A Travel Cost Analysis of the Value of Carnarvon Gorge National Park for Recreational Use

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National parks as natural areas preserved from the more disruptive forms of economic activity provide a multitude of benefits to humankind, and these may be classified as either on-site use benefits or off-site benefits. This paper reports an applied case which is concerned with the measurement of the value of the recreational use benefits for one such national park. Whilst the national park is under no immediate threat, having an indication of the economic value of recreational opportunities within the park can aid future planning and decision-making.

The emphasis in this study was to use and test TCM for rapid valuation appraisal. Demand curves for both camping and day visits are estimated, and consumer surplus calculated. A value of $40m. is estimated as the net present value of the recreational use alone in 1993-94 values at 6 per cent real rate of interest in perpetuity.

1. Introduction

Carnarvon Gorge National Park, the most popular segment of the major aggregation comprising Carnarvon National Park which encompasses more than 0.25m ha, is one of the prime tourist attractions in Queensland. The park has significant ecological and cultural values which contribute to the recreational benefits which the site provides.

The park lies along the Great Dividing Range which, in that location, divides the Murray-Darling Basin from the Fitzroy Basin, 600km NW of Brisbane. The varied topography together with weathered deep sandstone beds and remnant basalt caps ensure a multitude of micro-climates and resultant ecosystems. The park is renowned for its rare flora, for example, the ancient king fern, *Angiopteris evecta*. The presence in the gorge of permanent surface water, which flows from sandstone groundwater aquifers, in an otherwise dry region preordained an Aboriginal use of the area historically. The availability of smooth sheltered sandstone surfaces on which they recorded aspects of their lives and culture has made sure that evidence of that occupation survives and contributes to the cultural history of humankind in Queensland.

The Queensland Government late in 1992 committed itself to a policy of ecologically sustainable development. This policy necessarily dictates the use of natural resources in such a way that the needs of the future, as well as current, generations are met, and that essential ecological processes and support systems are maintained. A major shift in the focus of policy away from emphasis on the well-being only of current economic agents, such as this is, inevitably will produce losers as well as winners. Losers can organise themselves into powerful lobby groups, and can exert great pressure on governments.

Whilst the park is not, as far as can be ascertained, under any threat at present, from time to time sections of the community argue against the reservation of natural areas and try to promote the exploitation of timber and mineral supplies in order to gain the short-term benefits of jobs and immediate profits. In such arguments the long-term values and the benefits to be gained from recreational use tend to be ignored. This paper reports research designed to estimate the minimum value which may be attributed to recreational use of Carnarvon Gorge National Park, so that a data base of such values may be gradually assembled[1].

Carnarvon Gorge National Park currently is visited by approximately 18,000 people annually, who camp in the park mostly for three or four nights, and a further number of people who stay at commercial accommo-

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[1] Knapman and Stanley reported a similar study of the recreational use value of Kakadu National Park made at the behest of the Resource Assessment Commission and estimated the area has a net present value in perpetuity in 1991 values of $458m.

dation located just outside the boundaries of the park[2]. This latter group enters the park on a day visitor basis; the number of day visits is estimated by staff as approximately 10,000 per year. Few people visit the park as true day visitors, in the usual sense of leaving and returning home on the same day, because of its isolation. Day entry to the park is free; campers were charged $7.50 per night per group of up to six people at the time of this study[3].

The next section reviews briefly some of the literature concerning the travel cost method (TCM). Section 3 discusses the methodology for the study and Section 4 reports the estimation of the demand curve for camping. Section 5 estimates the demand curve for day visits and Section 6 reports the estimated consumer surplus, the measure of net benefit received by consumers used in this study.

2. TCM and Some Relevant Issues Reported in the Literature

TCM is one of several methods developed predominantly in the USA since the 1960s to estimate demand for, and to value, environmental goods or services which have no established markets or to value specific sites to which entry is either free or is priced in a nominal fashion. Interest in developing such methods grew as environmental awareness increased, and people became more conscious of the many benefits the natural environment supplies to human beings. In the United States various legislatures and judiciary have provided the impetus to focus attention on the proper valuation of these environmental benefits.

Essentially TCM is a method developed for the estimation of the value of use of a particular site or group of sites rather than the value of non-use benefits. Use of a natural site for outdoor recreation is a service produced and consumed simultaneously by an individual in conjunction with the natural resource. The product is recreational experiences and the chief characteristic of the product is the need for consumers to transport themselves to selected sites rather than have the services transported to them. For individuals, therefore, scarce resources such as recreation time and transport services must be used, and their allocation is central to the formation of demand for a particular recreation site.

The basic demand relationship that quantity demanded varies inversely with price is reflected in the proposition that the quantity of visits by users of parks will decrease the further consumers must travel to a specific park and thus the greater the travel and time costs. Even where an entry fee is charged, travel costs impact on the use of a particular site and contribute (negatively) to the creation of demand.

Briefly, the travel cost procedure involves two steps. A demand function for the recreation experience is estimated, and then a demand curve for the site is derived. An estimate of consumer surplus may then be made by estimation of the area under the curve net of cost.

TCM allows the investigation of the effect of changes in price on the quantity demanded of visits or days at the site (or some other unit of output). In essence, a demand schedule is compiled. The method rests on the assumption, among others, that consumers will react to the imposition of an entry fee no differently from an increase in travel costs.

2.1 Allocation of the Cost of Trips with Multiple Destinations

Many aspects of TCM have been subjected to research and refinement during the last three decades. The most intractable difficulties have involved the allocation of costs for trips with multiple destinations and the value of travel and on-site time.

For trips with multiple destinations, the costs of travel constitute joint costs and, as there is no theoretically-acceptable method of allocating such costs, the allocation method perforce must be arbitrary. Haspel and Johnson assigned a fraction of total costs to each destination and then estimated separate site demand curves. Clough and Meister suggested adjustments to travel costs for multi-site visits may bias results and instead adjusted the aggregate consumer surplus.

Mendelsohn *et al.* reported a solution of combining a number of popular sites as joint sites in order to overcome this problem. Whilst this solution may be acceptable in some situations such as a group of lakes in close proximity where most of the lakes in the group

2 About 1000 of the campers are overseas visitors; they have been omitted from the study.

3 In December 1994, the camping fee was changed to $3 per person per night.

are visited by recreators in a single trip, it suffers from the problem of researcher-designated values, in that the researcher must define the group of sites.

Smith (1971) recommended that only the cost of travelling the marginal distance from a previous site be included but, as Ulph and Reynolds (p.203) noted, this method could result in bias as a highly regarded site might be only a short distance from another stop-over site. The apparent willingness-to-pay would be underestimated. Stoeckl in her study of use of Hinchinbrook Island allocated costs according to the time spent on the Island as a proportion of total time spent at sites nominated by visitors as being important to them on their trips.

The problem that arises with most methods of allocation is that the allocation process reduces the apparent cost to the point where it undermines the basis of the methodology. TCM relies on the central tenet that demand falls to low levels when prices rise to high levels. Accordingly, a given site will be visited by few people from far distant origins because costs will be high. Yet, once that cost is split between a number of destinations, the apparent cost is much lower. In Stoeckl's study, for example, visitors to Hinchinbrook Island from Townsville, 100 km distant, paid an average of $389 per person in travel costs yet visitors from Tasmania, 2,000 km distant, paid an average of $187 in travel costs, the incongruity being due to the allocation process.

On the other hand, it might be argued that multi-site visitors did not value the site in question highly enough to spend their whole recreation time there. In contradiction, Sorg *et al.* found by use of contingent valuation methods that multiple destination visitors actually placed a higher value on the given site than single destination visitors.

2.2 The Cost of Time

The cost of time has been one of the most vexing issues raised by economists interested in valuing the use of a recreation or wilderness site. The argument over the value of time stems from the notion in economics of opportunity cost. A person travelling to a recreation site bears the cost of not doing something else as well as the cash costs of the trip. The opportunity cost is thus the benefit or utility which could have been gained by doing the next best alternative.

In a simple world and the conventional labour supply model where there is a continuous trade-off between work and recreation, the opportunity cost of recreation is the monetary and other benefits of work. In the modern world, however, where many people work fixed hours and are provided with week-end and public holidays as well as paid recreation leave, this trade-off notion is often not relevant, because people have no opportunity to substitute paid employment for leisure. On the other hand, it may be applicable to self-employed people and for those with opportunities to work in second and part-time employment.

Apart from the opportunity cost being working time foregone, there are many other possibilities. Alternatives to recreation at a particular site may be voluntary work, or other leisure activities such as sport, pottering around at home, doing manual crafts, reading, studying or indeed going to another site for recreation. The opportunity cost of going to the site in question is thus the benefits foregone of not doing one or more of those myriad other activities.

Estimates of travel time had been included as a separate variable, but it was soon realised that multicollinearity between travel cost and travel time would be a problem. Cesario and Knetsch reported that multicollinearity could be eliminated if the cost of travel time was estimated and added to the other travel costs. They suggested the cost would be some proportion of the wage rate, but the choice would be arbitrary. McConnell and Strand developed this theme further by suggesting that the cost would be some proportion (k) of each individual's wage rate, and that k could be determined by estimation within the regression analysis where travel time multiplied by the individual's income per hour is selected as the relevant variable. They estimated k to be 0.6 of the wage rate.

Smith, Desvousges and McGivney expanded the argument by reporting that the marginal value of on-site and travel time are related to the wage rate only indirectly through the income effect, if recreation time cannot be traded for work time. They estimated k as varying considerably and ultimately made on-site time endogenous in their model. Bockstael, Strand and Hanemann showed fixed work hours censored the continuous trade-off of work versus leisure hours and the opportunity cost may be greater than the wage rate. McConnell concluded costing on-site time had presented so difficult a problem that no systematic method had been developed, either conceptually or empirically.

Shaw argued in line with the discussion at the beginning of this section that the opportunity cost is not only related to work foregone, but also to other activities. Thus, he maintained that there is a difference between the value and cost of time, and that a worker with low wages might value time very highly. Individuals' value of time is virtually impossible for a researcher to observe. Shaw suggested that investigations of demand by survey technique might well include questions which would elicit information on employment opportunities and alternative activities. McKean, Johnson and Walsh built on Shaw's work and found survey information to be important so that time rationing rather than time pricing might be incorporated into models where there are certain institutional arrangements or labour market disequilibrium.

Walsh, Sanders and McKean raised the issue that travel to and from a site may also have consumptive value. There would thus be the measurement of benefits as well as costs to deal with, and an acceptable estimation of net travel cost would need to have the travel benefits deducted. As noted above in relation to cash costs, researchers are dealing with people's perceptions and only the individuals concerned can say whether travelling time results in net cost or net benefit.

2.3 Evaluation of TCM

Whilst the development of TCM during the last three decades has generated hundreds of papers in the literature examining, criticising and proposing refinements to all aspects, Smith (1993) in a review of non-market valuation methods judged that 'most evaluators concluded that the method had worked well'. Smith isolated four features which have been generally upheld in empirical investigations. Firstly, estimates are generally in accord with consumer demand theory, in that quantity demanded is negatively related to price; secondly, there is a broad consistency in the relative magnitudes of price and income elasticities, and different types of sites produce the differences in elasticities that would be intuitively expected. Demand for sites with numerous substitutes, for example, has been found to be more elastic than those with few alternatives. In addition, estimates are sensitive to the assumptions and judgements made during the modelling process and thus exhibit strong connections to underlying preferences, motivations and behaviour constraints. Finally, controlled experiments have endorsed the method's ability to characterise underlying consumer preferences.

In a report reviewing the methods for analysing development and conservation issues, the recently disbanded Resource Assessment Commission concluded the method is a 'reasonably reliable and robust technique' (RAC, 1992a: 31). Sinden (p.341) in a review of environmental valuation in Australia concluded that 'the method seems well suited to ex-post estimation of consumers' surplus values for goods and services for which quantities taken depend on the costs of travel to acquire them'.

2.4 Applications of TCM in Australia

The travel cost method was used in Australia early in its development to estimate the demand curve for visits to the Grampians State Forest in Victoria with data collected for the period 1970-71 (Grieg). More recently, Sinden used the technique to value the unpriced benefits of improved management of the Ovens and King Rivers.

As well as for the Kakadu study (Knapman and Stanley), the Resource Assessment Commission used the technique to estimate the recreational value of National Estate areas located within wood production zones in the forests of south-eastern Australia (RAC, 1992b).

Two of the most recently reported applications in Australia has been for locations in Queensland. The travel cost method was used in a case study of 'user-pays' at Green Mountains National Park (Scoccimarro) and to value the recreational use of Hinchinbrook Island National Park in the Whitsundays (Stoeckl).

3. Methodology of the Study

Even though the design of this research called for travel costs to be estimated by the researcher, some information still needed to be collected from visitors. The process of data collection by survey involved the identification of the population, the selection of the sample, the development of the questionnaire and the administration of the survey instrument. This section discusses these topics in turn and reports the response rates.

3.1 Identification of the Population and Selection of the Sample

This investigation concerns the visitors to Carnarvon Gorge National Park who chose to camp. To make the results as timely as possible, the sample was selected from the population of visitors issued with camping permits in 1993-94. In view of the response rate of approximately 50 per cent to a recent Girraween survey (Beal, 1995a), and the lesser data requirements of the estimation of demand with researcher-estimated travel cost values, 350 questionnaires were posted. The sample was selected by the systematic selection method of every nth permit issued, after a randomly selected starting point[4]. Carnarvon Gorge attracts about 1000 visitors from overseas each year; these names were omitted from the sample[5].

3.2 Development of the Questionnaire and Survey Procedures

The questionnaire was based on the instrument developed for the Girraween survey referred to above. It was, however, simplified, so that it comprised only one A4 page of 17 questions printed in two columns on the back of the introductory letter.

The questionnaires were posted on 15 November 1994 and recipients were asked to return them by 25 November. A 'freepost' return envelope was provided. As noted above, 350 questionnaires were posted out to selected campers.

3.3 Response Rate

Of the questionnaires posted, a total of 18 were returned unopened, because the recipients had left the address or were not known at the address given to the officer issuing the permits. A total of 187 responses were received, representing a response rate of 55.3 per cent of campers. The zonal response in the sample was a reasonable approximation of the zonal representation of the 1993-94 population of campers.

3.4 Development of Protocols for the Estimation of Values for the Variables

The 12 zones designated in the study are based on statistical divisions, which have been aggregated according to their approximate distance from Carnarvon Gorge. The dependent variable, V, visits per thousand zonal population, is estimated by scaling up the observed number of visits per zone to an annual rate and dividing that figure by the zonal population.

As noted above, the estimation of the demand curve for camping visits to Carnarvon Gorge is made on the basis of researcher-designated travel cost values, because costs reported by visitors are subject to a great deal of variation as a result of lack of records, poor recall, inherent differences in perceptions of cost, and so on (Beal, 1995b). Nonetheless, the cost of time to visitors is theoretically liable to vary widely between individuals, and information about personal situations is necessary if total monetary costs are to be incorporated in the estimates.

Where travellers gain pleasure and utility from the actual experience of travel, the net cost of travel is reduced. Indeed many people gain so much utility from travel that the benefits far exceed the cost, and they opt to repeat the experience as often as possible. To elicit more information on campers' attitudes to the road travel part of their visits, respondents were asked if they would give up all or part of the journey. If they answered in the affirmative, they were asked how they would spend the time saved[6].

Respondents were initially asked if they had given up income to make the trip to Carnarvon Gorge. Of the 48 individuals who indicated they had forfeited income, 24 (50 per cent) specified that they would not willingly give up the travel, 12 (25 per cent) indicated they would give up all or part of the trip and spend the time saved at Carnarvon Gorge and a further 12 (25 per cent) specified they would give up all or part of the trip and spend the time saved at another holiday spot. None of the respondents indicated they would spend the time saved at work and earning income. Thus, none incurred a net monetary opportunity cost of the travel time.

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[4] This method introduced an element of stratification into the selection of the sample.

[5] Omission of overseas visitors will introduce a bias to the analysis. However, whilst the size of the bias is unknown, the demand curve is likely to be estimated as being to the left of the true demand curve. Consumer surplus is likely to be underestimated.

[6] A more complete discussion of the cost of time as reported by respondents to this survey and a similar survey of campers at Girraween National Park is reported at Beal (1995c).

The values for the travel cost variable have been calculated by use of the following formula:

$$TC = \frac{1}{n}(.15d + 60a + p + f)$$

where n is the average number of people in each vehicle, d is the distance assumed travelled (in kilometres), a is the minimum number of nights that accommodation must have been purchased on the trip, assuming a rate of travel of about 600 kilometres per day, p the Carnarvon Gorge entry fees, and f the ferry fees for those respondents who travelled across Bass Strait from Tasmania.

The average number of people travelling in each vehicle has been assumed to be three. This figure is consistent with park records and the numbers indicated by respondents to the survey. The variable cost of running a vehicle has been assumed to be 15 cents, a figure based on Department of Primary Industry and Energy surveys (DPIE) and a fuel price in the order of 75 cents per litre[7]. Accommodation at motels of reasonable standard for a family group of three has been assumed to be $60 per night. Motel guides indicate room rates ranging from $50 to $70 for three people in three to four star accommodation. Each group is assumed to stay in the park for four nights. Ferry fees for Tasmanian visitors are $180 per person in a family cabin plus $180 for their vehicle for the return journey (McCaffertys Travel).

The assumptions are likely to underestimate the average vehicle cost, because many visitors would not travel directly from their homes to the park. On the other hand, the assumptions regarding accommodation simplify a complex situation, because some visitors do not use commercial accommodation. Some would stay some nights with friends; others travel with their own caravans and stay overnight in van parks. For caravaners, the accommodation component of their holiday cost is smaller, but their running cost for their vehicles increases significantly.

The issue of the appropriate allocation of cost in cases of multiple destinations where joint costs are incurred to achieve joint benefits is complex. This problem has not been satisfactorily solved. Some researchers have reduced costs to relevant costs according to the proportion of nights spent at the site in relation to the total number of nights away from home. This manipulation may tend to underestimate costs because a visitor from a region many hundreds of kilometres distant may need to spend four days and nights, for example, on the road during the return journey to the site where visiting it is the only reason for the trip. In this case, it would be inappropriate to reduce and pro-rate costs, because all costs relate to the principal and only reason for the trip.

In order to investigate visitors' motivations further, two questions were asked in the survey about motivation for visiting Carnarvon Gorge. The first asked if visiting Carnarvon Gorge was the chief reason for the trip, or was equally important with other places, or was not important at all. For respondents who indicated visiting Carnarvon Gorge was not the only reason for the trip, a follow-up question asked what places were important destinations and how long did respondents stay at those nominated places.

Table 1 provides the percentages of respondents from each zone who nominated visiting Carnarvon Gorge as the chief reason or the equally important reason for their trips. The zones are listed in the table in ascending order of distance from the park. Only two groups (1 per cent) indicated the park was used only as a convenient stop-over place on a journey for other reasons.

Whilst it is to be expected that proportionately more travellers from distant regions would plan to visit a number of destinations rather than a single site, respondents' nomination of Carnarvon Gorge as equally important implies no lesser value being placed on the site by these visitors over the value placed on it by visitors for whom visiting it was the prime reason for their trips.

Any adjustment of travel cost to account for multiple destinations, however, implies a lower value being placed on the site by these respondents because they are apparently willing to spend only a lesser amount to travel to the site. In addition, any adjustment to travel cost, by whatever method, by the researcher is necessarily arbitrary. The researcher is attempting to measure values internal to visitors by arbitrary adjustments to cost. For these reasons, and the additional problem that adjustment undermines TCM by reducing the apparent cost of travel by visitors from distant

[7] Fuel prices varied in 1993-94 from about 60 cents per litre in districts close to port or where price competition is strong to nearly 90 cents in isolated regions where there is little price competition and high freight cost is added to retail prices. The inherent variability in fuel cost, engine efficiency and vehicle size is captured and simplified by use of the wide-ranging DPIE survey data.

Table 1: Respondents' Motivation for Visiting Carnarvon Gorge

Zone No.	Distance From Carnarvon Gorge (000km)	Chief Reason (%)	Equally Important Reason (%)
1	0.4	93	7
4	0.6-0.7	67	28
2	0.75-0.8	64	36
3	0.85-0.9	56	37
5	1	45	55
6,7	1.1-1.5	25	75
8	1.6-2.0	14	84
9, 10	2.1-3.0	11	79
11, 12	3.1-7.0	0	100

regions, no adjustment of cost has been included in this analysis for multiple destinations. Whilst this may not be an entirely satisfactory solution, the alternatives are even less satisfactory.

4. Estimation of the Camping Demand Curve by Regression Analysis

Values for V, the rate of visitation from each zone, and the values for TC, travel cost constitute sufficient data to estimate the demand curve. Socio-economic variables have been omitted from this analysis in light of experience in the USA with small samples and the Girraween analysis (Beal 1995a).

Table 2 provides the regression statistics for six functional forms, the linear model and five models incorporating data transformation.

The estimated coefficients in all models are statistically significant at the .05 level, except the slope coefficient in the linear model and the intercept in the reciprocal (dependent variable) model. On the basis of the R^2s, the log:log model is the most acceptable and that equation is used in the estimation of the second stage demand curve.

Table 2: Regression Statistics for Six Functional Forms

Model	Value of Coefficients			Test Statistics
	b_1	b_2(TC)	R^2	F
Linear	5.5164 (2.6206)	-.0100 (-1.7121)	.23	2.9315
Linear:log	27.0264 (3.8919)	-4.5498 (-3.5395)	.56	12.5282
Log:linear	1.3270 (2.7836)	-.0053 (-4.0428)	.62	16.3445
Reciprocal (1/V)	-0.5417 (-1.0018)	0.0117 (7.8033)	.86	60.8926
Reciprocal (1/TC)	-2.5114 (-2.5855)	810.935 (6.9597)	.83	48.4387
Log:log	9.8426 (9.3823)	-1.8743 (-9.6519)	.90	93.1603

The equation used for estimation of the demand curve for camping at Carnarvon Gorge National Park is thus:

$$\ln V = 9.8426 - 1.8743 \ln TC$$

Entry fees of $5, $8, $10, $12, $15, $18 and $20 per person are sequentially added to the average travel cost for each zone. These are additional entry fees, because current fees on an individual person basis vary according to the size of the group.

Estimates are made of the visitation rates from each zone under these circumstances, and the total expected number of visitors at each entry price computed. Table 3 provides a summary of the total visits for each level of additional fees, which comprises the data for estimation of the demand equation for visits by campers to the park. The number of visits demanded at zero additional entry fee is the observed value; the other values are calculated with the initial regression equation.

Table 3: Estimated Demand Schedule for Camping

Entry Price Per Person (P)($)	Number of Visits Demanded (Q)
0	17,000*
5	13,736
8	13,156
10	12,796
12	12,456
15	11,981
18	11,540
20	11,265

* Observed value

Regression analysis has been used with these data to estimate a demand equation. Table 4 provides a summary of the estimated coefficients and R^2s for the several models.

All of these models appear to provide a reasonable description of the data. The models with logarithmically transformed data are asymptotic to one or both axes. Inspection of the scatterplot reveals that the data estimated by means of the initial regression equation is virtually linear, and it is the influence of the zero increase coordinates (observed value) which gives the models using transformed data better apparent fit. Without the zero observation, the linear equation is:

Table 4: Estimated Coefficients and Test Statistics

Model	Estimated Coefficients		Test Statistics
	b_2	b_2(TC)	R^2
Linear	15764.7	-252.09	.86
Linear:log	9.6673	-0.0185	.91
Log:linear	14061.8	-686.948	.92
Log:log	9.5391	-0.0480	.88
Reciprocal (1/P)	12413.9	45.8872	.80

$$Q = 14475.4 - 163.6Q$$

with a R^2 value of .99. However, the use of this demand equation would cause severe underestimation of demand at low prices, as would use of some of the other functional forms. The linear:log form, for example, predicts the number of visits at zero entry fee to be 14061, and the double log form predicts 13892. Consequently, the linear demand function estimated above is accepted:

$$Q = 15764.7 - 252.09P.$$

Inverted, this demand curve becomes:

$$P = 62.53 - .0040Q.$$

5. Estimation of Demand for Day Visits

Carnarvon Gorge attracts few local day visitors, because it is located in an isolated area where the population is small. Indeed the local population has a density of less than 0.3 persons per square kilometre (ABS). In addition, most local people live on relatively large grazing properties, and have little time or inclination for nature-based recreation.

According to the management of the commercial lodge where most day visitors stay, their guests stay mostly three to five days. The tariff is $96 per day (Carnarvon Lodge Reception). Thus, visitors who drive to the park and stay at the lodge incur additional costs for a four day visit, for example, of nearly $400 per person. Other guests fly in by light charter or private aircraft and stay at the lodge. These visitors incur even more expense.

Data are not readily available on the origins of the visitors who stay at the commercial accommodation, because this information is considered commercially sensitive. An alternative method to collect this information is to interview day visitors as they enter the park each day. However, if most of the 10,000 day visitors stay an average of four days, only about nine 'new' visitors arrive each day, and possibly only three 'new' groups each day. It is thus a very time-consuming and expensive exercise to collect a reasonable sample of visitors' origins. This data collection has been judged unnecessary for the purposes of this analysis.

As a practicable alternative, the distribution of residential origin of the day visitors is assumed to be similar to that of the campers, and this distribution is used to estimate the demand curve for day visits. The zones from which day visitors originate are assumed to be the same as those used in the analysis and estimation of the demand curve for camping. If the average day visitor stays at the commercial accommodation just outside the park for about 4 days, the estimate of 10,000 day visitors made by rangers represents in effect about 2,500 individuals. The value of V for each zone in the analysis of day visitor demand is thus about 15 per cent of V in the analysis of camping demand.

Day visitors are also assumed to spend $400 each more than the travel costs estimated in the camping demand analysis. This expenditure represents four nights accommodation, the purchase of souvenirs, and some extra vehicle running between the lodge and the park, less some food costs.

Regression analysis has been completed and Table 5 provides the values of the estimators and regression statistics for six models.

All of the estimated coefficients are statistically significant at the .05 level except the values estimated for the slope of the linear model and the intercepts in the log:linear and reciprocal (independent variable) models. The values of the R^2s are not high for any of the models, but are highest with the double log and reciprocal (dependent variable) models. Consequently, these two models have been used for the estimation of the demand schedule for the second stage of the analysis, because there is no basis on which to choose between them at this stage.

Table 5: Regression Statistics for Six Functional Forms

Model	Estimated Coefficients b_1	b_2(TC)	Test Statistics R^2
Linear	1.3754 (2.3177)	-.0014 (-1.7451)	.23
Linear:log	1.4382 (1.4562)	-.0052 (-3.7575)	.59
Log:linear	9.3768 (2.3866)	-1.3872 (-2.2891)	.34
Log:log	27.7103 (4.9357)	-4.6000 (-5.3125)	.74
Reciprocal (1/V)	-28.4686 (-3.1682)	.0685 (5.4605)	.75
Reciprocal (1/TC)	-1.4190 (-2.2192)	1135.32 (2.9196)	.46

Increases in entry fees of $5, $8, $10, $12, $15, $18 and $20 have been used sequentially, and visitation rates estimated. Table 6 presents the estimates of visitor numbers at each increase in entry fees per person, using the reciprocal (dependent variable) model.

Table 6: Estimated Demand at Various Increases in Entry Fees

Increase in Price	Estimated Demand ($)
0*	2,500
5	1,323
8	1,071
10	1,057
12	1,044
15	1,024
18	1,006
20	995

* Observed value

The sharp decrease in demand predicted by this model at entry prices between zero and $5 appears unrealistic and hence introduces an element of caution in relation to the acceptability of this model. Alternatively, the double log model could be used to estimate the second stage demand curve. Table 7 provides the estimated demand schedule using this functional form.

Table 7: Estimated Demand at Various Increases in Entry Fees

Increase in Price	Estimated Demand ($)
0*	2,500
5	2,160
8	2,110
10	2,078
12	2,046
15	2,000
18	1,955
20	1,925

* Observed value

Whilst the demand estimates from the use of the reciprocal (dependent variable) model appear to be low at low entry fees, the estimates of demand at high entry fees appear to be overstated with use of the double log model. A choice between them must be made, and the double log model is accepted for the next step in the analysis, because of the apparently more reliable estimates at low entry fees. A demand function for day visits has been estimated from these data in Table 7. Table 8 presents a summary of the estimated coefficients and R^2s.

Table 8: Estimated Regression Coefficients and R^2s

Model	Estimated Coefficients b_1	b_2	Test Statistic R^2
Linear	2370.5	-24.8836	.85
Log:linear	7.7711	-0.0114	.88
Linear:log	2203.9	-68.7636	.93
Log:log	7.6930	-0.0307	.90
Reciprocal (1/P)	2038.66	4.6158	.81

Similar to the situation with the estimated demand functions for camping, all of these functional forms have high R^2 s, which indicate an acceptable fit to the data. The three models with logarithmic transformation of the data have the highest R^2s, but the characteristic of being asymptotic to one or both axes is difficult to accept as a realistic model of demand in the circumstances. Inspection of the scatterplot shows the estimated data to be linear with the zero observation an outlier. When the zero observation is omitted from the data set and the regression run, the linear model has an R^2 of .999 and the equation is:

$$Q = 2235.36 - 15.61 \text{ P.}$$

Nonetheless, the zero observation is an observed value, where the other values are estimated. Hence, it must be given due weight and the equation should include the influence of the zero observation. The linear model gives an estimate of demand at zero entry fee closest to the observed level together with greatest ease of manipulation, and is accepted for inclusion in the aggregation process. The equation cuts both axes at predictable points and is:

$$Q = 2370.5 - 24.88 \text{ P.}$$

Inverted, the estimated demand curve for day visits is:

$$P = 95.28 - .04 \text{ Q.}$$

The estimated values in this demand equation is satisfactorily in line with *a priori* expectations. The slope of the line is negative, as would be expected. The choke price is higher than the estimated choke price for campers at the park, and the price elasticity of demand is more inelastic over a relevant range of price increases. At a marginal increase from $5, for example, the price elasticity of demand for day visits is estimated to be .055, in contrast to the estimate of .087 for the price elasticity for demand for camping at the same price point[8].

[8] The formula for price elasticity of demand is $\frac{dQ}{dP} \times \frac{P}{Q}$. In this case, price elasticity may be computed with the formula $b_2 \times \frac{P}{Q}$.

6. Estimated Consumer Surplus and the Value of Recreation

The aim of this paper is to measure the value of the recreational use of the park. The relevant economic concept is consumer surplus, a concept which recognises that use value is higher than exchange value or price, except at the margin where the use value should equal the exchange value. If it were otherwise, consumers would use more (or less).

Consumer surplus is a measure of the net benefit received by the consumer of a good, and is measured by the difference between the amount the consumer is willing to pay and the actual price. Geometrically, consumer surplus is the area under the demand curve above the price of the good.

The demand curves for camping and day visits estimated above are:

$$P = 62.53 - .004\ Q \quad \text{(camping), and}$$

$$P = 95.28 - .04\ Q \quad \text{(day visits).}$$

These equations have been estimated in terms of visitors undertaking four-day trips.

If the unit in which output is measured is changed to day equivalents so that demand may be understood in terms of the more familiar camper-nights or day entries, the demand curves shift iso-elasticly and the equations become:

$$P = 62.53 - .001\ Q \text{ ,and}$$

$$P = 95.28 - .01\ Q \text{ .}$$

The demand function for camping was estimated in terms of the additional entry fees consumers would be willing to pay over and above the variable fee they had already paid. On this basis, the whole of the area under the curve is consumer surplus. Similarly, the whole of the area under the estimated demand curve for day visits is consumer surplus, because no entry fee is currently charged.

Estimated consumer surplus is therefore \$2.4m. Based on a real rate of interest of 6 per cent, the net present value of future recreational use of the park in 1993-94 values in perpetuity is \$40m.

7. Conclusion

This research has been concerned with the rapid appraisal of the recreational use value of Carnarvon Gorge National Park. In this simplified application of TCM, demand curves for both camping and day visits have been estimated and consumer surplus computed.

Using a real rate of interest of 6 per cent, the minimum net present value of the recreational use of the park in 1993-94 values in perpetuity is \$40m. Whilst the study has not attempted to allocate arbitrarily joint costs incurred in multiple destination trips, which may or may not change the valuation significantly, it has also not attempted to incorporate the value placed on the site by some 1000 visitors who live overseas. Such incorporation would surely increase the recreational value of the area.

Another important factor which should not be overlooked is that the demand curves for use can be confidently expected to shift to the right as natural areas become fewer and smaller in extent than at present, and their value becomes correspondingly more appreciated. The estimation of consumer surplus will be affected by the units in which output is measured and the demand curves expressed. It is incumbent upon the researcher to determine the unit of output most appropriate to the purpose of the study.

Compared with the value placed by Knapman and Stanley on the recreational use value of Kakadu National Park of \$458m, Carnarvon Gorge appears to be a minor national park. However, the recreational use value of the park can be expected to increase significantly if analysts' expectations of the growth of tourism in Queensland are fulfilled. The value estimated by this study provides some base data.

References

ABS (AUSTRALIAN BUREAU OF STATISTICS) (1988), *Year Book, Australia*, ABS, Canberra: 256.

BEAL, D.J. (1995a), 'Estimation of Demand for Camping Visits to a National Park in South-East Queensland by the Travel Cost Method'.

BEAL, D.J. (1995b), 'Sources of Variation in Estimates of Cost Reported by Respondents in Travel Cost Surveys', *Australian Journal of Leisure and Recreation* 5(1), 5-8.

BEAL, D.J. (1995c), 'The Cost of Time in Travel Cost Analyses of Demand for Recreational Use of Natural Areas', *Australian Journal of Leisure and Recreation* 5(1), 9-13.

BOCKSTAEL, N.E., STRAND, I.E. AND HANEMANN, W.M. (1987), 'Time and the Recreational Demand Model', *American Journal of Agricultural Economics* 69(2), 293-302.

CARNARVON LODGE RECEPTION (1994), personal communication, 22 December.

CESARIO, F.J. AND KNETSCH, J.L. (1970), 'Time Bias in Recreation Benefit Estimates', *Water Resources Research* 6, 700-704.

CLOUGH, P.W.J. AND MEISTER, A.D. (1991), 'Allowing for Multiple-Site Visitors in Travel Cost Analysis', *Journal of Environmental Management* 32, 115-125.

DPIE (DEPARTMENT OF PRIMARY INDUSTRIES AND ENERGY) (1993), *Fuel Consumption Guide*, DPIE. Canberra.

GREIG, P. (1977), 'Cost-benefit Analysis in Recreation Planning and Policy-making', in Mercer, D. (ed), *Leisure and Recreation in Australia*, Sorrett Publishing, Victoria.

HASPEL, A.E. and JOHNSON, F.R. (1982), 'Multiple Destination Trip Bias in Recreation Benefit Estimation', *Land Economics* 58, 364-372.

KNAPMAN, B. and STANLEY, O. (1991), *A Travel Cost Analysis of the Recreation Use Value of Kakadu National Park*, Resouce Assessment Commission Inquiry, AGPS, Canberra.

MCCAFFERTY'S TRAVEL (1994), personal communication, 23 December.

MCCONNELL, K.E. (1992), 'On-Site Time in the Demand for Recreation', *American Journal of Agricultural Economics* 74, 918-925.

MCCONNELL, K.E. and STRAND, I. (1981), 'Measuring the Cost of Time in Recreation Demand Analysis: An Application to Sportfishing', *American Journal of Agricultural Economics* 63(1), 153-156.

MCKEAN, J.R., JOHNSON, D.M. and WALSH, R.G. (1995), 'Valuing Time in Travel Cost Demand Analysis: An Empirical Investigation', *Land Economics* 71(1), 96-105.

MENDELSOHN, R., HOF, J., PETERSON, G. and JOHNSON, R. (1992), 'Measuring Recreation Values with Multiple Destination Trips', *American Journal of Agricultural Economics* 74, 926-933.

RAC (Resource Assessment Commission) (1992a), *Methods for Analysing Development and Conservation Issues: The Resource Assessment Commission's Experience*, Research Paper No. 7, Canberra.

RAC (Resource Assessment Commission) (1992b), *Forest and Timber Inquiry Final Report*, Volume 2B, Appendix U, Canberra.

SCOCCIMARRO, M. (1992), An Analysis of User-Pays for Queensland National Parks, unpublished B. Econ Honours thesis, University of Queensland.

SHAW, W.D. (1992), 'Searching for the Opportunity Cost of an Individual's Time', *Land Economics* 68, 107-115.

SINDEN, J.A. (1990), *Valuation of Unpriced Benefits and Costs of River Management*, A Report to the Department of Water Resources, Victoria.

SINDEN, J.A. (1994), 'Environmental Valuation in Australia', *Review of Marketing and Agricultural Economics* 62(3), 337-368.

SMITH, R.J. (1971), 'The Evaluation of Recreational Benefits: The Clawson Method in Practice', *Urban Studies* 8, 89-102.

SMITH, V.K. (1993), 'Nonmarket Valuation of Environmental Resources: An Interpretive Appraisal', *Land Economics* 68(1), 1-26.

SMITH, V.K., DESVOUSGES, W.H. and MCGIVNEY, M.P. (1983), 'The Opportunity Cost of Travel Time in Recreation Demand Models', *Land Economics* 59, 259-278.

SORG, C., LOOMIS, J., DONNELLY, D., PETERSON, G. and NELSON, L. *Net Economic Value of Cold and Warm Water Fishing in Idaho*, Resource Bulletin, RM-11, USFS, Fort Collins. (1985)

STOECKL, N. (1993), A Travel Cost Analysis of Hinchinbrook Island National Park, unpublished M. Econ. thesis, James Cook University.

ULPH, A.M. and REYNOLDS, I.K. (1981), *An Economic Evaluation of National Parks*, Centre for Resource and Environmental Studies, Australian National University, Canberra.

WALSH, R.G., SANDERS, L.D,. and MCKEAN, J.R. (1990), 'The Consumption Value of Travel Time on Recreation Trips', *Journal of Travel Research*, Summer, 17-24.