The Australian Journal of
Agricultural and Resource Economics
Journal of the Australian Agricultural and Resource Economics Society

The Australian Journal of Agricultural and Resource Economics, 56, pp. 498–520

Valuing Australian botanic collections: a combined travel-cost and contingent valuation study*

Paul Mwebaze and Jeff Bennett†

Economic values of biological collections in three Australian botanic gardens in Canberra, Melbourne and Sydney were estimated using the travel-cost method (TCM) and the contingent valuation method (CVM). The TCM component of the study produced average per-trip consumer surplus (CS) values of $39 and $18 for single- and multiple-site visitors, respectively, for each botanic garden, resulting in an estimate of approximately $194 million for the total social welfare generated by trips to the three sites. Marginal willingness to pay (WTP) for access to botanic gardens was also investigated through payment vehicles of entry fees or higher parking charges using the CVM component. The analysis revealed a positive mean WTP of between $3 and $5 per trip per person. The difference between the CVM and TCM results reflect the different underlying concepts of value under investigation: average CS per visit for the TCM and the utility arising from a marginal visit for the CVM. Marginal changes in CS from the TCM were derived. The confidence intervals from the TCM marginal values overlap the WTP estimates from the CVM. These findings will be useful for resource management decisions in the botanic gardens collection in Australia.

Key words: biological collections, botanic gardens, contingent valuation method, economic value, travel-cost method, willingness to pay.

1. Introduction

Collections of biological material generate benefits to society in realm areas ranging from biosecurity, public health and safety, monitoring of environmental change to traditional taxonomy and systematics (Suarez and Tsutsui 2004). However, these biological resources may not be optimally utilised by the private sector because of the transaction costs incurred in accessing them (Bennett and Gillespie 2008). Furthermore, P.G. Whiting and Associates

* This study was funded by the Australian Department of Sustainability, Environment, Water, Population and Communities through the Commonwealth Environment Research Facilities. We would like to thank the management and staff of the botanic gardens in Canberra, Melbourne and Sydney for helping to facilitate the visitor survey. We are grateful to Tertius Greyling, Lucy Chaplain and Marie-Caroline Vandromme, research assistants from the Crawford School of Economics and Government (ANU), who helped with interviewing visitors at the botanic gardens and data preparation.

† Paul Mwebaze (email: mpaul48@hotmail.com) and Jeff Bennett are at the Crawford School of Economics and Government, The Australian National University, Canberra, ACT, Australia.

doi: 10.1111/j.1467-8489.2012.00595.x

(1995) argue that the benefits supplied by plant collections are often undervalued by public policymakers, resulting in insufficient resources being allocated for their management.

Botanic gardens maintain collections of biological material. These include preserved and living whole plants as well as DNA libraries. Botanic gardens, in particular, face rising costs and a decline of their traditional uses in medicine and pharmacy (Garrod *et al.* 1993). Botanic gardens also play a role as a public leisure amenity. Table 1 shows the popularity of visiting a selection of Australian botanic gardens. Botanic gardens are now the second most popular cultural venue visited in Australia after the cinema (Botanic Gardens Trust, 2010). Approximately 40 per cent of the Australian population over 15 years old visit at least one botanic garden each year. However, most botanic gardens in Australia do not charge an entry fee, and a question arises as to the magnitude of benefits generated from free public access.

The aim of this study is to assess current recreational visitor use values at three selected botanic gardens in Australia. The study employs observed and stated behaviour methods to make inferences about consumer preferences for the selected botanic gardens. A travel-cost method (TCM) is used to measure the consumer surplus (CS) enjoyed by visitors to the botanic gardens. The advantages of using this technique include its foundations in welfare economics and its reliance on revealed preferences (Shrestha *et al.*, 2002). There is a growing pool of recreation value estimation studies that use the TCM (e.g. Bennett 1996; Common *et al.* 1999; Whitten and Bennett 2002; Stoeckl and Mules 2006; Prayaga *et al.* 2010; Rolfe and Dyack 2010). However, there have been limited efforts to estimate the economic values of botanic gardens. A notable exception is the study by Garrod *et al.* (1993), which assessed the recreational value of four botanic gardens in the UK.

Another objective is to use the contingent valuation method (CVM) to estimate visitors' marginal willingness to pay (WTP) an entry fee for access to botanic gardens. The CVM is routinely used to value a change in the provision of scientific collections (Noonan 2003; Throsby 2003; Provins *et al.* 2008). The CVM is also increasingly used to value unique biological resources as discussed in OECD (2002, 2006). This suggests that it can be used to provide useful information about the value of botanic collections.

Table 1 Features of Australian botanic gardens

Parameters	Australian National Botanic Garden	Royal Botanic Garden Melbourne	Royal Botanic Garden Sydney
Size (ha)	40	36	58
Total expenditures ($M)	9.65	18.38	41.64
Own-earned revenue ($M)	–	10.08	16.49
Government funding ($M)	–	11.41	23.92
Total revenue ($M)	10.45	21.49	40.41
Number of visitors/year	429,109	1,709,846	3,854,750

Source: Annual reports of the respective botanic gardens for the financial year 2009–2010.

This study contributes to the current valuation literature by examining the nature of the relationship between values estimated under the TCM and CVM. A number of studies valuing recreation have concluded that the TCM produces higher estimates of value than the CVM (Carson *et al*. 1996; Fix and Loomis 1998; Shrestha and Loomis 2001, 2003; Loomis 2006; Rolfe and Dyack 2010). However, there remains much debate why the TCM generates higher values than the CVM for the estimates of recreation values. Rolfe and Dyack (2010) suggest that the most important factors causing the estimate divergence are likely to be the different decision points taken by respondents, the inclusion of substitute sites in the decision calculus, and the roles of strategic and uncertain responses in the CVM.

In this study, we argue that while the TCM is designed to estimate the extent of average WTP (as a Marshallian CS per visit), the CVM – through its use of a hypothetical entry fee/parking fee as the payment vehicle – is focused on visitors' marginal WTP a per-unit price. Hence, the two methods are aimed at the estimation of two different aspects of the demand for botanic garden visitation. The remainder of the study is structured as follows. The next section describes the methodology followed and the survey instrument used in the study. The main results are reported and discussed in Section 3. Section 3 sets out the CS from botanic garden visitation estimated using the TCM. Section 4 reports and discusses the CVM results. Section 5 is a comparison of the TCM and CVM results. Section 6 provides a synthesis of the results and concludes the study.

2. Methods

2.1. The survey instrument

The survey questionnaire developed for this study consisted of two parts (Figure 1). The first part was designed to collect information on trip motivation, travel costs, travel time and on-site expenditures. This information was used to estimate the recreational use benefits generated by individuals visiting botanic sites. The second part involved the CVM application. This was designed to estimate user's marginal WTP for access to the botanical gardens. The NOAA guidelines were followed in designing the CVM questions (Arrow *et al*. 1993). The payment vehicle used was an 'entry fee' to gain access to a botanic garden. The dichotomous choice (DC) format was used. This type of question was favoured because it gives the respondent no incentive for not answering truthfully, that is, the format is incentive-compatible (Bateman *et al*. 2002; Alberini and Khan 2006).[1] Before administering the survey, a first draft of the questionnaire was pretested in three pilot surveys. The study

[1] Note that incentive compatibility also requires the stipulation of a provision rule (Bateman *et al*., 2002). In the surveys, respondents were informed that if 50 per cent of respondents agreed to pay, then an entry fee/additional parking fee would be established.

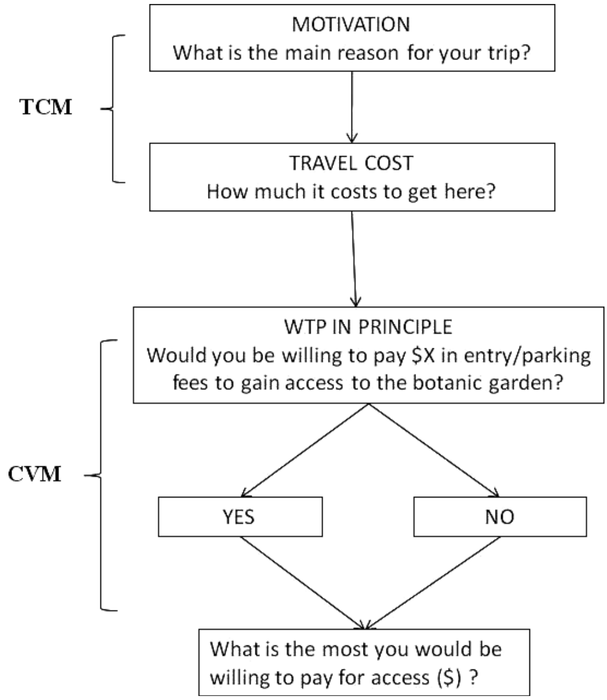

Figure 1 Linking motivation to visit botanic gardens to willingness to pay amounts.

opted for an in-person survey because it generally yields the highest survey response rate (Bateman *et al*. 2002).

The final revised questionnaire was administered at three selected botanic gardens: the Australian National Botanical Garden (ANBG) in Canberra, the Royal Botanic Garden Melbourne (RBGM) and the Royal Botanic Garden Sydney (RBGS). The data for the study were collected over a 4-month period from July to November, 2010. A number of sampling strategies were used to achieve a representation of the visitor population. Potential participants were intercepted at random, and an in-person written survey was conducted in the visitor centre, cafe, gardens, parking places and at access points. The sample was stratified to make it representative of the temporal distribution of visits (e.g. weekend vs. weekdays; different hours of the day). Every fourth individual encountered was invited to participate in the survey. The survey was administered through the Australian winter/spring months to minimise the effect of seasonality on visitation.[2]

Interviewers were instructed to target individuals, avoiding wherever possible participation of other members of the same group. Only adult members were interviewed, and interviewers were instructed to question the head-of-

[2] Australian seasons follow the sequence: Summer (December–February); Autumn (March–May); Winter (June–August) and Spring (September–November).

household responsible for expenditure decisions if family groups were encountered. One problem often encountered with on-site surveys is that they are conducted when a trip is still in progress and respondents may not be able to provide reliable data on total costs (Upneja *et al*. 2001). For this survey, visitors were intercepted in the middle or at the end of their trip as they prepared to leave, by which time they had incurred the costs and had sufficient data to report.

2.2. Descriptive statistics

Descriptive statistics of the sample are summarised in Table 2. A total of 1600 visitors were interviewed at the three botanic gardens. Of the total responses, 1139 were usable for the travel-cost demand estimation. Visitors sampled were more likely to be women (57–64 per cent) and they were on average 36 years old and had a relatively high average annual income of $77,000. These statistics indicate that the sample is representative of the general profile of visitors to Australian botanic gardens (Botanic Gardens Trust (BGT) (2010). Comparison with statistics for Australia as a whole (Australian Bureau of Statistics (ABS) (2012) indicates that the sample age structure is statistically similar to that of the general adult population (median age = 36.8 years). However, statistical tests showed that our sample enjoyed a significantly higher income compared to the national average for full-time working adults ($66,000) indicating that, in this aspect, the sample is not representative of the rest of Australia.

On average, respondents visited the selected botanic gardens between six and eight times a year, with each trip lasting over 2 h, depending on the site. Figures 2–4 give the stated principal motivating factors for the trips. Note that the recreational experience includes not only learning about plant collections but also other potentially valued joint products such as relaxation, meeting and spending time with friends, natural beauty and scenic view, and

Table 2 Descriptive statistics of variables used in regression models, by selected locations

Parameters	ANBG	RBGM	RBGS
Trip demand (visits/year)	7.49	8.48	6.82
Travel cost ($)	45.34	32.43	20.94
Travel time (hours)	2.39	0.85	0.75
Length of trip (hours)	1.92	2.84	2.61
Multiple sites (yes = 1, no = 0)	0.28	0.34	0.49
Annual income (‘000 $)	94.64	70.35	83.88
Age (years)	43.89	36.13	30.87
Male (Male = 1; Female = 0)	0.38	0.33	0.43
Sample size (*n*)	650	300	650

Note: ANBG, Australian National Botanical Garden; RBGM, Royal Botanic Garden Melbourne; RBGS, Royal Botanic Garden Sydney.

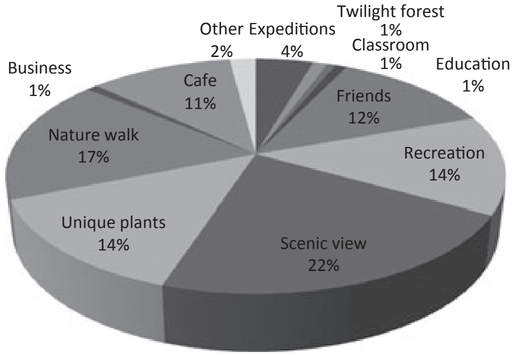

Figure 2 What were the most important reasons for your trip to the Australian National Botanical Garden?

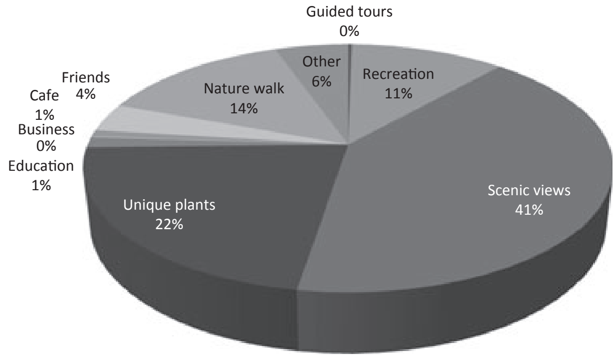

Figure 3 What were the most important reasons for your trip to the Royal Botanic Garden Melbourne?

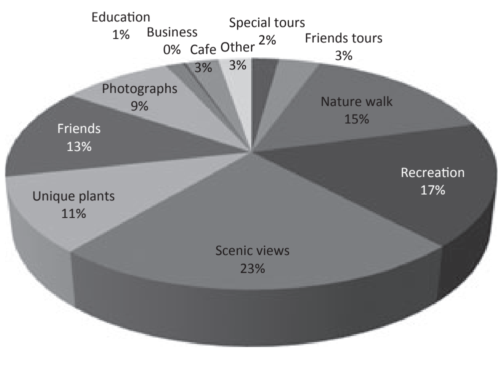

Figure 4 What were the most important reasons for your trip to the Royal Botanic Garden Sydney?

nature walk. A number of these motivating reasons given above, for example natural beauty and scenic view, highlight the benefits of plant collections for the visitors.

3. Estimating visitation benefits using the TCM

3.1. The individual TCM

The TCM assumes that an individual must visit a botanic garden to consume its services. The non-market benefits accruing to the individual from the botanic garden can be inferred from the relationship between travel-cost expenditures and the number of visits to the botanic garden. Travel cost is used as a proxy for an entry price, with a change in price causing a change in consumption (Freeman 1993; Garrod *et al.* 1993). More specifically, the individual TCM stipulates that the number of visits (V_{ij}) made by an individual i to botanic site j is a function of a number of variables including the following: the cost of travel to gain access to the site, plus any existing entry and parking fees; socio-economic characteristics of individual i; the attributes of site j and the cost of visiting substitute sites (Hanley and Barbier 2009). In this study, the visitation model is specified as:

$$V_{ij} = f(\mathrm{TC}_{ij}, \mathrm{SS}_{ij}, X_{ij}, e_i) \tag{1}$$

where V_{ij} = Number of visits by individual i to botanic garden j in the previous 12 months;

TC_{ij} = Travel cost variables by individual i to gain access to botanic garden site j, these include distance costs for each individual i, time costs (which is often approximated as a fraction of the wage rate) and any entry/parking fee (which is charged for entrance to site j);

SS_{ij} = A dummy variable to capture whether individual i specified a substitute site to j (it takes on the value 1 for substitute sites and zero otherwise);

X_{ij} = Vector of socio-economic characteristics of individual i (income, education and age);

e_i = Error term assumed to be normally distributed with constant variance and zero mean.

An important statistical feature of the TCM given by Equation (1) is that the dependent variable (V_{ij}) can only take integer values. This kind of data is known as 'count data' and using the standard ordinary least squares regression to estimate Equation (1) is not appropriate. A Poisson or negative binomial regression method was used instead. The Poisson model has the property that the conditional mean (expected value) should be equal to the variance. However, if the variance is greater (or smaller) than the mean, implying some over-dispersion (or under-dispersion) problem, then a negative binomial regression should be used instead (Cameron and Trivedi 1986, 1998). Other problems associated with the application of count data models for estimating recreation site demand using onsite surveys arise from two sources (Chakraborty and Keith 2000):

1. The probability of being surveyed depends on the frequency of visits (endogenous stratification).

2. Non-users are often not sampled (truncation).

The standard Poisson and negative binomial estimators will be biased and inconsistent if applied to a truncated sample. Hence, we used the zero-truncated Poisson (ZTP) and zero-truncated negative binomial (ZTNB) regressions to estimate Equation (1). These count data models are now widely applied in recreation studies (Creel and Loomis 1990; Fix and Loomis 1998; Coupal *et al.* 2002; Shrestha *et al.* 2002; Prayaga *et al.* 2010; Rolfe and Dyack 2010).

A count data model which assumes a semi-log functional form, has the simple and convenient property of allowing the estimation of CS per visit as the inverse of the travel cost coefficient (Creel and Loomis 1990; Englin and Shonkwiler 1995; Shrestha *et al.* 2002; Prayaga *et al.* 2010; Rolfe and Dyack 2010). The demand function for recreational visits to the botanic garden is specified in Equation (2), where V_r is the expected number of visits, TC is travel costs per trip, and X_n is a vector of explanatory variables.

$$\ln V_r = \beta_0 - \beta_1 TC - \beta_2 D_{ij} - \beta_3 (D_{ij} * TC) - \beta_4 TIME + \cdots \beta_n X_n + e_i \quad (2)$$

$$\text{CS} = -\frac{1}{\beta_1} \quad (3)$$

Another methodological problem in the TCM is the incidence of multi-purpose and multiple-site trips (Mendelsohn *et al.* 1992; Loomis 2006). It has been shown that ignoring the cost of visiting other sites along the way can bias the estimate of CS per trip upwards on average (Smith and Kaoru 1990). The multiple-site issue was accounted for in this study using a dummy variable D_{ij} (it takes the value 1 for a multiple-site trip and zero otherwise). This variable can be constructed to determine the allocation of joint costs for multiple site trips. Following Stoeckl and Mules (2006, p. 501), a dummy variable (D_{ij}) and an interactive dummy variable (D_{ij} * TC) were specified in the model (Eqn 2). This implies that the model (and not the analyst) will determine how best to allocate joint travel costs for multiple-site visitors. Data were collected about the different activities that visitors engage in, including other sites visited as part of the trip, time spent and the underlying reasons for the trip (Figures 2–4). The information derived was then used to identify single- and multiple-site visitors and to construct the appropriate dummy variables.

The variable TIME is the trip travel time in hours. The opportunity cost of travel time is often included in the travel cost variable by using a fraction (one-quarter) of the wage rate and then adding it to travel cost. This is carried out to avoid multicollinearity between travel time and travel cost. However, the popularity of botanic gardens implies a diversity of origins and travel times for individual visitors. Statistical tests confirmed sufficient independent variation to include travel time as its own variable.[3] This separate treatment of the time variable can allow the determination of the opportunity cost of travel time within the model, rather than the analyst assigning a fraction of the wage rate. This approach has been applied in many travel-cost studies (e.g. Loomis and Walsh 1997; Fix and Loomis 1998; Shrestha *et al*. 2002).

3.2. Estimated travel-cost visitation models

Travel costs can be estimated in a number of different ways by changing the definition and inclusion of variables used in the model. Historically, three methods have been used for estimating travel costs (Bateman 1993; Common *et al*. 1999). The first method uses only estimated fuel costs as a function of distance while the second method captures estimated full car costs that include fuel, insurance, maintenance and depreciation as a function of distance. The third method uses 'perceived' costs as reported by the respondents. This study used reported costs because it is most likely to represent the opportunity costs that respondents considered when making their trip decision (Bennett 1996; Prayaga *et al*. 2010).

Figure 5 shows a graphical example of the data relating the number of trips to the cost of the trip. It shows the expected inverse relationship where the number of trips tends to reduce with increasing travel costs. The data appear to exhibit over-dispersion problems, with a wide range of costs associated with a single-trip frequency. Negative binomial models were used to account for the problem of over-dispersion, while the truncated version of the model was used to account for endogenous stratification. Results for the estimated models using reported costs are summarised in Table 3. Based on model performance, only the ZTNB model results are reported for discussion. In general, the signs and significance of the variables included in the models are consistent with economic theory and the valuation literature. The likelihood ratio tests for alpha confirm the presence of over-dispersion across the three estimated models and that the ZTNB models should be preferred over ZTP models.

The results demonstrate that the travel-cost variables have negative signs and are statistically significant ($P \leq 0.05$) across all the models. This is consistent with Creel and Loomis (1990), and Grogger and Carson (1991). Transport cost as a price variable with negative sign is the main result of the recreation demand model, indicating a downward sloping demand curve. This implies that visitors to botanic gardens will take fewer trips as transport costs increase. The price elasticity of demand was calculated from the estimated models in Table 3 (values are −0.064, −0.047 and −0.049 for ANBG, RBGM and RBGS, respectively). Demand elasticities for recreational trips

[3] Correlation tests between travel time and travel cost yielded a maximum correlation coefficient of 0.42.

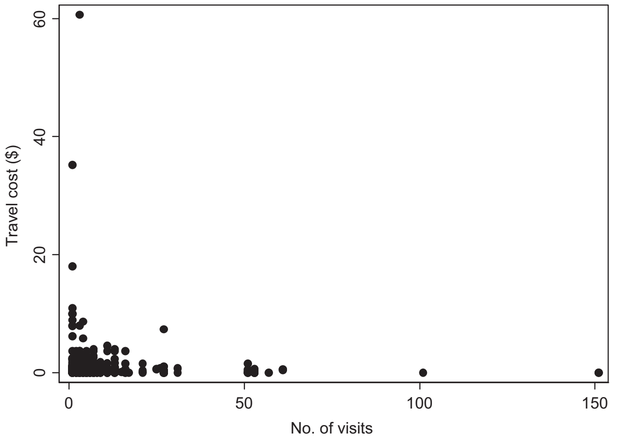

Figure 5 Relationship between travel costs and the number of visits to the Australian National Botanical Garden.

Table 3 Estimated TC models of recreational visits to selected botanic gardens

Parameters	ANBG	RBGM	RBGS
Travel cost	−0.0159 (−4.75)***	−0.0118 (−3.46)***	−0.0109 (−3.67)***
Multiple sites	−1.3545 (−8.25)***	−0.4927 (−7.05)***	−0.4211 (−4.29)***
Travel cost*multiple sites	−0.0104 (−2.61)***	−0.0139 (−2.87)***	−0.0167 (−3.71)***
Travel time	−0.0327 (−1.36)	−1.5552 (−16.71)***	−0.3458 (−3.47)***
Duration	−0.1294 (−2.60)***	−0.1842 (−7.46)***	−0.0944 (−3.81)***
Age	0.0074 (2.68)***	−0.0048 (2.75)**	−0.0343 (−6.76)**
Male	0.0812 (2.59)***	−0.1232 (2.50)***	−0.2961 (−3.82)***
Income	0.0021 (2.68)***	0.0126 (6.11)***	0.0019 (5.73)***
Constant	2.0610 (9.22)***	3.3086 (34.48)***	3.6238 (23.68)***
Alpha (dispersion)	1.87***	1.39***	2.13***
Log likelihood	−1346.15	−2008.30	−654.78
χ^2 value	127.28	940.72	285.21
No. of Obs.	519	224	610
CS/group ($)	62.98	84.68	91.66
95% Confidence interval ($)	44.59–107.18	54.08–195.02	42.2–135.30
CS/person trip ($)	27.38	42.34	45.83
95% Confidence interval ($)	19.39–46.60	27.04–97.51	21.10–67.65
CS for multiple-site trips ($)	16.53	19.46	18.12

Notes: TC, travel cost; ANBG, Australian National Botanical Garden; RBGM, Royal Botanic Garden Melbourne; RBGS, Royal Botanic Garden Sydney. Coefficients are given with *t*-statistics in parentheses. $^{**}P < 0.05$; $^{***}P < 0.01$; the log likelihood reported is for the full sample. Estimated average group size are as follows; 2.3, 2.0 and 2.0 for the ANBG, RBGM and RBGS, respectively. The CS for single/multiple-site visitors are adjusted by the group size. Marginal effects are not reported for the purpose of brevity.

are important in providing information to evaluate changes in visitation rates if user fees were imposed. This result is relevant to guide policy decisions because any measures that target transport-related costs (e.g. taxes on fuel, parking fees etc) will influence the quantity demanded of annual trips to botanic gardens. Hence, a policy option that implies changing the parking fees might change consumer recreational behaviour. The negative sign on the travel-cost variable is strongly supported by the travel-time variable, with a negative and statistically significant coefficient ($P \leq 0.05$) in all the models.[4]

The interactive dummy variable for multiple-site trips is also negative and statistically significant ($P \leq 0.05$) across all the models. This variable was used to capture whether or not respondents visited any other sites on their trip to the botanic gardens. The negative coefficient on this variable simply indicates that the availability and use of multiple sites suppresses the demand for trips to the botanic gardens, consistent with *a priori* expectations and previous studies (e.g. Stoeckl and Mules 2006; Rolfe and Dyack 2010). This means that values for the botanic gardens are lower because respondents visited other sites along the way. In other words, the total surplus from the trip is shared across multiple sites.

The coefficient of the duration of the visit variable is statistically significant ($P \leq 0.05$) with a negative sign in all the estimated models, consistent with Creel and Loomis (1990). In general, the longer trip duration is likely to reduce frequency of visits to the selected botanic gardens. This is a similar finding to that reported by Shrestha *et al*. (2002) who looked at recreational fishing in the Brazilian Pantanal. The mean duration of the trip to the selected botanic gardens is approximately 2.5 h, averaged for the three sites (from Table 2).

Our results show that the demand for visits to botanic gardens is sensitive to income, with the coefficient of income elasticity being positive and statistically different from zero ($P \leq 0.05$). With respect to other socio-economic characteristics, the results suggest that the annual number of trips to the RBGM and RBGS is expected to be significantly higher ($P \leq 0.05$) for younger, female visitors, than for the average respondent. However, the signs of both variables were reversed in the ANBG model, suggesting that the effect of socio-economic variables may be site-specific. However, it is more likely to be the case that the RBGM and RBGS are very different in characteristics to ANBG and so attract a different type of visitor.

3.3. Visitation benefits derived from botanic gardens

The economic values of visits to botanic gardens were derived using the trip generation functions reported in Table 3. Following Creel and Loomis

[4] A cautionary note is appropriate here. The decision to treat travel time as a separate variable from travel costs introduces limitations in interpreting this result. It implies that the coefficient on travel-cost variable does not capture the full effect of travel costs because the cost of time has not been explicitly estimated. The most that can be said is that it is likely to be smaller than the ones reported here (e.g. more negative than −0.0159 and more negative than −0.0263, in the case of ANBG, for example) as time has the expected negative effect on visitation. Thus, the estimates of CS presented in this study are likely to overstate true population measures. We thank the reviewers for these observations.

(1990), the mean CS per-trip estimates for single-site visitors were obtained using the negative inverse of the coefficient of travel-cost variable $(-1/(\bar{\beta}))$. To account for 'group' costs of travel (e.g. fuel costs), the estimated CS was divided by the average group size for the sample in order to estimate the individual per-trip CS for single-site visitors. We note that dividing by group size implicitly assumes that each member of the group receives equal surplus. Confidence intervals were constructed using the formula below (Fix and Loomis 1998).

$$\mathrm{CS}_L = \frac{1}{[\beta_{\mathrm{TC}} + 1.96(\mathrm{se})]}; \quad \mathrm{CS}_U = \frac{1}{[\beta_{TC} - 1.96(\mathrm{se})]} \tag{4}$$

The CS values per person trip and the 95 per cent confidence intervals per trip for the single-site visitors are given in Table 3. The model predicts that the average CS attributable to recreation in the botanic gardens lies between \$27 and \$46 per visitor per year. In other words, if the selected botanic gardens were closed to visitors for an entire year, the total recreational welfare loss would equal, on average, \$39 per individual. Note that the CS estimates for the RBGM and RBGS are significantly higher than that for ANBG. As hypothesised, the RBGM and RBGS are different in character to ANBG. The products and experiences offered at the RBGM and RBGS differ substantially from those provided at the ANBG. Another plausible explanation may be the availability of substitute or complementary sites.

The next step is to compute the correct coefficient associated with travel costs for multiple-site visitors, and this will equal the coefficient of the travel cost variable plus the coefficient on the interactive dummy variable $(-1/(\beta_1 + \beta_3))$. For example, the results from Table 3 for the ANBG only show the travel-cost coefficient = −0.0159; the coefficient of the interactive dummy variable = −0.0104; and thus the mean CS for multiple-site visitors = −1/(−0.0159 + −0.0104) = −1/−0.0263 = \$38.91. After adjusting for the average group size for the sample (2.3), the mean CS per person trip for multiple-site visitors is approximately \$17 for the ANBG. This calculation is repeated for the RBGM and the RBGS. The mean CS per person trip for multiple-site visitors to the selected botanic gardens is, on average, \$18 (Table 3).

The social welfare value of recreational opportunities in the botanic gardens can be estimated using the total annual trips to each botanic garden by the visitor population (Garrod *et al.* 1993; Shrestha *et al.* 2002). An estimate of the aggregate annual CS for each botanic garden was generated in three steps:

1. The mean CS per person trip for single-site visitors was multiplied by the estimated annual number of single-site visitors (which is calculated as the proportion of single-site visitors in the sample x the total number of visitors).

2. The mean CS per person trip for multiple-site visitors was multiplied by the estimated number of multiple-site visitors (which is calculated as the proportion of multiple-site visitors in the sample x the total number of visitors).
3. The two estimates were added to obtain the total CS.

Note that these calculations assume that the sample is representative of the visitor population. Based on 2010 visitor statistics, the total social welfare values are approximately $10.45 million, $59 million and $124 million for the ANBG, RBGM and RBGS, respectively, in 2010 Australian dollars (Table 4).

4. Contingent valuation results

4.1. Results from payment principle question

In addition to questions about travel behaviour, the questionnaire asked respondents whether they would be willing to pay an entry fee (or higher parking charge in the case of the ANBG) to gain access to the botanic gardens. Questions of this nature are often used in recreation demand surveys to elicit some measure of respondents' WTP to use or to gain access to a specific site (Garrod *et al*. 1993; Nunes and Van den Bergh 2004). The use of a per-visit 'price' surrogate such as an entry fee focuses respondents' attention on their marginal WTP. This is in contrast to the focus on CS estimation in the TCM. Hence, the two methods are delivering estimates of two different concepts of value.

As well as using a DC question, a follow-up open-ended WTP question was included to improve the statistical efficiency of the WTP estimates (Bateman *et al*. 2002). If the response to the open-ended question was a zero WTP, then the respondent was asked to indicate his or her main reason for this choice. By locating the CVM questions at the end of the questionnaire, the survey ensured that respondents were already aware of budget constraints and opportunity costs. In the dichotomous choice format CVM, responses

Table 4 Aggregate annual consumer surplus (CS) estimates for the selected botanic gardens

Parameters	ANBG	RBGM	RBGS
Mean CS per trip ($)–single site visitors	27.38	42.34	45.83
Mean CS per trip ($)–multiple site visitors	16.53	19.46	18.12
Estimated No. of single-site visitors	308,958	1,128,498	1,965,923
Estimated No. of multiple-site visitors	120,151	581,348	1,888,828
Estimated CS–single site visitors ($)	8,459,283	47,780,621	90,098,228
Estimated CS–multiple site visitors ($)	1,986,088	11,313,025	34,225,554
Total CS ($)	10,445,371	59,093,646	124,323,782

Notes: ANBG, Australian National Botanical Garden; RBGM, Royal Botanic Garden Melbourne; RBGS, Royal Botanic Garden Sydney. Visitor statistics for the year 2010 taken from the annual reports of the botanic gardens.

are ascertained when different prices are used. Seven different price levels were used for the payment bid in this CVM exercise ($1, $3, $4, $5, $7, $9 and $10). The wide range of bid price levels was used to account for uncertainty about the range of WTP for different respondents. Seven different versions of the survey with the rotating CVM bid levels were offered at random to recreation users. The text of the CVM question read as follows:

Q13. Suppose that visitors to the RBGS were asked to help fund conservation activities that protect the collection of plants in the gardens, would you be willing to pay to fund such programs, for example through paying entry fees of $5.0 for access to the garden? Current entry fee is $0.00.

☐ Yes → Go to Q14/Q16. ☐ No. → Go to Q14/Q15.

Q14. What is the most that you would be prepared to pay, through entry fees, to help fund conservation activities at the RBGS? $____________

Respondents who stated 'No' to the DC WTP question represented on average about 50 per cent of the survey sample at the three selected botanic gardens (Tables 5 and 6). We explored why this number of respondents opted to stay out of the market. The primary stated motive for not being willing to pay anything was that the Australian Government should cover the costs, and a secondary reason was that changing entry or parking fees may be a deterrent for some visitors. Some respondents preferred to give a voluntary donation while other reasons were not disclosed. The other well-known reason might have been the strategic behaviour to 'free ride'. Dealing with protest zero bidders is a critical issue in CV studies. As these reasons suggest a zero valuation of the proposed change (or reflect a disapproval of the payment vehicle), we used the strategy of considering them as real zero bids. This results in conservative estimates of the visitors' WTP (Santagata and Signorello 2000).

4.2. WTP estimation from single-bounded DC valuation question

Tables 5 and 6 summarise the basic data set derived from the single-bounded DC valuation question for the survey sample. For each bid price, the tables

Table 5 Distribution of responses to parking fee increases (ANBG)

Bid price ($)	Rejecting bids, 'no'		Accepting bids, 'yes'		Total
	Number	% No	Number	% Yes	
2	5	0.21	19	0.79	24
2.4	27	0.41	39	0.59	66
2.6	26	0.44	33	0.56	59
3.8	159	0.47	176	0.53	335
4	42	0.66	22	0.34	64
5	40	0.68	19	0.32	59
Total	299	0.49	308	0.51	607

Notes: ANBG, Australian National Botanical Garden. Some neighbouring price bands have been merged together.

Table 6 Distribution of responses to entry fee question, by location

Bid price ($)	RBGM			RBGS		% yes
	Total	No. of 'yes'	% yes	Total	No. of 'yes'	
1	30	26	0.87	99	78	0.79
3	39	21	0.54	181	92	0.51
4	35	17	0.49	–	–	–
5	39	14	0.36	87	41	0.47
7	40	11	0.28	159	33	0.21
9	25	7	0.28	–	–	–
10	32	7	0.22	95	19	0.20
Total	240	103	0.43	621	263	0.42

Notes: RBGM, Royal Botanic Garden Melbourne; RBGS, Royal Botanic Garden Sydney. Some neighbouring price bands have been merged together to maintain monotonicity condition.

show the number of respondents facing that bid, the number of 'yes' responses and the proportion of 'yes' responses. The pattern of responses confirms diminishing levels of support as the cost increases. The dichotomous choice data set was analysed using (i) a logit regression model; and (ii) a Turnbull estimator (Haab and McConnell 1997, 2002). The logit model is parametric because it is based on the assumption that in the population the latent true variable WTP follows a logistic distribution. The logit model is specified as follows:

$$\ln\left(\frac{\text{prob(yes)}}{1-\text{prob(yes)}}\right) = \alpha - \beta_1 * \text{bidprice} + \beta_2 * \text{income} + \beta_3 * \text{age} \quad (5)$$

where bidprice is the dollar amount the individual was asked to pay; income and age were previously defined; α and β are the model parameters to be estimated.

The results of the logit model estimation are presented in Table 7. In all the three estimated models, the coefficients have the expected signs and are statistically significant ($P \leq 0.05$). From the estimated logit equations, the expected

Table 7 Estimated logit models

Parameters	ANBG	RBGM	RBGS
Bid price	−0.6794 (−5.84)***	−0.2841 (−5.34)***	−0.2931 (−9.25)***
Constant	−2.2644 (−5.81)***	−1.2096 (−3.98)***	−1.2141 (−6.74)***
Log likelihood	−402.12	−147.26	−372.22
χ^2 value	37.11	33.35	101.85
No. of obs.	607	240	621
Mean WTP ($)	3.48	5.18	5.03

Notes: ANBG, Australian National Botanical Garden; RBGM, Royal Botanic Garden Melbourne; RBGS, Royal Botanic Garden Sydney. Coefficients are given with *t*-statistics in parentheses. **$P < 0.05$; ***$P < 0.01$. The log likelihood reported is for the full sample.

value of the mean WTP, E(WTP), was calculated using the formula developed for a WTP distribution truncated at zero in the left side (Hanemann 1984; Carson and Hanemann 2006), as given below:

$$\text{Mean WTP} = \left(\frac{1}{\beta 1}\right) \ln(1 + \exp(\alpha)) \tag{6}$$

The Turnbull estimator is a non-parametric or a 'distribution-free' approach (Turnbull 1976). Full details on how to use a non-parametric approach to analyse CVM data can be found in Haab and McConnell (2002) and Hanley and Barbier (2009). A similar procedure was followed when applying the Turnbull estimator to estimate a lower-bound for the mean WTP. The equation for the Turnbull estimator is (Hanley and Barbier 2009).

$$E(\text{WTP}) = \sum_{j=0}^{M} t_j (F_{j+1} - F_j) \tag{7}$$

where F_j is the probability that a respondent will say 'no' to a bid price of t_j; the quantity $(F_{j+1} - F_j)$ is the difference between the proportion of 'no' responses at a given price and the proportion of 'no' responses at the next lowest price, this quantity is then multiplied by the bid price. These amounts are summed together. It is assumed that the probability of saying 'no' to a zero price is zero, and the probability of saying 'no' to a 'choke price' is one. Table 8 reports the mean WTP estimates for the three selected botanic gardens. As expected *a priori*, all parametric mean WTP values are bounded from below by the estimated lower-bound Turnbull mean WTP values.

4.3. WTP estimation from the open-ended valuation question

Table 9 reports results from the open-ended WTP question. The open-ended WTP values are smaller than the single-bounded DC mean. There are a number of possible explanations for this disparity. One argument could be 'strategic bias' leading to understatement of the true WTP. Another explanation may be that answering an open-ended question is a more difficult task as quantitative information is required (Alberini and Khan 2006). Where cognitive difficulty and preference uncertainty are present, it is more likely that

Table 8 Single-bounded discrete choice and Turnbull estimates of mean WTP ($)

Model	ANBG (parking fee)	RBGM (entry fee)	RBGS (entry fee)
Logit	3.48	5.18	5.03
Turnbull	2.97	4.11	3.81

Note: Conventional logit model used to estimate mean WTP. Formulas and procedures are given in the text.

Table 9 Open-ended WTP estimates ($)

	Protest zero bids included			Protest zero bids excluded		
	Mean	Median	SD	Mean	Median	SD
ANBG	3.21	3.00	2.53	3.65	3.00	2.38
RBGM	4.20	4.00	3.36	4.89	5.00	3.12
RBGS	4.18	4.00	3.78	4.79	5.00	3.66

Notes: WTP, willingness to pay; ANBG, Australian National Botanical Garden; RBGM, Royal Botanic Garden Melbourne; RBGS, Royal Botanic Garden Sydney. Mean WTP estimates generated using a Tobit model.

individuals will give lower values. Conversely, DC data may also be affected by a certain degree of ‘yea-saying’ (Blamey *et al.* 1999). This could bias DC estimates of mean WTP upward.

A number of studies have reported a certain bias in CV surveys where an open-ended valuation question format followed a DC question format (e.g. Santagata and Signorello 2000; Bateman *et al.* 2002; Alberini and Khan 2006). This anomaly is known as the ‘anchoring’ effect, whereby the open-ended WTP values are not independent of the bids that were randomly distributed among the respondents in a CV survey. The anchoring effect can be regarded as a type of starting point bias. The presence of the anchoring effect was tested by regressing the open-ended WTP values on the bid price used in the previous stage of the questionnaire. These linear regression models indicated that the coefficient estimate of the bid price was not statistically different from zero in all the estimated models. Hence, our data set does not appear to have a serious anchoring problem. Further inspection of the data set supports this conclusion. The percentage of cases in which the stated WTP was equal to the randomly distributed bid price averaged 14 per cent for the three surveys.

The possibility that the WTP estimates reported above may be biased downwards cannot be ignored. Hence, an alternative analysis of protest responses was conducted to provide a comparison with the existing results. Table 9 demonstrates the empirical consequences of excluding protest zero votes altogether from the data set. The mean and median WTP values derived from the open-ended WTP responses increase across the three botanic gardens by 15 per cent, on average. This indicates that caution may be needed whenever open-ended WTP data might contain a large number of protest zero bids. The decision to include, modify or exclude protest zero bids can have a significant impact on aggregate value estimates of WTP.

4.4. WTP valuation functions

It is standard practice in CVM studies to estimate a valuation function that relates discrete choice or WTP to variables that are expected to have an influence on the choice or on the stated WTP amount. This explorative estimation allows us to perform a test of construct and theoretical validity by determining whether choices or WTP amounts are significantly related to variables suggested by economic theory. A large number of variables were available for inclusion in the valuation functions. Table 10 gives the estimated logit models that best fitted the data. The coefficients on the bid price, distance, frequency of visits, age and income were statistically significant ($P \leq 0.05$) and of the expected signs, consistent across the three models. The results indicate that the relative probability of a 'yes' decreases with increases in the 'cost' asked of a respondent and increases with income, which is consistent with economic theory. In the RBGM and RBGS models, the older and male respondents were less likely to contribute entry fees or higher parking charges. However, the signs of these variables were reversed in the case of ANBG. This suggests the effects of these variables might be site-specific. Note also that respondents with a high visitation frequency have a lower WTP than the average respondent. Respondents who travel longer distances (and so incurred higher travel costs) have a lower WTP. This indicates that the values obtained with the TCM and CVM are consistent. Hence, the TCM has captured other value categories than the CVM.

The open-ended valuation functions are reported in Table 11. Following Greene (1997) and Santagata and Signorello (2000), the multivariate linear equations were estimated using a Tobit regression model, as data are censored at zero. The Tobit models reinforce the signs and significance of the variables already obtained in the logit valuation functions. The signs and significance are consistent across all the estimated models. Again, the WTP was higher for individuals with higher income and less for respondents who travel longer distances and incur higher travel costs. In the RBGM and RBGS models, the results from the Tobit model confirm that the older and male respondents were willing to pay less than younger, female respondents. The signs of

Table 10 Logit valuation functions

Parameters	ANBG	RBGM	RBGS
Bid price	−0.0623 (5.20)***	−0.0211 (2.09)***	−0.0288 (7.86)***
Distance	−0.0003 (−2.24)**	−0.0004 (−2.40)	−0.0002 (−2.55)**
No. of visits	−0.0021 (−2.32)**	−0.0247 (−2.24)**	0.0111 (2.35)**
Age	0.00301 (2.55)**	−0.0812 (−2.10)**	−0.0248 (−3.12)***
Gender	0.0333 (2.19)	−0.4805 (−2.51)**	−0.2271 (−2.10)
Income	0.0063 (2.06)**	0.0102 (2.97)**	0.0634 (2.25)**
Constant	−2.1753 (−4.61)***	2.5777 (1.38)**	−0.3709 (−1.23)
Log likelihood	−374.99	−125.26	−278.78
χ^2 (5)	130.35	40.80	89.96
No. of obs.	563	213	503

Notes: ANBG, Australian National Botanical Garden; RBGM, Royal Botanic Garden Melbourne; RBGS, Royal Botanic Garden Sydney. Coefficients are given with t-statistics in parentheses. **$P < 0.05$; ***$P < 0.01$. The log likelihood reported is for the full sample.

Table 11 Tobit valuation functions

Parameters	ANBG	RBGM	RBGS
Distance	−0.0002 (2.65)***	−0.0007 (−2.63)**	−0.0003 (−2.32)**
No. of visits	−0.0095 (−2.08)***	−0.0004 (−2.02)**	−0.0149 (−2.09)*
Age	0.0051 (−1.65)	−0.0021 (−2.11)**	−0.0398 (2.60)**
Gender	0.0071 (2.03)**	−0.5264 (−1.96)**	−0.2129 (−2.57)
Income	0.0002 (2.66)***	−0.0037 (2.36)**	0.0041 (2.06)**
Constant	3.2783 (9.04)**	1.3263 (2.78)***	2.6683 (5.34)***
Log likelihood	−168.22	−99.46	−112.72
χ^2 (7)	119.19	100.00	126.95
No. of obs.	505	213	467

Notes: ANBG, Australian National Botanical Garden; RBGM, Royal Botanic Garden Melbourne; RBGS, Royal Botanic Garden Sydney. Coefficients are given with *t*-statistics in parentheses. $^{**}P < 0.05$; $^{***}P < 0.01$. The log likelihood reported is for the whole sample.

these variables are reversed in the case of the ANBG. Finally, respondents with a high visitation frequency have a lower WTP than the average respondent.

5. Comparison of TCM and CVM estimates

Given the functional form used for the TCM demand function (Eqn 2), it is possible to calculate the marginal change (ΔCS) in CS for a single trip. Following the ZTNB regression model, the partial derivatives (or marginal effects) were derived with respect to the travel cost variable, and then the negative inverse $(-1/(\bar{\beta}))$ was used to approximate the marginal change in CS, ΔCS. Confidence intervals were also constructed around the marginal values using the formula in Equation (4). The marginal CS values per person trip and the corresponding 95 per cent confidence intervals per trip are given in Table 12.

We are now in a position to compare the TCM and CVM estimates. The CVM exercise asked visitors for their WTP for entry or parking fees to gain access to three botanic gardens. The analyses resulted in a positive mean WTP of between $4 and $5 per trip for entry fees and approximately $3 per hour in higher parking fees to the botanic gardens. The TCM estimates are

Table 12 Marginal consumer surplus derived from the TCM ($)

	$\partial V/\partial TC$	Lower 95% CI marginal CS	Mean marginal CS	Upper 95% CI marginal CS
ANBG	−0.0643	4.78	6.76	13.27
RBGM	−0.0471	7.13	10.62	20.84
RBGS	−0.0491	4.67	10.21	14.32

Notes: TCM, travel-cost method; ANBG, Australian National Botanical Garden; RBGM, Royal Botanic Garden Melbourne; RBGS, Royal Botanic Garden Sydney. Marginal effects (dy/dx) following ZTNB regressions estimated using STATA 11.

Table 13 Cost and benefit estimates for selected Australian botanic gardens

Parameters	ANBG	RBGM	RBGS
Total annual visitation benefits ($M)	10.45	59.09	124.32
Total annual operating costs ($M)	9.65	18.38	41.64
Net benefits ($M)	0.80	40.71	82.68
Indicative benefit/cost ratio	1.08	3.22	2.99

Notes: ANBG, Australian National Botanical Garden; RBGM, Royal Botanic Garden Melbourne; RBGS, Royal Botanic Garden Sydney. Source: Costs taken from Annual Reports of the respective botanic gardens for the financial year 2009–2010. Benefits estimates derived using the TCM.

significantly larger than the CVM values. We argue that this is because the TCM estimates the average WTP (as a Marshallian CS) while the CVM estimates the marginal WTP. At the margin, the surplus gained from a visit is likely to be lower than the average because of diminishing marginal utility. This is supported by the analysis presented in Table 12. The mean values of the marginal CS derived from the TCM are much closer to the mean CVM estimates. However, as noted earlier in the study, it should be re-iterated that the TCM estimates are likely to overstate true values of CS.

There may be other reasons for the differences. First, the CVM responses may be conditioned by a consumer desire to maintain some surplus after payment of the entry fee. Second, the responses to the CVM questions may be influenced by the expectations of what an entry fee is likely to be. Such expectations would be formed from experiences in other, substitute, recreational venues. This could be regarded as a form of anchoring.

Other researchers have similar alternative explanations for this disparity. For example, Rolfe and Dyack (2010) suggest that different decision points used by respondents in answering the two types of questions can drive differences as can the recognition of substitute sites. Strategic and uncertain responses to the CVM can also create differences. It can be argued that after reminding respondents about the cost of travel and then asking if they would be WTP an additional amount (entry fee), the respondent is more likely to change his/her individual assessment of the opportunity cost of the trip and hence the decision of whether or not to visit the botanic garden. This change might affect the CVM response.

6. Conclusions

Recreational trips to botanic gardens are a popular activity in Australia. The frequency of visits to the three botanic gardens targeted in this study are largely influenced by transport costs, proximity of multiple sites and visitors' socio-economic characteristics such as age, gender and income. Their average CS estimate per trip of approximately $39 for single-site visitors and $18 for multiple-site visitors are higher than the average CS figures reported from other recreational studies in botanic gardens around the world. This study shows the total welfare measure attributable to recreational trips to the three botanic gardens in Australia is around $194 million annually. In contrast, an earlier TCM study of four botanic gardens in the UK generated a smaller CS per single visit of £2.24 ($3.58) in 1993 (Garrod *et al*. 1993). However, there are several differences in the character of these two studies; for example, the size of the botanic gardens investigated, their location, the functional forms and estimation procedures implemented. A range of methodological issues may potentially explain the differences between the values estimates. Nonetheless, the values obtained in this study are within one order of magnitude of other recreational activities in Australia. For example, Stoeckl and Mules (2006) estimated the average CS attributable to recreation in the Australian Alps to lie between $280 and $860 per visitor per year. Prayaga *et al*. (2010) used the TCM to estimate the value of recreational fishing in the Great Barrier Reef to be approximately $167 per trip per angler. Rolfe and Dyack (2010) estimated values per adult visitor per recreation day at $149 with the TCM and $116 with the CVM for recreation in the Coorong, along the Murray-Darling River.

Finally, it may be worthwhile to compare the costs and benefits to the botanic gardens. This comparison is given in Table 13. We acknowledge that the TCM estimates of consumer benefits are sensitive to assumptions about the visitor population from which a sample is drawn (Common *et al*. 1999). Hence, a degree of caution should be exercised when interpreting and using these estimates. In this study, the TCM estimates are treated as 'indicative' values. Comparing the estimates obtained in this study with the total cost of government funding indicates that the TCM estimates of the welfare benefits of recreation at the three botanic gardens outweigh the operational costs at the selected botanic gardens by a ratio of between 1.1 and 3.2. Botanic gardens represent a good investment of public funds.

References

Alberini, A. and Khan, J.R. (2006). *Handbook on Contingent Valuation*. Edward Elgar, Cheltenham.

Arrow, K., Solow, R., Portney, P., Leamer, E., Radner, R. and Schuman, H. (1993). Report of the NOAA panel on contingent valuation, *Federal Register* 58(10), 4602–4614.

Australian Bureau of Statistics (ABS) (2012). Statistics. Available from URL: http://www.abs.gov.au/ausstats/abs@.nsf/web + pages/statistics [accessed 2 March 2012].

Bateman, I.J. (1993).Valuation of the environment, methods and techniques: revealed preference methods, in: Turner, R.K. (ed.), *Sustainable Environmental Economics and Management*. Belhaven Press, London, pp. 192–265

Bateman, I.J., Carson, R.T., Day, B., Hanemann, M.W., Hanley, N., Hett, T., Jones-Lee, M., Loomes, G., Mourato, S., Ozdemiroglu, E., Pearce, D.W., Sugden, R. and Swanson, J. (2002). *Economic Valuation with Stated Preference Techniques: A Manual*. Edward Elgar, Cheltenham

Bennett, J. (1996). Estimating the recreational use values of national parks, *Tourism Economics* 2(4), 303–320.

Bennett, J. and Gillespie, R. (2008). Bio-resources for biotechnology in Australia: an economic perspective. Report prepared for the Commonwealth Department of the Environment, Water, Heritage and the Arts, Canberra.

Blamey, R.K., Bennett, J.W. and Morrison, M. (1999). Yea saying in contingent valuation surveys, *Land Economics* 75, 126–141.

Botanic Gardens Trust (BGT) (2010). Botanic Gardens Trust. Annual Report 2009–2010, Sydney.

Cameron, A.C. and Trivedi, P.K. (1986). Econometric models based on count data: comparisons and applications of some estimators and tests, *Journal of Applied Econometrics* 1, 29–53.

Cameron, A.C. and Trivedi, P.K. (1998). *Regression Analysis of Count Data*. Cambridge University Press, Cambridge.

Carson, R.T. and Hanemann, W.M. (2006). Chapter 17 contingent valuation, in Maler, K. and Vincent, J. (eds), *Handbook of Environmental Economics Valuing Environmental Changes*. Elsevier, Amsterdam, pp. 821–936.

Carson, R.T., Flores, N.E., Martin, K.M. and Wright, J.L. (1996). Contingent valuation and revealed preference methodologies: comparing the estimates for quasi-public goods, *Land Economics* 72(1), 80–99.

Chakraborty, K. and Keith, J.E. (2000). Estimating the recreation demand and economic value of mountain biking in Moab. Utah: an application of count data models, *Journal of Environmental Planning and Management* 43(4), 461–469.

Common, M., Bull, T. and Stoeckl, N. (1999). The travel cost method: an empirical investigation of Randall's difficulty, *Australian Journal of Agricultural and Resource Economics* 43, 457–477.

Coupal, R.H., Bastian, C.T. and Taylor, D.T. (2002). Economic benefits of sport fishing and angler wildlife watching in Pennsylvania: a comment, *Journal of Travel Research* 41, 210–211.

Creel, M.D. and Loomis, J.B. (1990). Theoretical and empirical advantages of truncated count estimators for analysis of deer hunting in California, *American Journal of Agricultural Economics* 72, 434–441.

Englin, J.E. and Shonkwiler, J.S. (1995). Estimating social welfare using count data models: an application to long-run recreation demand under conditions of endogenous stratification and truncation, *Review of Economics and Statistics* 77, 104–112.

Fix, P. and Loomis, J. (1998). Comparing the economic value of mountain biking estimated using revealed and stated preference, *Journal of Environmental Planning and Management* 41(2), 227–236.

Freeman, A.M. (1993). *The Measurement of Environmental and Resource Values: Theory and Methods*. Resources for the Future, Washington, DC.

Garrod, G., Pickering, A. and Willis, K. (1993). The economic value of botanic gardens: a recreational perspective, *Geoforum* 24(2), 215–224.

Greene, W. (1997) *Econometric Analysis*, 3rd edn. Prentice-Hall, NJ.

Grogger, J.T. and Carson, R.T. (1991). Models for truncated counts, *Journal of Applied Econometrics* 6, 225–238.

Haab, T.C. and McConnell, K.E. (1997). Referendum models and negative willingness to pay: alternative solutions, *Journal of Environmental Economics and Management* 32, 251–270.

Haab, T.C. and McConnell, K.E. (2002). *Valuing Environmental and Natural Resources: The Econometrics of Non-Market Valuation*. Edward Elgar, Cheltenham.

Hanemann, M. (1984). Welfare evaluations in contingent valuation experiments with discrete response data, *American Journal of Agricultural Economics* 66, 332–341.

Hanley, N. and Barbier, E.B. (2009). *Pricing Nature: Cost-Benefit Analysis and Environmental Policy*. Edward Elgar, Cheltenham.

Loomis, J. (2006). A comparison of the effect of multiple destination trips on recreation benefits as estimated by travel cost and contingent valuation methods, *Journal of Leisure Research* 38(1), 46–60.

Loomis, J.B. and Walsh, R.G. (1997). *Recreation Economic Decisions: Comparing Benefits and Costs*, 2nd edn. Venture Publishing, Inc, Philadelphia, PA.

Mendelsohn, R., Hof, J., Peterrson, G. and Johnson, R. (1992). Measuring recreation values with multiple destination trips, *American Journal of Agricultural Economics* 74(4), 926–933.

Noonan, D. (2003). Contingent valuation and cultural resources: a meta-analytic review of the literature, *Journal of Cultural Economics* 27, 159–176.

Nunes, P.A.L.D. and Van den Bergh, C.J.M. (2004). Can people value protection against invasive marine species? Evidence from a joint TC-CV survey in the Netherlands, *Environmental and Resource Economics* 28, 517–532.

Organisation for Economic Co-Operation and Development (OECD) (2002). *Biodiversity Valuation Handbook: A Guide for Policy Makers*. OECD, Paris.

Organisation for Economic Co-Operation and Development (OECD) (2006). *Cost-Benefit Analysis and the Environment: Recent Developments*. OECD, Paris.

P.G. Whiting and Associates (1995). *The Social and Economic Value of Scientific Collections*. Federal Biosystematics Group, Ottawa, ON.

Prayaga, P., Rolfe, J. and Stoeckl, N. (2010). The value of recreational fishing in the Great Barrier Reef. Australia: a pooled revealed preference and contingent behaviour model, *Marine Policy* 34(2010), 244–251.

Provins, A., Pearce, D., Ozdemiroglu, E., Mourato, S. and Morse-Jones, S. (2008). Valuation of the historic environment: the scope for using economic valuation evidence in the appraisal of heritage-related projects, *Progress in Planning* 69, 131–175.

Rolfe, J. and Dyack, B. (2010). Testing for convergent validity between travel cost and contingent valuation estimates of recreation values in the Coorong, Australia, *The Australian Journal of Agricultural and Resource Economics* 54, 583–599.

Santagata, W. and Signorello, G. (2000). Contingent valuation of a cultural public good and policy design: the case of 'Napoli Musei Aperti', *Journal of Cultural Economics* 24, 181–204.

Shrestha, R.K. and Loomis, J.B. (2001). Testing a meta-analysis model for benefit transfer in international outdoor recreation, *Ecological Economics* 39, 67–83.

Shrestha, R.K. and Loomis, J.B. (2003). Meta-analysis benefit transfer of outdoor recreation economic values: testing out-of-sample convergent validity, *Environmental and Resource Economics* 25, 79–100.

Shrestha, R.K., Seidl, A.F. and Moraes, A.S. (2002). Value of recreational fishing in the Brazilian Pantanal: a travel cost analysis using count data models, *Ecological Economics* 42(1-2), 289–299.

Smith, V.K. and Kaoru, Y. (1990). Signals or noise? Explaining the variation benefit estimates, *American Journal of Agricultural Economics*, 72, 419–433.

Stoeckl, N. and Mules, T. (2006). A travel cost analysis of the Australian Alps, *Tourism Economics* 12(4), 495–518.

Suarez, A.V. and Tsutsui, N.D. (2004). The value of museum collections for research and society, *BioScience* 54(1), 66–74.

Throsby, D. (2003). Determining the value of cultural goods: how much (or how little) does contingent valuation tell us? *Journal of Cultural Economics* 27, 275–285.

Turnbull, B.W. (1976). The empirical distribution function with arbitrarily grouped, censored and truncated data, *Journal of the Royal Statistical Society* 38, 290–295.

Upneja, A., Shafer, E.L., Seo, W. and Yoon, J. (2001). Economic benefits of sport fishing and angler wildlife watching in Pennsylvania, *Journal of Travel Research* 40(1), 68–78.

Whitten, S.M. and Bennett, J.W. (2002). A travel cost study of duck hunting in the upper southeast of South Australia, *Australian Geographer* 33(2), 207–221.