 36 of the respondents as to why they were not at all concerned were mainly that they did not feel that a loss of vegetation would negatively affect them in any way (50%). However, there was also a fair amount of distrust in the predictions, with 22% of these respondents believing that the scenario shown was highly unlikely. Several respondents were not concerned because they would not be alive in 50 years time (17%), these respondents clearly not being concerned about future generations either. In addition, 6% of respondents claimed to like deserts and 6% said there was no reason for concern because God would provide.

3.7. WTP to reduce impacts of climate change

A total of 76% of respondents stated that they would be in favour of a policy, which increased charges on polluting commodities such as electricity or petrol in order to raise funds towards reducing carbon emissions globally. These respondents were then asked to choose between three given options: a high-priced option which would hypothetically lead to a total prevention of the loss of vegetation to climate change, a middle-priced

option which would allow intermediate damage, and a zero-payment option which would lead to the full effects as shown to the respondent on a map. The reaction of respondents to this choice was strongly determined by the range of prices given (Fig. 7). When the price to prevent any damage was lowest, the highest proportion of respondents chose that option, but as the top price increased, so more respondents chose the intermediate option, and towards the highest prices, more respondents started to choose the zero payment option (i.e. they could neither afford the middle nor high prices). In the highest price version of the questionnaire, more respondents opted for the intermediate option than the full conservation option. Fig. 5 shows the trade-offs made between price and the amount of vegetation conserved.

The question consisted of a sequence of binary choices made by the respondent. The results of the first choice—"am I willing to pay × to prevent any damage"—resemble a simple demand curve for preventing damage due to climate change (Fig. 8). Using this relationship, one could roughly estimate that the average WTP among those favouring the policy was $44.5, corresponding to the amount at which 50% of the population would agree to 'sign up'.

However, although visually appealing and roughly acceptable, the rough technique shown above is not strictly correct in mathematical terms. This is because the relationship is not constrained between absolute probabilities of zero and one, which means that the equation becomes inaccurate towards the outer bounds. The data thus had to be constrained to a probability distribution between 0 and 1. The data were described by the following logistic regression (Logit) model:

$$P = \frac{e^{0.7186 - 0.001487*A}}{1 + e^{0.7186 - 0.001487*A}}$$

where P is the probability of a respondent accepting bid A. The model was highly significant ($\chi^2 = 39.15$, d.f. $= 1$, $P < 0.0001$). From the model, average WTP was estimated to be $48.3 among the 76% respondents that were in a favour of the policy to prevent the effects of climate change through increased tariffs. This is effectively equivalent to an overall average WTP of $36.7.

In addition to the closed-ended question, the same subset of respondents were also asked an open-ended question as to their maximum WTP an electricity surcharge to prevent the effects of global warming on climate change. Mean WTP was $27, with 95% confidence limits from $2.5 to 288 ($n = 500$). This is equivalent to an overall average WTP of $20.5, about 56% of the amount calculated using the Logit model.

Thus, the total WTP by 1.06 million Western Cape households is estimated to be between $21 and 39 million per year, and the overall national WTP, extrapolated by race group, is estimated to be between $161 and 263 million per year. Based on the allocation to different biomes given above, local (Western Cape) WTP for the Fynbos Biome was $8.2–15.3 million per year. Averaged across the whole biome, this is equivalent to $1.18–2.15 ha^{-1} per year, but averaged across the area of fynbos threatened by climate change, the value is $1.97–3.60 ha^{-1} per year.

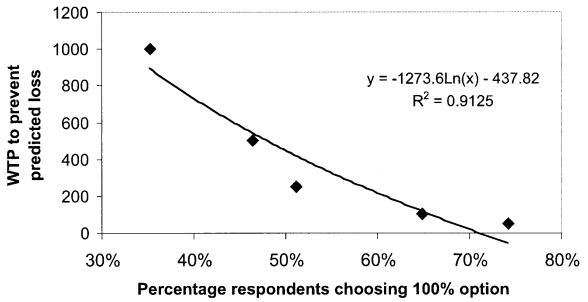

Fig. 8. Relationship between the number of respondents willing to 'buy into' a scheme for total prevention of climate change damage to vegetation and the price of that scheme. Data only include the 76% of respondents in favour of such a policy ($n = 620$). Values in Rands.

4. Discussion

The results of this study suggest that local WTP for biodiversity protection is relatively high in relation to income levels, which are substantially lower, on average, than those in Europe or North America. Before the threat of climate change was

introduced, total provincial WTP for conservation of South African biodiversity was some $8.4 million per year. Assuming that the data could be extrapolated to the national population, national WTP was estimated to be $58 million. These figures are significant when compared with budgets allocated to conservation agencies in South Africa. For example, the Western Cape's nature conservation agency has an annual budget of approximately $10 million, while the provincial WTP for fynbos was some $3.3 million.

It should be noted, however, that these estimates might be slightly higher than true WTP, because of a tendency for 'yea-saying', or trying to please the enumerator (Holmes and Kramer, 1995), which is difficult to eliminate in surveys such as these. However, it is assumed that embedding bias was minimised by getting respondents to consider the problems at a national scale. Values for the Fynbos biome were then elicited by asking respondents to distribute their donation among all the possible biomes.

Part of the explanation for the relatively high existence values for biodiversity revealed by this study is the fact that there is a relatively high level of interest in nature. Interest levels were shown to have a strong influence on individual WTP. The majority of respondents reported having at least a passive interest in nature. Levels of experience were also relatively high: about half of respondents had experienced a visit to a South African national park, and a fifth of respondents had visited one of the three largest protected areas in the province (excluding the Cape Peninsula National Park within Cape Town) in the past 2 years. The racial skew in park visitation rates is probably partly a result of the effects of South Africa's *apartheid* history, which saw expropriation of black-occupied lands for the creation of parks, on attitudes to parks. Visitation to national parks and nature reserves is a manifestation of an active or passionate level of interest, which was claimed by a total of 51% of respondents. Thus, although stated levels of interest were higher than expected, they seemed to be supported by the activities of the respondents. Interestingly, however, neither the number of national parks visited nor the frequency of visits to major nature reserves in the past 2 years were correlated with WTP. Indeed, interest in nature is probably exhibited by a more complex range of behaviour, although experience can still be expected to enhance peoples' interest and WTP.

Despite the high levels of interest and experience, the levels of knowledge about the dominant vegetation biome of the province were fairly poor. Almost a third of respondents had never heard of fynbos, and few could identify species or types of fynbos. More astonishing was the level of knowledge about the species richness of the biome, a fact which is second nature to the scientific and conservation community, and of interest internationally. Three quarters of respondents underestimated species richness by at least an order of magnitude, with these answers being less than the total number of threatened ('red-data') species in the biome. This could put an interesting new perspective on how the public perceives information about threatened species.

Knowledge was correlated to interest, although unravelling cause and effect would be difficult. Both knowledge and interest were positively correlated to WTP for nature conservation, a fact which should be taken seriously by conservationists and policy makers. If one examines how wealth and level of interest both interact to determine WTP it is clear that WTP is constrained by income, or ability to pay, irrespective of interest levels. Indeed, most of those who were not willing to contribute gave inability to pay as their reason. This has important implications for conservation policy, and also demonstrates the potential impact of overall government policy on economic growth and education on the very existence value of biodiversity. If knowledge and interest are positively reinforced by experience, then looming policies which aim to make local protected areas more self-sufficient by raising prices may reduce such values to the local populace by reducing their opportunities for access to parks.

The first estimate (WTP for conservation) was derived from an open-ended question, while the second (WTP to prevent climate change effects) was derived using both closed- and open-ended questions. In the closed dichotomous choice question, precaution was taken against starting point bias by offering a wide range of starting bids in

different survey versions and by including a follow-up open-ended question (see Herriges and Shogren, 1996). The results of the open-ended follow-up question was somewhat lower than the former. This yielded a range of possible values. However, true WTP is probably closer to the upper-bound estimate, since (a) the use of a dichotomous choice question replicates a real decision more closely and is thus considered to yield more realistic results, and (b), because the higher incidence of illogical responses that had to be excluded from the analysis suggested that the open-ended question was not well understood by all respondents.

When respondents were shown the predicted impacts of climate change on South African biomes, local WTP was elevated to between $21 and 39 million (up to a 5-fold increase), of which $8.2–15.3 million could be allocated to fynbos protection. The national WTP for biodiversity protection, based on extrapolation, increased to an estimated $161–263 million. Thus WTP was strongly influenced by the levels of threat to South African biodiversity perceived by the respondents, although part of this WTP could conceivably be for combating other negative effects of climate change. If one considers that the climate-change question related to approximately half the vegetation area (the area threatened by climate change), then the WTP at a unit area level were even more elevated. WTP for fynbos increased to up to $3.60 ha^{-1} per year, compared with $0.46 ha^{-1} per year in the face of 'normal' conservation threats.

This suggests that WTP was genuinely influenced by perceptions of the relative threats to biodiversity with and without climate change. It is the estimate of WTP to prevent climate change losses that would appear to provide a better estimate of the existence value of biodiversity. In comparison, WTP for normal conservation activities simply reflects the existence value of whatever the respondent perceives is at risk from prevailing threats, and not the full utility that they gain from the natural area in question. In essence, the average respondent is probably 'free-riding' on the belief that, without intervention, the existing threats would not make too serious an impact on biodiversity. Thus estimates based on WTP for protection of habitats (e.g. Turner et al., 1995; Carson et al., 1994) may often be underestimates of the full existence values of these areas.

Although this result was anticipated, the first question (WTP for conservation) was important in order to provide respondents with an opportunity to express a preference for different biomes, specifically to isolate the value of the local fynbos Biome. Thus $15.3 million can be taken to be the current local annual existence value of the area of fynbos which is predicted to be lost by 2050. Note that all the values for fynbos are only at the local provincial level, to which should be added the WTP by the rest of South Africans and the rest of the world. Total South African WTP for fynbos could not be estimated from the Western Cape dataset as the allocation of donations to different biomes would have differed from province to province.

The above estimates thus provide some insight into the potential non-market costs of climate change in South Africa. In South Africa, the impacts of climate change are unlikely to be as high as other developing African countries, due to the relatively small reliance on the agricultural sector (3% of GDP) compared with the secondary and tertiary sectors. Thus, non-market costs associated with biodiversity loss are likely to be a significant proportion of total costs of climate change, along with the impacts of increased incidence of disease. Indeed, this study suggests that the total national WTP to prevent climate-change damages to biodiversity in the country are at least as much as 0.3% of GDP. In the developed world, total unmitigated climate change impacts are predicted to be in the order of 1.5% of GDP (Fankhauser et al., 1997).

Nevertheless, the above findings also illustrate the highly dynamic nature of existence value. Income, knowledge, experience and interest are all factors that can be increased or decreased over time by changes in government policy and economic climate, as well as by other strong forces such as media and the prevalence of HIV-AIDS. The non-market value of biodiversity can thus never be accurately projected over time. This is particularly pertinent to the measurement of non-market impacts of climate change. Value systems

may have changed within 50 years. While increasing poverty may lessen the value of biodiversity to households, the demise of these resources can be expected to lead to an increase in their unit-area values. Further research is needed to estimate how climate-induced changes in biodiversity will impact on societal wellbeing in the longer term.

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References

Ajzen, I., Brown, T.C., Rosenthal, L.H., 1996. Information bias in contingent valuation: effects of personal relevance, quality of information and motivational orientation. Journal of Environmental Economics and Management 30, 43–57.

Arrow, K., Solow, R., Portney, P.R., Learner, E.E., Radner, R., Schuman, H., 1993. Report of the National Oceanic and Atmospheric Administration (NOAA) panel on Contingent Valuation. National Oceanic and Atmospheric Administration, Washington DC, pp. 64.

Bower, J.M., Stoll, J.R., 1988. Use of dichotomous choice nonmarket methods to value the whooping crane resource. American Journal of Agricultural Economics, 327–381.

Carson, R.T., Wilks, L., Imber, D., 1994. Valuing the preservation of Australia's Kakadu conservation zone. Oxford Economic Papers 46, 727–749.

Carson, R.T., Flores, N.E., Meade, N.F., 1996. Contingent Valuation: Controversies and Evidence. University of California, San Diego, p. 45.

Cooper, J., Loomis, J., 1992. Sensitivity of willingness-to-pay estimates to bid design in dichotomous choice contingent valuation models. Land Economics 68, 211–224.

Diamond, P.A., Hausman, J.A., Leonard, G.K., Denning, M.A., 1993. Does contingent valuation measure preferences? Experimental evidence. In: Contingent Valuation: A Critical Assessment. North-Holland, Amsterdam.

Edwards, P.J., Abivardi, C., 1998. The value of biodiversity: where ecology and economy blend. Biological Conservation 83, 239–246.

Fankhauser, S., Tol, R.S.J., 1996. Climate change costs: recent advancements in the economic assessment. Energy Policy 24, 665–673.

Fankhauser, S., Tol, R.S.J., 1997. The social costs of climate change: the IPCC second assessment report and beyond. Mitigation and Adaptation Strategies for Global Climate Change 1, 385–403.

Fankhauser, S., Tol, R.S.J., Pearce, D.W., 1997. The aggregation of climate change damages: a welfare theoretic approach. Environment and Resource Economics 10, 249–266.

Fankhauser, S., Tol, R.S.J., Pearce, D.W., 1998. Extensions and alternatives to climate change impact valuation: on the critique of IPCC Working Group III's impact estimates. Environment and Development Economics 3, 59–81.

Hanemann, W.M., Loomis, J.B., Kanninen, B., 1991. Estimation efficiency of double bounded dichotomous choice coningent valuation. American Journal of Agricultural Economics 73, 1255–1263.

Herriges, J.A., Shogren, J.F., 1996. Starting point bias in dichotomous choice valuation with follow-up questioning. Journal of Environmental Economics and Management 30, 112–131.

Holmes, T.P., Kramer, R.A., 1995. An independent sample test of yea-saying and starting point bias in dichotomous-choice contingent valuation. Journal of Environmental Economics and Management 29, 121–132.

Kahneman, D., Knetsch, J., 1992. Valuing public goods: the purchase of moral satisfaction. Journal of Environmental Economics and Management 22, 57–70.

Kiker, G.A., 2000. Synthesis report for the vulnerability and adaptation assessment section: South African Country Study on Climate Change, Department of Environmental Affairs and Tourism, Pretoria.

Mitchell, R.C., Carson, R.T., 1989. Using Surveys to Value Public Goods: The Contingent Valuation Method. Resources for the Future, Washington, DC.

Myers, N., 1990. The biodiversity challenge: expanded hotspots analysis. Environmentalist 10, 243–256.

Schwarz, N., 1997. Cognition, communication, and survey measurement: some implications for contingent valuation

surveys. In: Determining the Value of Non-Marketed Goods: Economic, Psychological, and Policy Relevant Aspects of Contingent Valuation Methods. Kluwer, Boston, pp. 129–149.

Stevens, T.H., DeCoteau, N.E., Willis, C.E., 1997. Sensitivity of contingent valuation to alternative payment schedules. Land Economics 73, 140–148.

Svedsäter, H., 2000. Contingent valuation of global environmental resources: test of perfect and regular embedding. Journal of Economic Psychology 21, 605–623.

Turner, R.K., Folke, C., Gren, I.M., Bateman, I.J., 1995. Wetland valuation: three case studies. In: Biodiversity Loss: Economic and Ecological Issues. Cambridge, Cambridge, MA, pp. 129–149.