Tourists' perceptions and willingness to pay for the control of *Opuntia stricta* invasion in protected areas: A case study from South Africa

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Invasive alien plants have a long history of establishment in the national parks of South Africa. In particular, *Opuntia stricta* (sour prickly pear) has invaded several protected areas in the country, threatening the biodiversity conservation mandate of these conservation areas. This article focuses on the economic estimation of *O. stricta*'s negative impacts in protected areas by using Contingent Valuation surveys conducted amongst a sample of tourists in the Pilanesberg National Park (North West Parks and Tourism Board, South Africa). Tourists' familiarity and awareness of selected invasive alien plants and their willingness to pay for the implementation of a control programme for *O. stricta* were assessed. The results show that many tourists are familiar with invasive alien plants and their (positive and negative) impacts and, in particular, perceived the presence of *O. stricta* to be negative, due to the impacts on aesthetics and recreation. Socio-demographic characteristics, as well as individual attitudes and biocentric beliefs, have an influence on the willingness to contribute financially to a control programme for *O. stricta*. The individual willingness to pay assessment found that the majority of respondents (78%) were willing to pay a higher entrance fee (an additional R57.30 or $7.00 per day) for a hypothetical programme to control the invasion of *O. stricta* in the Pilanesberg National Park.

Conservation implications: The willingness of tourists to pay for *O. stricta* management provides useful insights in the decision-making process of park management. The results are encouraging, since, in general, tourists are aware of the problem and are in support of providing additional economic input for preventing future alien plant invasions.

Introduction

Biophysical aspects of invasive alien plants (IAPs) have been relatively well studied over a long period of time (e.g. Simberloff, Martin & Genovesi 2013; Vilà *et al.* 2011), whilst socio-economic aspects linked to alien plant invasions have been analysed only during the last two decades (Born, Rauschmayer & Bräuer 2005; Charles & Dukes 2007). This was mainly attributed to (1) the inability of the markets to capture the economic value of the damage caused by IAPs on many ecosystem services, (2) limited knowledge and experience with IAP impacts on many ecosystems and (3) conflicts of interest often associated with IAPs (Pejchar & Money 2009; Van Wilgen, Khan & Marais 2011), which can heavily influence IAP management and conservation policy. Constructive consideration of these challenges is of crucial importance, especially for protected areas (PAs) where management needs to ensure biodiversity conservation in the face of serious challenges (Emerton, Bishop & Thomas 2006), such as human-induced pressures, lack of financial resources and competing conservation projects (e.g. animal poaching).

Several methods for the economic valuation of IAP impacts have been employed in the past (Garrods & Willis 1999; Pejchar & Money 2009), namely cost-based (production function, replacement cost and avoided damage cost) and preference-based (travel cost method, contingent valuation and choice experiment) methods. Amongst the preference-based techniques, Contingent Valuation (CV) has commonly been used to assess the public's perception of the impacts of IAPs and their willingness to pay (WTP) for control programmes. CV is a survey-based method where respondents directly state their preferences for quantitative or qualitative changes in ecosystem goods or services (Alberini & Kahn 2006; Mitchell & Carson 1989). Despite the fact that CV has its own limitations (Venkatachalam 2004), it is still viewed as a useful way to provide input into the

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decision-making process, especially when dealing with effects that are not expressed through market signals (Bräuer 2003). CV was employed to assess the economic value of potentially eradicating a single IAP, such as *Eichhornia crassipes* (Law 2008), *Acacia saligna* (Lehrer, Becker & Kurtiel 2013) or a set of IAPs (Bardsley & Jones 2006; Turpie 2004; Van Wilgen *et al.* 2001). Still, few studies have examined both tourists' perceptions and their WTP for IAP control, especially in PAs that are directly dependent on tourism for their income.

The aim of this article is to assess tourists' perceptions and knowledge of selected IAPs present in South Africa (SA) and, in particular, to investigate tourists' WTP for the control of *Opuntia stricta* in PAs, using combined CV and visual aids surveys. *Opuntia stricta* was chosen because it can have severe impacts on PAs, without any important potential benefits for PAs, or for local communities in or around conservation areas, as the plant is not used for animal forage or human consumption. Other representatives of this group, like *Opuntia ficus-indica*, are important food and fodder resources for humans and animals and play an important role in the livelihood of local communities in Africa (Larsson 2004). *Opuntia* species were abundant in the Pilanesberg National Park (PNP) in the period from 1960–1984 and were treated mechanically and with herbicides (Carruthers 2011). Although it was not specified whether *O. stricta* was included in the species controlled, the plant has not become established; or if previously locally eradicated, has not become re-established and invaded PNP. However, we use this species as an example of a species (and specifically an *Opuntia* spp.) that could become problematic in PNP, as it has in other PAs in SA for example, Kruger National Park (Foxcroft *et al.* 2007) and Mapungubwe National Park (SANParks 2012).

Native to south-eastern USA, eastern Mexico and Cuba, *O. stricta* (Haw.) Haw. was introduced worldwide through natural (wind, bird, animal and floodwater) and anthropogenic pathways (Monteiro *et al.* 2005; Vilà *et al.* 2003). The causes for the man-made pathways include intentional introduction for ornamental purposes and as hedge plants (Monteiro *et al.* 2005). *Opuntia stricta* is present across much of the north-eastern region of SA (Henderson 2001; Rouget *et al.* 2004), including several PAs (Kruger National Park, Mapungubwe National Park, Camdeboo National Park and Karongwe Private Game Reserve, amongst others), indicating that even conservation areas are not immune to its invasion (Foxcroft *et al.* 2007; Masubelele, Foxcroft & Milton 2009).

Opuntia stricta can reach high densities and cause multiple negative ecological and economic impacts, such as the reduction of food production and the loss of grazing potential (Jullien, McFadyen & Cullen 2012; Menkins 2010); the restriction of human access that impedes people's ability to travel and move without hindrance, mainly in rural areas (Larsson 2004); the reduction of the aesthetic value of a landscape and recreational activities (Parsons & Cuthbertson 2001); habitat transformation (Walters *et al.* 2011) and changes in biodiversity (Robertson *et al.* 2011).

Given the above-mentioned impacts and need for control, we estimated the potential economic value of reducing the negative impacts of *O. stricta*, as perceived by tourists in PAs. Tourists in PNP were considered as a sample group of visitors of PAs to test their WTP in a hypothetical situation of *O. stricta* invasion in a protected area.

Firstly, the knowledge and the perceptions of tourists towards IAPs in general, and *O. stricta* specifically, were investigated. Secondly, the tourists' WTP for the implementation of an *O. stricta* control programme was determined. Studies on the outcomes of the Working for Water programme have shown that the control of IAPs results in increased water runoff, and enhances biodiversity (Van Wilgen *et al.* 2011). The associated cost–benefit analysis of this programme highlighted the net economic benefits in the long-term. The hypothesis of this study is that such a control programme produces extended benefits by improving the landscape value in PAs, enhancing financial support from tourists. We then discuss the advantages and drawbacks of using CV to elicit tourists' perceptions and their willingness to contribute to a control programme, as well as the potential value of our preliminary results in reducing the knowledge gap in this field. Moreover, we discuss the potential contribution of the CV method in quantifying the negative impacts of an IAP that do not hold any market price, which could assist policy makers in placing an economic tolerance threshold on the invasiveness of alien plants.

Material and methods

Study area

The PNP is situated in the North West Province of SA, and has a total surface area of 57 200 ha. It is set in the crater of an extinct volcano and appears as a complex series of eroded rings of low mountains and hills that rise approximately 300 m – 600 m above the surrounding land (Carruthers 2011).

The PNP was proclaimed in 1977, but was not considered a 'natural' area because of the various anthropogenic activities by many inhabitants in the previous centuries. Nevertheless, it was restored ecologically from previous farmlands and converted into a conservation area (national park) where a variety of indigenous animals were reintroduced (Anderson 1986). This area is significant for biodiversity conservation because it is a transition zone between the Arid Savanna and the Moist Savanna Biome (Carruthers 2011). The landscape is highly heterogeneous and has many landscapes and habitat types, providing refuge for many species of plant and animal. It also has aesthetic attributes that attract many domestic and foreign tourists. Emerging from its recent complex political and management history, the number of visitors has increased steadily from fewer than 50 000 in 1992 to over 500 000 in the most recent records, which place PNP as the leading tourist attraction in North West Province (Ndabeni *et al.* 2007). Its close proximity to Gauteng (less than 3 hs' drive) favours the presence of day (short-term) visitors from this province.

Data collection

Tourists' perceptions of *O. stricta* invasion and their WTP for

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the implementation of a control programme were assessed using a CV survey (Alberini & Kahn 2006). We pre-tested the CV survey with students doing their Master's degrees in ecology, and visited PNP a week before the formal survey to ask tourists in PNP for their comments. We discussed respondents' understanding of IAPs and their impacts, and obtained feedback on the clarity and flow of the questionnaire content, provision of sufficient information, and time needed to fill in the questionnaire. Modifications were made based on the participants' comments. Once finalised, the questionnaire was presented in person (by N. Nikodinoska) to a random sample of 61 visitors in PNP in December 2011 (one out of ten visitors sitting in the picnic site was interviewed). The survey lasted approximately 10 min per person. The semi-structured questionnaire comprised 24 closed-form questions (see Online Appendix 1), subdivided into four parts, following standard procedures described by Arrow *et al.* (1993).

Part 1 focused on tourists' motivations, and total costs to visit the park (including tickets, travel, meals and lodging).

In Part 2, we evaluated tourists' perceptions about the current status of selected IAPs and their knowledge of the negative and positive impacts that these have on ecosystem services, and function, using a 5-point Likert scale (1 = very low impact, 2 = low impact, 3 = medium impact, 4 = high impact, 5 = very high impact). The questions on familiarity and knowledge of the selected IAPs were important in understanding the quality of information provided in the WTP section (check questions). In the case of the negative impacts, a high value on the Likert scale is associated with high concerns amongst the respondents, whereas a high value given for the positive impacts reflects the perception of the historical or current usefulness of IAPs for industries or local livelihoods. Positive and negative impacts of IAPs were selected based on studies of social perceptions of the impacts of IAPs in different areas of SA (e.g. Bardsley & Jones 2006; Joubert & McLahren 2002; Tessendorf 2007). Six of the main genera and invasive species in SA were included: *Acacia* sp. (wattle), *Pinus* sp. (pine tree), *Lantana camara* (lantana), *Eucalyptus* sp. (gum tree), *E. crassipes* (water hyacinth) and *Opuntia* spp. (the common name 'prickly pear' is generally used for most species of platyopuntoid cacti). The negative impacts included in the list were agricultural weeds, damage to livestock, human health, ecosystem functioning, landscape aesthetics and costs of control methods. Positive impacts included the use or role of IAPs in the forestry sector, ornamental uses, historical uses and landscape aesthetics.

Part 3 assessed the visual preferences of the presence of *O. stricta*, using landscape photographs across a gradient of *O. stricta* abundance (see Online Appendix 2), as well as the WTP for the implementation of a control programme of *O. stricta* invasion. The photographs represented four scenarios of *O. stricta* infestation: about 10%, 20%, 40% and 60% of the total vegetation cover. A 'business as usual' scenario is characterised by a percentage of cover less than 5%. Thereafter, we presented a hypothetical scenario where *O. stricta* had invaded PNP and required a control programme to determine the invasion status, select and implement an appropriate control method, and conduct further monitoring. We used the first and the last photograph to represent two invasion scenarios: (1) less than 10% invasion, where a prompt control programme is necessary (i.e. rapid response) and (2) where a control programme is not in place (more than 50% infestation). An open-ended response format for the WTP question was adopted. The daily entrance fee was used as a means of determining tourists' WTP for the implementation of the control programme, as respondents had already paid an entry fee for PNP, and this could be increased (or remain the same) depending on their response. Respondents were first asked to state whether they were prepared to pay a higher fee if they knew that this contribution would go directly to an *O. stricta* control programme, and then to state their maximum WTP. Whilst the surveys were conducted in December 2011, all values presented here are based on 2012 values. The entrance fee for 2012 was R65 for adults and R20 for pensioners and children.

Part 4 of the questionnaire requested personal information from the respondent (gender, age, level of education, home language and income).

Analysis

A Tobit model was fitted to analyse the data and generate a predictive model of WTP (Tobin 1958). It is a censored (or truncated) regression model in which the range of the dependent variable (WTP values) is constrained in one way: above or below. In this particular case the censoring was made from below, with the threshold set to zero, meaning that values below zero were constrained. In cases of relatively large numbers of zero values, Tobit regression models using maximum likelihood estimation are preferred to linear models using ordinary least squares, as they predict only positive rational WTP values (Maddala 1983; Tobin 1958). Ordinary least squares models are in these cases downward biased. The Tobit model is still widely employed in CV surveys that use open-ended WTP questions (e.g. Du Preez, Tessendorf & Hosking 2010; Halkos & Jones 2012; Halstead, Lindsay & Brown 1991).

The selection of the variables (see Table 1 for variables and definitions) and their expected relationship with the individual WTP per day was based on behavioural theory review and previous studies on tourists' perceptions of IAPs in SA (De Wit 2006; Tessendorf 2007). The explanatory variables are of both a qualitative and a quantitative nature. Qualitative variables are represented by dummy variables, where a value of 1 indicates the presence of the subject (e.g. previous visits to the park) and 0 the absence of the subject, whilst the quantitative variables are expressed by a continuous variable. The expected relationship between the explanatory variables and the WTP is positive if the monetary value increases in response to higher values of the predictive variable (e.g. respondents with a higher income are expected to state higher WTP values). The expected effect is negative if the amount increases in response to lower values of the predictive variables (e.g. tourists who give lower values

TABLE 1: Explanatory variables used in the Tobit model and their theoretical (expected) relationship with the individual willingness to pay.

Variable name	Code	Description	Expected effect†
Previous visits in South African parks	1	If the respondent has visited any parks in South Africa before	+
	0	Has not visited any parks	+
Costs per family per visit	Continuous variable	Estimate of the total cost of the family for the holiday in the park	+
Conservation	Likert scale (from 1 = not important at all to 5 = very important)	How important is the conservation of the environment in protected areas	+
Photograph	Likert scale (from 1 = unpleasant to 5 = very pleasant)	Preferences related to photograph with major (30% – 50%) *Opuntia stricta* infestation	–
Gender	1	Male	+
	0	Female	+
Nationality	1	If the respondent is from South Africa	–
	0	Otherwise	–
Province	1	If the respondent is from Gauteng	+
	0	Otherwise	+
Income	Income categories from 1 to 6	1 is referred as lowest income category, 6 is the highest income category	+
Number of days in Pilanesberg National Park	1	More than 3 days in the park	+
	0	Otherwise	+

†, Anticipated response by tourists to key questions or expected relationship between the predicative (explanatory) variable and stated individual willingness to pay.

for photographs with major infestations are expected to state high WTP amounts).

Results

Willingness to pay for the control of *Opuntia stricta*

The results from the CV show that 78% of the respondents were willing to pay additional fees in order to control the spread of *O. stricta* (Table 2). The value of WTP for these respondents ranged from R5 – R150 per day. About one third of the respondents who were willing to pay gave R100 as their WTP amount, 17% indicated R20 and 13% stated R10 as their WTP value.

Of the remaining responses, 13 tourists (22% of the respondents) refused to pay higher fees, and 12 had valid WTP zero values (i.e. tourist responses showed that they did not perceive invasion as a problem, therefore were not willing to pay). The reasons for valid zero WTP were mainly that the respondents perceived *O. stricta* and IAPs in general as a way of enhancing species diversity (three respondents), they were not interested in plants (one respondent), and they have become familiar with seeing them in the natural environment (one respondent). There was one protest response that stated his refusal to pay a higher price as a consequence of already high fees in the park. Of the respondents who were willing to pay higher fees, two did not quantify the amount they were willing to pay, and responded with 'not sure' and 'reasonable amount'. One respondent did not provide his WTP. In this survey the 'I don't know'-type answers were excluded from the WTP analysis.

The Tobit model selection was based on the Bayesian information criterion value, where a lower value indicates a better fitting model. The variables in the Tobit model provide a relatively good explanation of WTP (Table 3). The mean daily WTP estimated by the Tobit model was found to be R57.30 (± 28.80 standard deviation [s.d.]). The positive value of the coefficient for the variable 'Previous visits in South African parks' shows that respondents who had previously visited parks are willing to pay a higher entrance fee for an IAP control programme. Similarly, the coefficient for the variable 'Conservation' (16.747) indicates that visitors who rated the conservation of the environment and typical landscape in PAs highly are willing to pay more. The respondents who perceived the photograph that represents the scenario of higher infestation levels (30% – 50% density) as unpleasant

TABLE 2: Willingness to pay values (2012 values).

Willingness to pay amount (in R)	Frequency	Frequency (%)
0.00	13	22.41
5.00	2	3.45
8.00	1	1.72
10.00	5	8.62
15.00	6	10.34
20.00	8	13.79
30.00	1	1.72
32.50	1	1.72
35.00	2	3.45
40.00	1	1.72
60.00	1	1.72
65.00	2	3.45
100.00	13	22.41
120.00	1	1.72
150.00	1	1.72
Total	**58**	**100**

TABLE 3: Tobit model.

Variable	Coefficient	Standard error	$P[\|Z\|>z]$
Constant	-59.8790	39.1090	0.1258
Previous visits in South African parks	65.4260	23.0360	0.0045
Costs per family per visit	0.0115	0.0061	0.0579
Conservation	16.7470	7.8010	0.0318
Photograph	-17.6900	5.6460	0.0017
Gender	30.5550	10.7770	0.0046
Nationality	-53.0190	20.4250	0.0094
Province	27.4360	11.7390	0.0194
Income	0.0484	0.0200	0.0155
Number of days in the park	5.4320	13.4800	0.6870
Log-likelihood	-	-	-238.3520
Bayesian Information Criterion	-	-	8.5561

The estimated coefficients are to be interpreted as the effect of the regressors (independent variables e.g. 'Previous visits in South African parks') on the latent variable (willingness to pay). Positive values of the coefficient mean that a one point increase in the independent variable 'Previous visits in South African parks', for instance, is associated with a 65 point increase in the predicted value of willingness to pay.

are willing to pay more in order to prevent the possible spread of *O. stricta* (Figure 3, in Online Appendix 2). Foreign respondents have a higher WTP for controlling IAPs than domestic respondents (variable 'Nationality'). Tourists who come from Gauteng are also prepared to pay more than visitors from other regions (variable 'Province'). Personal income, not surprisingly, influences the respondents' WTP; namely, respondents with higher incomes are willing to pay a higher entrance fee (variable 'Income'). The average annual income of the interviewed tourists is relatively high, with 26% earning more than R385 711 and 11% earning less than R55 100 per year (26% did not respond; Table 4). The rest of the tourists' socio-demographics are included in Table 5.

Perceptions of tourists to invasive alien plant species in South Africa

Tourists' knowledge of IAPs was relatively high, with 75% of respondents having previously heard of the six invasive species (Figure 1). Where the respondents were asked to select the IAPs (of the given options) they know or have heard about, *Acacia* and *Pinus* (pine) spp. were the best known, followed by *Eucalyptus* sp. and *Opuntia* spp. When asked which species they could recognise when they see them, *Opuntia* spp., together with *Pinus* sp., were listed most frequently. *Eichhornia crassipes* was indicated as a problematic species in SA by 27% of the respondents, followed by *Acacia* sp. (23%) and *Pinus* sp. (22%). *Opuntia* species (generally prickly pear) and *Acacia* sp. (wattle) were indicated as problematic species within PAs (Figure 1). With the 'Other' option where respondents could list other species they were familiar with, *Cereus jamacaru* (Queen of the night) and *Chromolaena odorata* (Chromolaena) were frequently identified as problematic IAPs in SA.

In assessing the impacts from the list of benefits of IAPs in SA (Table 6), relatively high positive impact values were attributed to forestry uses (mean of 3.4), and pastoral and ornamental uses (3.03). Historical uses as well as landscape aesthetics were comparatively less 'valued' and with more variation in the responses.

All listed negative impacts of the IAPs had an average value higher than 3 (out of 5), which means that respondents recognised the serious potential treats that invasions can cause. The highest negative values, 4.39 and 4.26 (out of 5), are related to the potential reduced performance of ecosystem functioning and increased costs for implementation of control programmes, respectively.

Discussion

Willingness to pay for the control of *Opuntia stricta*

This survey design included landscape visual aids to better explain the hypothetical scenario. We believe that the use of photographs in CV surveys helps in the design of valuation scenarios, because landscape changes appear more understandable or visual to respondents (Madureira *et al.* 2011). Tourists' perception of the aesthetic value of *O. stricta* control is therefore easier to convey using visual aids. A possible drawback of using these photographs could be due to the fourth photograph (see Online Appendix 2) representing an *O. stricta* invasion of more than 50%, in the description of the hypothetical scenario, which could have partially influenced some of the WTP positive values. Whilst this may not be a common situation, it is not unfeasible. Nevertheless, the outcomes of the photograph preference

TABLE 4: Categories of respondents' income per year.

Income category (in R)	Frequency	Frequency (%)
Less than 55 100	6	11
55 111–165 300	5	8
165 311–275 500	10	16
275 511–385 700	8	13
385 711–495 900	5	8
More than 495 911	11	18
Not answered	16	26
Total	**61**	**100**

TABLE 5: Socio-demographics of tourists in the Pilanesberg National Park.

Category	Profile	%
Gender	Male	54
	Female	46
Age	18–34	57
	35–49	25
	50–64	13
	More than 64	5
Nationality	South African	82
	European	12
	Chinese	5
	Canadian	1
Province of residence	Gauteng	72
	North West	12
	Mpumalanga	8
	Other	8
Home language	Afrikaans	47
	English	41
	Other	12
Level of education	School	31
	Graduate degree	34
	Post graduate	25
	Master and Doctorate	10

TABLE 6: Mean value and standard deviation of positive and negative impacts of invasive alien plants in South Africa.

Impacts	Mean	s.d.
Positive impacts		
Forest use	3.36	1.40
Pastoral food, ornamental uses	3.03	0.98
Historical uses	2.59	1.40
Landscape aesthetics	2.46	1.33
Negative impacts		
Ecosystem functioning	4.39	0.97
Expensive control methods	4.26	0.95
Landscape aesthetics	3.92	1.06
Agricultural weeds	3.78	0.98
Human health	3.71	1.20
Death to livestock	3.68	1.12

5-point Likert scale from 1 (low) to 5 (very high).
s.d., standard deviation.

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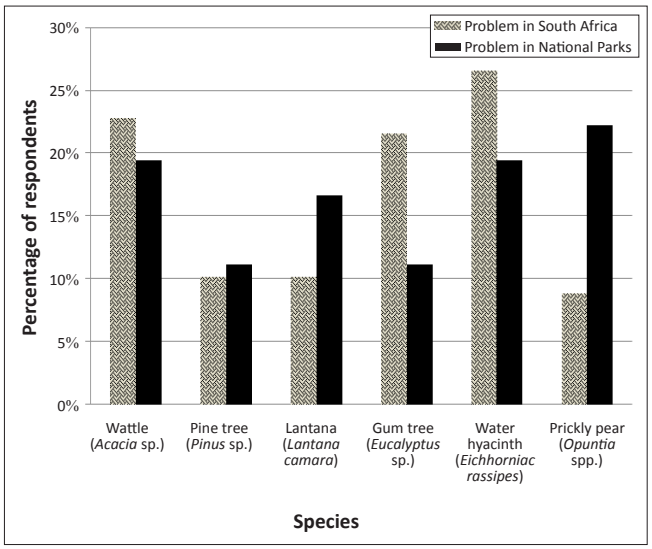

FIGURE 1: Tourists' perceptions of the negative impacts of invasive alien plants in South Africa and in protected areas in general.

have shown that people attribute negative values to the *O. stricta* invasion, starting from the second photograph (11% – 30% invasion). Moreover, the outcome from the Tobit model showed that people who expressed their displeasure for the third photograph (30% – 50% invasion) were willing to pay more for the control programme.

One of the advantages of using an open-ended WTP question format is that the use of data sets are smaller than required by, for example, a dichotomous choice, which reduces the time and expense of the survey process (Halstead *et al.* 1991). This approach can, however, provide a lower (conservative) WTP value than other methods. Critics of this format assert that it can create a large number of non-responses, protest bids and outliers (Carson, Flores & Meade 2001; Hanemann 1994), but is efficient if respondents are familiar with paying for the subject of the survey and does not result in a starting point bias (Mitchell & Carson 1989). In our case study, the respondents demonstrated their awareness of the problem of IAPs and thus we are confident in the validity of our results.

The similarity of the tourists' profile between PNP and other national PAs in SA (SANParks 2012; Van der Merwe & Saayman 2008) gives relatively higher validity to some of the socio-demographics features that were used as explanatory variables in the Tobit model. In particular, we focused on the variable 'Income' as an important predictor of the stated WTP. The average income of the respondents is relatively high, with 15% earning around R220 400 and another 15% earning more than R385 711 per year. This could be due to the tourists' profile that (1) a large percentage comes from Gauteng, widely known as the most developed South African province and (2) eco-tourists are often people with a middle-high income (Statistics South Africa 2013). However, a non-negligible number of respondents (approximately 26%) refused to answer this question, which could have altered this outcome.

The individual daily WTP to finance a control programme in PNP is, on average, an additional R57.30, which is a substantial amount when considering the entrance fee for an adult is R65.00. The fact that 78% of the visitors are prepared to support an *O. stricta* control programme, of which a third are willing to pay R100.00 or more, strongly suggests that visitors to national parks are aware of the threat, and the seriousness, posed by IAPs. The individual WTP lies within a range of values obtained for another IAPs control programme in SA (Du Plessis 2003; Du Preez *et al.* 2010). A study on the WTP for the removal of alien vegetation and restoration of indigenous vegetation in several sites (including conservation areas) in Underberg (KwaZulu-Natal Province, SA), by the Working for Water programme, derived a WTP value of R26.40 (R36.30 in 2012 values) per project, and R27.34 (R37.30 in 2012 values) per hectare (Du Preez *et al.* 2010). Du Plessis (2003) estimated the individual average WTP for the removal of IAPs and biodiversity conservation in several sites in the Eastern and Western Cape Provinces (nature reserves included) using a CV survey conducted amongst both residents and tourists. The mean individual WTP was R111.54 (R153.57 in 2012 values).

Our estimation of the WTP appears to be relatively low, which could be explained by the fact that we investigated tourists' preferences for a control programme implemented for just one IAP species. There is still a possibility that respondents overstated their WTP and that if *O. stricta* was to be included as only one of many IAPs to be controlled, the WTP amount could have been even lower (Garrods & Willis 1999). Another constraint is that due to the limited time available, there were fewer questionnaires than would be ideal; however, with the similarities in visitor profiles to other PAs, the spread of questionnaires across the range of tourists is acceptable.

Perceptions of tourists to invasive alien plant species in South Africa

The respondents rated the impact to ecosystem function and the expense of control methods as the highest concern, which is similar to the results found in a study in the Mediterranean region (Bardsley & Jones 2006). These were followed by the impacts to landscape aesthetics and by agricultural weeds. However, another study conducted in Spain shows that the changes in ecosystem stability is considered the third greatest impact of alien plants, after competition with native species and the effects on fauna (Andreu, Vilà & Hulme 2009). The results show that the impacts of IAPs on ecosystems and management control programmes are broadly recognised by the respondents.

The benefits of IAPs that were ranked highly by the respondents included use of species for forestry (commercial plantation forestry), pastoral uses, food, ornamental uses and historical uses. Greater importance placed on IAPs for forestry uses is perhaps related to the fact that there are still large areas of commercial plantations in SA (e.g. *Eucalyptus* and *Pinus* spp.). In the context of national parks, on the other hand, trees and woody shrubs (*Acacia* spp., *Pinus* spp. and

L. camara) as well as Cactaceae (*Opuntia* spp.) were most frequently considered to have negative impacts.

Conclusion

Reducing the knowledge gap in the public perception of IAP impacts by providing quantitative data that could be integrated with other research in PAs can contribute to the scientific understanding on the economic valuation of IAP control programmes. The outcomes of studies on people's perceptions of both positive and negative impacts of IAPs in SA can play a role in improving the development and implementation of conservation projects, especially in cases where 'conflict' alien species are considered. Moreover, it can also provide insight into the long-term potential of visitor-funded IAP control programmes as a feasible option. The benefits of a control programme could be over-estimated if it has not been established whether the beneficiaries (i.e. tourists and local community) recognise the problem and are willing to contribute to the restoration of the invaded areas.

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Competing interests

The authors declare that they have no financial or personal relationship(s) that may have inappropriately influenced them in writing this article.

Authors' contributions

The authors contributed equally to this work.

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