The Recreational Value of Lake McKenzie: An Application of the Travel Cost Method

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Abstract

Lake McKenzie is one of the most highly used and popular visitor destinations of all Fraser Island's natural sites, attracting 2,000 visitors a day in peak periods. Many consider this level of visitation to be unsustainable and the management authority is considering a range of management options. In assessing the alternatives it is useful to have some idea of the recreational value of the Lake under the current regime. This paper estimates this value using the travel cost method. Once adjustments for multiple-site visitors are made, the method yields recreational values of the Lake ranging from $13.7 M. to $31.8 M per annum, or from $104.30 to $242.84 per-person per-visit.

Key words: Lake McKenzie; Fraser Island; travel cost method; recreation.

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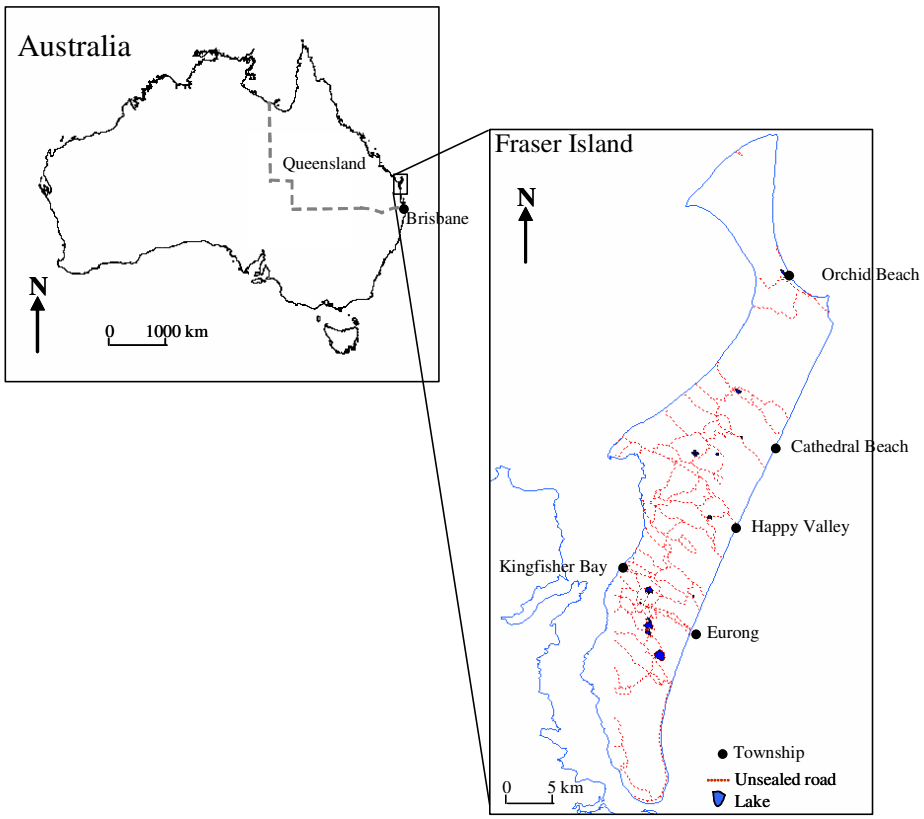
1. INTRODUCTION

Situated less than five kilometres off the Queensland coast, at the southern end of the Great Barrier Reef and some 250 kilometres north of Brisbane (see Figure 1), Fraser Island is the largest sand island in the world (166,283 hectares) and one of Australia's iconic natural attractions. Inscribed on the World Heritage List in 1992, the Island attracts approximately 300,000 visitors per year. This level of visitation poses some significant environmental threats to the long-term preservation of the Island, with visitors contributing to a range of environmental problems including erosion, litter disposal, human-wildlife interactions and contamination of the Island's freshwater resources.

Figure 1: Location of Fraser Island, featuring main townships, lakes and unsealed roads.

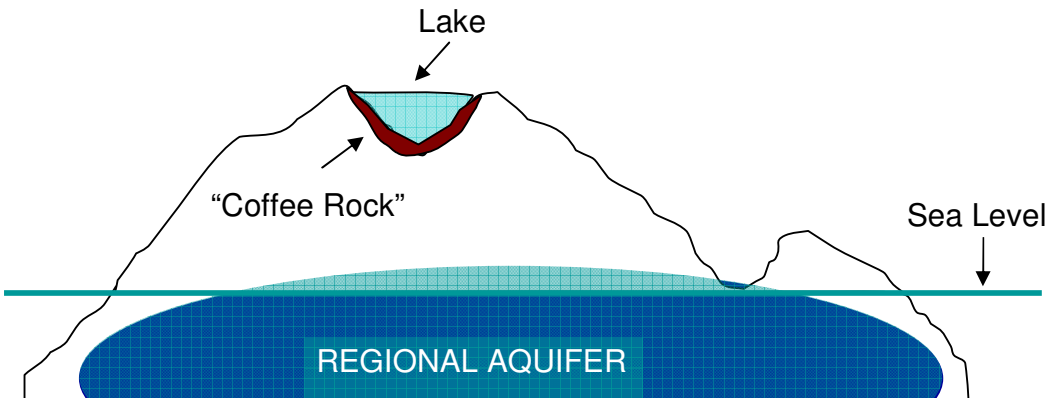


Source: Hadwen and Arthington (2003)

Of particular concern is the health of Fraser Island's perched dune lakes, of which there are more than forty, half the number of such lakes in the world. These lakes are formed when organic matter, such as leaves, bark and dead plants gradually build up and harden in depressions created by the wind, creating an impermeable layer known as 'coffee rock' (see Figure 2). They sit above the regional aquifer and do not typically have inflow or outflow creeks and as such are generally hydrologically closed basins of rainwater. Owing to the fact that rainfall on Fraser Island exceeds water loss via

evaporation, very few of the Island's perched dune lakes dry out. In fact, Longmore (1997) found that some perched dune lake sediments contain a continuous history (in excess of 300,000 years) of the Island's hydrology and vegetation changes through Quaternary glacial and interglacial periods. The lakes are therefore a critical component of Australia's natural heritage.

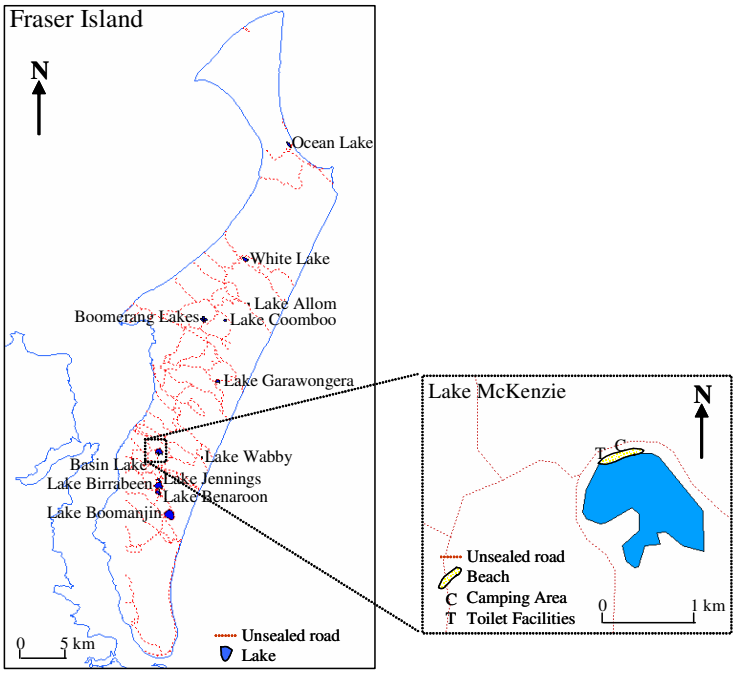
Figure 2: A perched dune lake



Source: Hadwen (2002)

The most highly used and popular visitor destination of all Fraser's dune lakes, attracting 2,000 visitors a day in peak periods, is Lake McKenzie, situated in the southern third of the Island (see Figure 3). Lake McKenzie has a long history of conflict between user groups and has been ranked the site most under pressure from tourism on the Island (Hadwen *et al.*, 2003). Further, a recent report commissioned by the Queensland Environmental Protection Agency highlights the fact that many sites on Fraser Island are being used well beyond their capacity, suggesting that intervention may be required to ensure the Island's long-term sustainability (Edaw, 2002). This has prompted the Queensland Parks and Wildlife Service to close the lakeside campsite to vehicle based camping, however day visitors, in particular those accessing the lake by privately-owned 4WD vehicles, represent a continuing problem (Henderson, 2004). If the Lake's environment continues to degrade, particularly if nutrient levels rise, there is a risk of unsightly and damaging algae blooms. In this case it may be necessary to extend the ban to all vehicle-based visitors, day trippers and campers alike, or in the worst case scenario, to all visitors regardless of access mode.

Figure 3: Fraser Island, the Island's lakes and Lake McKenzie



Source: Hadwen and Arthington (2003)

To gain an appreciation of the potential welfare effects of any move to restrict access to Lake McKenzie, it is useful to estimate the consumer surplus associated with current visitation. While organised tours already face access restrictions, and in the short- to medium-term are unlikely to be restricted further, independent visitors currently face no restrictions and are thus the group most likely to have some form of access restrictions imposed upon them in the future. This paper, therefore, using the zonal travel cost method, attempts to estimate the current (unrestricted) consumer surplus attributable to visits to Lake McKenzie by independent visitors. This surplus, or at least some portion of it, is that most likely to be effected by future management interventions.

It is possible to estimate consumer surplus using a stated preference method, such as contingent valuation. However, the survey instrument used in this study contained questions relating to another stated preference method (choice modelling) investigating visitor preference for alternative management actions. Discussion with practitioners and our own judgement lead us to believe the cognitive burden of answering two sets of stated preference questions was too great. Furthermore, controversy surrounding a previous study (Hundloe *et al.*, 1990) that attempted to place a monetary value on the preservation of Fraser Island, increased our reluctance to use the contingent valuation method. Thus, the travel cost method was deemed the most appropriate non-market valuation technique to employ.

In Section 2 we present an overview of the travel cost method, including a discussion of some well-known difficulties highlighted in the literature and encountered in this application. Section 3 describes

survey methodology and presents key socio-demographic characteristics of respondents. Section 4 gives further details of the modelling process and presents first-stage estimation results. Consumer surpluses are estimated in Section 5. Finally, Section 6 serves as a conclusion.

2. THE TRAVEL COST METHOD

When items are not bought and sold in real markets it is difficult to identify their true value. The travel cost method seeks to place a value on recreational sites by using consumption behaviour in related markets. In other words, this is a non-market procedure whereby a value for a recreation site is obtained by considering how much people are prepared to spend to reach the site. Specifically, the costs of consuming the recreational amenity of a particular site are used as a proxy for price; these costs can include travel costs, entry fees, on-site expenditures and outlay on capital equipment. The method assumes *weak complementarity* between the recreational site and consumption expenditure. This implies that when consumption expenditure falls to zero, the marginal utility of visitation is also zero, or alternately the recreational site will only be valued if consumption expenditure is positive (Hanley and Spash, 1993). The method has become widely accepted and is generally regarded as one of the success stories of non-market valuation (Smith, 1993).

In Australia, Greig's (1973) study of the Grampian Mountains in Victoria represents one of the earliest applications of the travel cost method and many subsequent studies have paid particular attention to estimating the recreational values of Australia's National Parks, with Warrumbungle (Ulph and Reynolds, 1981), Kakadu (Knapman and Stanley, 1991), Lamington (Scoccimarro, 1992), Hinchinbrook Island (Stoeckl, 1993), Girraween (Beal, 1995b), Carnarvon Gorge (Beal, 1995c) and Mount Buffalo (Herath and Kennedy, 2004) among the recreational sites examined.

There are essentially two types of travel cost models, the *individual*, where the dependent variable is the number of trips per year (or per season) by individual users of a recreation site, and the *zonal*, where the dependent variable is the number of trips taken to the site by the population of a particular region or zone. While the former is more appropriate for local, frequently visited, sites, the latter is more appropriate for sites visited infrequently by travellers from afar, and is thus the model employed here.

There are two approaches that may be taken when estimating a zonal travel cost model, the traditional Clawson-Knetsch two-stage methodology (Clawson and Knetsch, 1966) and the gravity model, often used in geography and transport studies to model commuting decisions. The methodology and theoretical underpinnings of these two models are extensively discussed elsewhere (see for example, Hanley and Spash (1993) and Garrod and Willis (1999)) and will not be revisited here. It is sufficient to note that the gravity model 'short-cuts' the two-stage method and has been shown to produce the same consumer surplus estimates as the more cumbersome Clawson-Knetsch method. In all, the

gravity approach is more elegant and has become increasingly popular with practitioners in recent times and is subsequently the approach taken in this paper.

2.1 Difficulties with the Travel Cost Method

In practical application, there are a number of difficulties with using the travel cost method.[2] The three difficulties encountered in this paper are: the treatment of time; the treatment of multiple-site visitors; and the treatment of overseas visitors. These are discussed in turn below.

2.1.1 Treatment of time

Since the very earliest applications of the travel cost method (see for example, Cesario and Knetsch, 1970; Cesario, 1976) the treatment of the cost of time, both travel time and time spent on-site, has been problematic. In its essence, the argument for including time costs within the travel cost framework is that, as a scarce commodity, the opportunity cost of time must be included and that failure to do so will increase the price elasticity of demand and therefore reduce the estimated benefits of visiting the recreation site (Freeman, 1993).

Building upon the framework of Becker (1965) and following the work of Cesario (1976), who drew on evidence from the transportation literature, many studies assume that time can be valued at a fraction (usually between ¼ and ½) of the wage rate. There are, however, numerous difficulties with this approach. First, and perhaps most critically, it assumes that individuals are able to continuously trade-off time spent at work, with time spent in leisure. While this may be the case for some (the self-employed, for example) for most, including those who have fixed working hours or who are outside the labour force, this assumption is untenable (Bockstael *et al.*, 1987). In one of the few empirical tests of this assumption, McKean *et al.* (1995) conclude:

> …opportunity time values can differ markedly between those able to substitute time for income and those who cannot. Models which ignore institutional constraints on time allocation thus may misstate opportunity time costs and consumer surplus.
>
> (McKean *et al.*, 1995 p.104)

In a further criticism, Shaw (1992) argues that distinction needs to be made between the value (net benefit) of time spent in an activity and the opportunity cost (the net benefit of time spent in the next best alternative activity). Shaw notes that, for example, low income earners may have a low opportunity cost of time, not necessarily a low value of time. Moreover, it seems implausible that the opportunity cost is time spent in paid employment; it is more likely that this time would be spent pursuing alternative leisure activities. That is, the opportunity cost of leisure is seldom wages (or other benefits of work) that are foregone, as in most cases work hours are fixed and people use weekends and paid holidays for vacations and recreation trips.

[2] A more thorough examination of the difficulties discussed here and others can be found in Freeman (1993).

Other difficulties with using the wage rate (or a fraction thereof) as a measure of the value of time, include the implicit assumption that time spent at work is neither liked nor disliked (Lew and Larson, 2005), and the fact that surveys often provide data on household income rather than the hourly wage rate; inferring wage rates by dividing household income by some estimate of hours worked will introduce measurement error (Freeman, 1993). In all, in evaluating the validity of this approach, Smith *et al.* (1983) conclude:

> …simple approximations, such as treating the opportunity cost as a fixed multiple of an individual's wage rate, are not likely to resolve the problems associated with defining a measure of these costs that is both theoretically consistent and practically feasible with existing data sources.
>
> (Smith *et al.*, 1983 p.259)

With specific regard to on-site time, McConnell (1992) notes that its inclusion is problematic, as spending more time at a site should enhance the value of the visit, while simultaneously increasing the (time) cost. This dual-role as a determinant of cost and quality creates a problem for travel cost demand estimation and many researchers advocate its exclusion (Ward and Beal, 2000). Time spent on-site may be considered exogenously determined and the marginal utility derived equals that from other activities. Whitten and Bennett (2002), for example, therefore treat it as having no impact on consumer surplus and hence do not include it.

In response to these criticisms, researchers have developed a range of alternative approaches including the use of a labour supply model (Feather and Shaw, 1999) and the use of stated preference data (Shaw, 1992; Casey *et al.*, 1995; Alvarez-Farizo *et al.*, 2001; Larson *et al.*, 2004). Although the latter approach shows promise, difficulties remain, including the increased cognitive burden associated with adding stated preference questions to travel cost surveys. In all there is a strong case for not including time costs at all and this is the approach taken here. This is consistent with that of a number of other practitioners including Siderelis and Moore (1995), the aforementioned Whitten and Bennett (2002) and Prayaga *et al.*(2006).

Moreover, the decision to exclude time costs is supported by Beal (1995a), who in a study seeking to elicit the opportunity cost of travel time for visitors to Girraween and Carnarvon Gorge National Parks in Australia, finds:

> The evidence…supports the hypothesis that recreation travel to camping sites has no monetary opportunity cost for the majority of visitors…it would be inappropriate for researchers estimating travel costs to include time costs in their valuations. The inclusion of a researcher-estimated value for travel time will serve to make the estimated demand function more price inelastic than it really is.
>
> (Beal, 1995a p.13)

2.1.2 Treatment of multiple-site visitors

One of the major assumptions of the travel cost methodology is that only one site is visited per trip. In other words, all the travel costs are incurred exclusively to obtain access to the particular recreation site being valued (Haspel and Johnson, 1982). When the site is remote but unique, some visitors would be from far distances and so the visit for them would be one of a group of activities and other destinations. When travel costs are shared inseparably between more than one site, there exists the problem of joint consumption benefits (Clough and Meister, 1991). If a trip has multiple objectives, it implies the full cost of the trip is not an implicit price for the particular recreation site under consideration. Allocating the full costs would overestimate the visitation rate and the recreation value (Kerr *et al.*, 1986). On the other hand, if all visitors are included and the total travel costs for visiting multiple sites are adjusted and only part thereof applied to a single-site, the basis of the travel cost procedure may be undermined (Beal, 1995c). The travel cost methodology relies on the tenet that demand falls as prices rise. The correlation between demand and prices disappears when only a fraction of the total costs are used. One solution is to exclude multiple-site visitors from the sample. Although methodologically reasonable this will have the effect of overestimating per-person benefits whilst underestimating total benefits.[3] In this paper, the total travel costs of all (multiple- and single-site) visitors are used and the resulting zonal consumer surplus estimates are adjusted according to the average proportion of the total trip that is spent at Fraser Island by visitors from each zone, a method first suggested by Clough and Meister (1991).

2.1.3 Treatment of overseas visitors

The treatment of overseas visitors can vary. One option is to take their costs of travel from their temporary residence. Prayaga *et al.* (2006) did this, treating all overseas visitors (to the Gemfest event in central Queensland) as coming from the local region. In this study, employing this strategy would mean that overseas visitors travel costs could be determined as originating from Hervey Bay, Rainbow Beach, Brisbane or Gympie. This would be an arbitrary assessment as international visitors would also travel to other parts of the state and country.

A second option is to treat the various countries-of-origin of international visitors as zones. This was done by Carr and Mendelsohn (2003) in their travel cost analysis of visitors to the Great Barrier Reef. They determined the benefit (ostensibly consumer surplus) for each zone and the total was expressed as the value of the recreational benefits of the Great Barrier Reef.[4] This does not seem appropriate as

[3] An attempt was made to use both of these methods, namely omitting all multiple-site visitors and using only a portion of travel costs; however, neither yielded satisfactory results. Models using the full sample and adjusted travel costs had poor explanatory power, and in some cases the travel cost variable was not significant at a 10% level. The exclusion of all multiple-site visitors substantially reduced the number of zones, and thus observations, leading to difficulties with model estimation.

[4] Carr and Mendelsohn (2003) do not explain where their survey took place. Since the Great Barrier Reef is 2,000km in length, it is arguable that it cannot be termed a 'site' in the travel cost analysis sense. Value estimates would be dubious if the survey was only conducted at one or two points, regardless of whether international visitors were included or not.

all the travel spending of overseas visitors does not occur in Australia, which indicates that it does not contribute to consumer surplus.

A third option is to omit all overseas visitors from the sample. When considered from an Australian perspective, the expenditure of overseas visitors while in Australia might more appropriately be considered as contributing to producer surplus and not to consumer surplus (which is measured by the travel cost method). Accordingly, in this paper, overseas visitors are excluded from the analysis.

3. THE FRASER SURVEY

Although the objective of this study is to estimate a recreational value of Lake McKenzie, doing so using the travel cost method is problematic because almost all visitors to the Lake also visit other attractions on Fraser Island. In fact Fraser Island itself could be viewed as an attraction and most of the travel costs are spent in reaching the Island. The decision was made therefore, to estimate the recreational value of Fraser Island in its entirety and then apportion some of this value to Lake McKenzie. How much of the total value allocated to the Lake is determined in this paper by using two methods:

(i) the satisfaction from visiting Lake McKenzie as a proportion of total satisfaction from visiting Fraser Island (as reported by respondents); and

(ii) the time spent at the Lake as a proportion of total time spent on Fraser Island.

The information required to estimate these proportions was available from the survey responses.

3.1 Survey administration

Following the method of Wilson and Tisdell (2004), visitors to Fraser Island were given surveys with pre-paid self addressed envelopes attached.[5] This was to give respondents the opportunity to carefully consider replies in their own time. A total of two sampling occasions during 2006 were undertaken, the first in April and the second in August. In April, 800 surveys were distributed over a period of seven days, in August, 560 surveys were distributed over a period of eight days; reflecting the fact that August is a much quieter time of year on Fraser Island. In both cases, surveys were distributed at various locations, predominantly in the lower third of the Island.

As we are interested in the consumer surplus accruing to independent vehicle-based visitors only (as this is the group of visitors most likely to be affected by any restrictions on future access), only these visitors, and not those on organised commercial tours, were surveyed. As noted in the Introduction, Commercial tour operators are already subject to management control, whereas there is currently no

[5] A copy of the survey is available on request.

limitation on the number of independent travellers able to access either Fraser Island as a whole, or Lake McKenzie in particular.

Of relevance to this paper, in addition to questions asking the respondents' home town and from where they departed the mainland to travel to Fraser Island, was a question seeking to obtain information from which travel costs could be estimated (see Box 1).

Box 1: The travel cost question

Question 7:

Briefly describe how you travelled from your home to the departure point given in Question 6 above. If you travelled by car or 4wd please indicate the approximate size of the vehicle i.e. light car (Toyota Echo or similar), small car (Toyota Corolla or similar), medium car (Mazda 6 or similar), large car (Ford Falcon or similar), compact 4wd (Ford Escape or similar) medium 4wd (Nissan Pathfinder or similar) or large 4wd (Toyota Landcruiser or similar) and whether it was privately owned or rented.

For example:

I flew from Sydney to Brisbane and then drove a medium sized rental car from Brisbane to Inskip Point.

……
……
……
……
……

Due to the wide range of potential methods of travelling, and routes, to Fraser Island, the open-ended format was deemed the most appropriate means of obtaining information on travel behaviour and therefore costs. In all, this question was well-answered by respondents and we would recommend practitioners consider this approach in the future.

3.2 Socio-demographic characteristics of respondents

Out of the 1,360 surveys distributed over both sampling periods, a total of 463 surveys were returned, of which 430 were useable, giving a response rate of 31.6%. Of these, 349 (75%) respondents were Australian residents and thus used in this study. These respondents represented 1,299 adult and 290 child visitors to Fraser Island. Of the 349 Australian resident respondents, 187 (54%) are male, 232 (67%) have visited the Island previously and 336 (96%) indicated that they had visited Lake McKenzie either on this current trip, or on a previous one.

The majority of respondents (70%) are from Queensland, with the remainder from New South Wales (17%), Victoria (9%), South Australia (3%) and Western Australia (1%). There were no respondents from the ACT, Tasmania or the Northern Territory.

The mean age of respondents is approximately 43, compared with a mean age of the wider Australian population of 34 (ABS, 2004), The sample is highly educated, with almost half of respondents reporting that they have a bachelor degree or above (compared with only 12.9% of the Australian adult population) (ABS, 2002). Respondents were also comparatively wealthy, reporting a mean weekly household income of $1,200-$1,400, compared to an Australia-wide mean of $700-799. Further, 31% of respondents report a weekly household income in excess of $2,000, compared to only 9% of households Australia-wide (ABS, 2002).

Respondents were asked whether they intended to return to Fraser Island some time in the future, and if so, were they likely to return during peak, off-peak or a mix of peak and off-peak months. The majority (82%) indicated that they would return, with almost half of these suggesting that they would return during a mix of peak and off-peak months. Only 18% suggested that they were unlikely to return to the Island.

4. APPLICATION OF THE TRAVEL COST METHOD

It is hypothesised in a travel cost analysis that the rate of visitation to the recreation site (in this case Fraser Island) is a function of the travel cost and some other socioeconomic variables. In other applications some site variables are also included. This is not appropriate here since the whole Island is the site and it is a unique natural World Heritage Area. In the following subsections the dependent variable and the various independent variables are described.

4.1 Definition of the dependent variable

The dependent variable for a zonal travel cost analysis is the rate of visitation from each of a number of researcher determined zones to the study site. In early applications, researchers defined concentric zones, designated according to their distance from the site under consideration. While concentric zones are appropriate in theory, incorporating them into the analysis is problematic; population and other socio-economic data is collected according to administrative boundaries not concentric circles (Ward and Beal, 2000). For this reason, researchers typically define zones which are consistent with these boundaries. In the Australian context, zones have often been based on Statistical Divisions[6] (Stoeckl, 1995; Cook and Harrison, 2002; Prayaga *et al.*, 2006) and this is the approach taken here. In all, the sample included observations from 25 different Statistical Divisions throughout Australia, and thus 25 observations are used in the first-stage estimation.

[6] A Statistical Division is a defined area which represents large, general purpose, regional type geographic areas. It represents a relatively homogeneous region characterised by identifiable social and economic links between the inhabitants and between the economic units within the region. They cover, in aggregate, the whole of Australia without gaps or overlaps. They do not cross State or Territory boundaries (ABS, 2003).

It was decided to calculate separate visitation rates for each zone for the April and August samples, and then use a weighted average to obtain an annual zonal visitation rate. Thus, for April (denoted subscript 1) the visitation rate (per 10,000) for zone *i* is given by:

$$VR_{1,i} = \frac{V_{1,i}}{N_i \times 0.04027} \tag{1}$$

and for August (denoted subscript 2) by:

$$VR_{2,i} = \frac{V_{2,i}}{N_i \times 0.04903} \tag{2}$$

where, $V_{1,i}$ is the number of adult visitors sampled in April from zone *i*,

$V_{2,i}$ is the number of adult visitors sampled in August from zone *i*,

N_i is the population of zone *i* aged 15 years and over (in units of 10,000) and

0.04027 and 0.04903 are the sampling fractions for April and August respectively.[7]

The annual zonal visitation rates are calculated using a weighted average of the monthly rates calculated above. The April rate, representing a peak visitation month, is given a weighting of 1/3rd reflecting the fact that 4 of 12 months (January, April, September and December) are regarded as peak visitation months, the August rate, representing an off-peak visitation month is therefore given a weighting of 2/3^{rds}. The formula is as follows:

$$VR_{A,i} = \frac{1}{3} \times VR_{1,i} + \frac{2}{3} \times VR_{2,i} \tag{3}$$

4.2 Definition of travel costs

Total travel costs are initially calculated per 'party' and include (where applicable): vehicle costs; air, bus and rail fares; recreational areas management (RAM) vehicle access permit fees; and barge fees. These costs are considered in more detail below. Per-person travel costs are then estimated by dividing 'party' travel costs by the number of adults in the party.[8] Per-person travel costs are therefore calculated using the formula depicted in equation 4:

$$\text{TC per person} = \frac{\text{Vehicle Costs} + \text{Air Fares} + \text{Bus Fares} + \text{Rail Fares} + \text{RAM Fee} + \text{Barge Fee}}{\text{Number of Adults in the Party}} \tag{4}$$

In regard to vehicle costs, respondents were asked to indicate the approximate size of vehicle in which they traveled. Seven size categories were suggested, corresponding to categories in the 2006 National

[7] The sampling fraction is the ratio of the number of parties in the sample to the annual number of permits issued to Australians, and thus scales the visitation rate to be applicable to the population.

[8] It is assumed children do not contribute to paying costs and therefore represent an additional cost burden to the adults in the party.

Roads and Motorists' Association (NRMA) Private Motoring Cost Schedule. The NRMA vehicle costs are calculated using an average price of 137.5c per litre[9] for unleaded petrol and include capital costs (depreciation, costs of funds), fixed costs (registration, compulsory third party insurance, comprehensive vehicle insurance, NRMA membership) and operating costs (fuel, tyres, service & repairs) (NRMA, 2006). A 10% operating cost premium was added for those respondents who indicated that they were towing a trailer. These costs are presented in Table 1.

Table 1: Vehicle operating costs

Vehicle size	Average operating cost (cents/km)
Light car	46.29
Small car	57.01
Medium car	73.53
Large car	89.46
Compact SUV	74.06
Medium SUV	96.39
Large SUV	103.97

The vehicle cost included in the travel cost variable was obtained as the product of the NRMA operating cost and the road distance traveled. Road distances are calculated using the Royal Automobile Club of Queensland (RACQ) Trip Planner (RACQ, 2006), with points of departure and arrival entered as postcodes. The trip planner calculates the shortest, not always the most scenic, route and distance calculations should therefore be viewed as conservative.

Air fares, bus and rail fares are calculated using the respective appropriate websites (Flight Centre, 2006; Greyhound Australia, 2006; Travel Train, 2006). In each case it is assumed the fare is for the economy class booked four weeks in advance. These costs should therefore be viewed as conservative.

Before bringing a vehicle onto Fraser Island, visitors must obtain a RAM vehicle access permit. The fee for this permit (valid for one month) at the time of the survey was $33.45 (per vehicle). An annual permit is also available for a fee of $172.30. It is assumed all parties bringing a vehicle onto the Island had purchased a one month RAM vehicle access permit.

There are a number of barges operating between the mainland and Fraser Island. Those departing from Inskip Point can travel on the Manta Ray, Rainbow Venture or Fraser Explorer, those departing from River Heads can travel on the Fraser Venture or Kingfisher Bay Barge and those departing from Urangan can travel on the Fraser Dawn or Kingfisher Bay Fastcat. Respondents were not asked to indicate which barge they traveled on, they were, however, asked to state a departure point from the

[9] This is a relatively high fuel price, reflecting the fact that New South Wales, where the NRMA calculations are derived, has a higher level of taxation on fuel than Queensland.

mainland and this is used to determine an approximate barge fee. In all cases it is assumed a return ticket was purchased.

4.3 Definition of socioeconomic variables

The survey asked respondents to identify their age, highest level of educational attainment and household income. The age question presented respondents with a series of age brackets at ten-year intervals. In order to calculate the average age of respondents from each zone, the age of each respondent was assumed to be equal to the mid-point of each bracket.

Four education categories were defined, coded as 1 to 4, where 1 represented having completed less than Year 12 (or equivalent), and 4 represented having at least a bachelor degree. From this information the average code of respondents from each zone is calculated.

As with the age question, respondents were asked to indicate their before-tax household income by selecting a particular income bracket. Mid-points were again used to determine the average household income of respondents from each zone.

4.4 Model selection

To obtain the trip generating function, the zonal visitation rate was regressed against average zonal travel cost (TC) and the three socio-demographic variables. As there is no theoretical reason for choosing one functional form over another, the linear, linear-log, log-linear, log-log and equations using the reciprocal of travel cost were all estimated. Equations were assessed using F and t-tests, adjusted R^2 values, and consideration of autocorrelation and heteroskedasticity problems. Of the full set of estimated equations, the two most preferred are given in Table 2.[10]

Table 2: Preferred first-stage estimation equations

Model No.	Dependent Variable	Constant (t-statistic)	Independent Variable (t-statistic)	adjR^2	F statistic (p-value)
1.	Ln(VR)	11.22568 (17.1717)	-1.067552 Ln(TC) (-10.6931)	0.8253	114.3424 (0.0000)
2.	Ln(VR)	5.411866 (26.7723)	-0.001258 TC (-6.8015)	0.6679	46.2597 (0.0000)

Of these, model 1 (log-log) was chosen for further analysis. Substituting in current average zonal travel cost and multiplying by zonal population, this model yields an estimated number of annual visits of 130,909. Given there are approximately 300,000 visitors annually, and the model estimates only Australian residents traveling independently, this figure seems reasonable. Further, if this level of visitation is divided by the annual number of vehicle permits estimated to be issued to Australian

[10] In all estimated equations, none of the socio-demographic variables were found to be significant even at the 10% level.

residents (38,775), an average of 3.4 adults per vehicle is obtained, which is also a reasonable estimate since the average number of adults per vehicle in the sample was 3.6.

5. CONSUMER SURPLUS ESTIMATION

With the assumption that people will respond to increases in price in a similar way to increases in travel cost, the visitation levels corresponding to a schedule of travel costs was derived. In theory this involves incrementing the travel cost variable until zero visitation is obtained, thus identifying the choke price for each zone. However, due to the nature of a logarithmic function, it is not possible to obtain a zero level of visitation. Instead choke prices were identified at that point where the level of visitation in each zone reached one. For each zone the level of visitation V_i was calculated using two equations:

$$\mathrm{Ln(VR)} = 11.22568 - 1.067552 \ln(\mathrm{TC}) \tag{5}$$

$$\mathrm{V_i} = \mathrm{VR_i} \times \frac{\mathrm{N_i}}{10{,}000} \tag{6}$$

where VR_i is the weighted average visitation rate as defined in equation (3), and V_i represents the scaled number of visits per 10,000 population from each zone for the year.

Hence,

$$\mathrm{V_i} = \frac{\mathrm{N_i}}{10{,}000} \mathrm{e}^{11.22568} \times \mathrm{TC}^{-1.067552} \tag{7}$$

The trip generating function was integrated for each zone between the actual travel cost and the zonal choke price travel cost. This estimates consumer surplus for each zone.

Consumer surplus is thus,

$$\mathrm{CS_i} = \frac{\mathrm{N_i}}{10{,}000} \mathrm{e}^{11.22568} \int_{\mathrm{TC_i}}^{\mathrm{TC_i}+\Delta \mathrm{C_{max}}} \mathrm{TC}^{-1.067552}\, \mathrm{dTC} \tag{8}$$

$$\mathrm{CS_i} = \frac{\mathrm{N_i}}{10{,}000} \mathrm{e}^{11.22568} \times \left[\frac{\mathrm{TC}^{-0.067552}}{-0.067552} \right]_{\mathrm{TC_i}}^{\mathrm{TC_i}+\Delta \mathrm{C_{max}}} \tag{9}$$

All the zonal answers were added to obtain the estimate of total consumer surplus. This yielded a surplus of $417,494,101 per annum, which converts to $3,189.20 per-person per-visit which is not a reasonable value and is clearly too high. The reason for this is the multiple-site issue. For example, we have one group traveling from Adelaide who was away for 28 nights and only spent 3 on Fraser Island. Attributing the total travel cost of such a trip contributes to the model producing patently absurd estimates. For this reason we look at the adjusted number below.

To account for multiple-site visitors, each zonal estimate of consumer surplus was adjusted according to the average zonal proportion of time spent on Fraser Island, relative to the time spent away from home on the trip, as given by equation (10).

$$\text{Proportion of consumer surplus allocated to Fraser Island} = \frac{NI_x}{TN_x} \quad (10)$$

where NI_x is the number of nights spent on Fraser Island by visitor x and TN_x is the total number of nights spent away from home by visitor x. If this proportion is greater than or equal to 1, or if TN_x is zero (signifying a day trip), then 100% of the consumer surplus is allocated to the Island. This yields an adjusted consumer surplus of $191,353,287, which converts to $1,461.73 per-person per-visit.

5.1 Estimates for Lake McKenzie

The above consumer surplus value is the estimate for Fraser Island. Once on Fraser Island visitors undertake different activities and visit various sites. In order to determine what proportion of consumer surplus may be attributed to Lake McKenzie, two methods, one using reported satisfaction and one using time, have been employed.

5.1.1 Satisfaction measure

In order to gauge the level of utility or satisfaction gained from visiting Lake McKenzie, respondents were asked a question regarding their enjoyment of their visit to the Lake, as a proportion of their total enjoyment of their visit to Fraser Island (see Box 2).

Box 2: The enjoyment question

> Question 12:
>
> Of the total enjoyment from your visit to Fraser Island, what proportion would you attribute to the time spent at Lake McKenzie (for example, 5%, 15% etc.)?.....%

In an earlier pilot, a more complete list of possible attractions of Fraser Island were listed, with respondents asked to attribute a proportion of enjoyment to each. However, this question was poorly answered and left blank by many respondents and was thus replaced with the question above.

To estimate a consumer surplus for Lake McKenzie, the average zonal reported satisfaction measure (which ranged from 0 to 35%, with an average of 15.6%) is multiplied by the estimated zonal consumer surplus, and then all adjusted surpluses are summed. This yields a consumer surplus for Lake McKenzie of $75,713,369, or an average of $578.37 per-person.

Using the consumer surplus estimates adjusted for multiple-site visitors yields a consumer surplus for Lake McKenzie of $31,789,212 or an average of $242.84 per-person.

5.1.2 Time measure

An alternative method for determining the appropriate portion of consumer surplus is to use time spent at Lake McKenzie, relative to total time spent on Fraser Island. The average time for each zone are used similar to the satisfaction measure. This approach yields a consumer surplus of $33,582,451 or an average of $256.53 per adult. Using the consumer surplus estimates adjusted for multiple-site visitors, yields a consumer surplus estimate for Lake McKenzie of $13,653,883 or $104.30 per-person.

6. DISCUSSION AND CONCLUSIONS

In this paper a commonly used non-market estimation technique called the travel cost method, has been applied to estimate a recreation use value for Fraser Island in terms of consumer surplus. This is not the total economic value of the Island as non-use values and, for example, scientific, medicinal, and ecological values have not been included. A proportion of this value was then allocated as a value estimate for Lake McKenzie.

One of the assumptions of the travel cost method is that there is only one site visited on the journey. This is not reasonable when people travel long distances to a unique site, so adjustments may be made. Instead of adjusting the cost of travel (which undermines the theory behind the travel cost methodology), in this paper the total travel costs for both single-site and multiple-site visitors were used and then the resultant zonal consumer surplus values were adjusted according to the average proportion of the total trip time spent on Fraser Island. The Fraser Island consumer surplus estimates are presented in Table 3. The unadjusted estimates are not considered reasonable.

To obtain recreation value estimates for Lake McKenzie the appropriate proportion was calculated using two methods – a measure of satisfaction as reported in the survey, and a measure of time spent at the lake as a proportion of total time on Fraser Island. These estimates may also be seen in Table 3. All the estimates indicate that visitors place a high value on Fraser Island and their visit(s) to Lake McKenzie. This is to be expected as the Island has unique and important natural values already protected by being inscribed on the World Heritage List. Management therefore has an obligation to preserve the area for future generations, as well as allow access to the present generation.

Table 3: Summary of consumer surplus estimates ($A per annum)

	Full Sample unadjusted	Adjusted for multiple-site visitors
Fraser Island		
Total	$417,494,101	$191,353,287
Per-person per-visit	$3,189.20	$1,461.73
Lake McKenzie		
Satisfaction measure		
Total	$75,713,369	$31,789,212
Per-person per-visit	$578.37	$242.84
Time measure		
Total	$33,582,451	$13,653,883
Per-person per-visit	$256.53	$104.30

The consumer surplus estimates for Lake McKenzie using the two methods of proportioning value have yielded values that differ greatly. Using the satisfaction measure obtains a consumer surplus more than twice the size of that obtained when the proportion of time is used. The result can be easily explained. Since vehicle-based visitors do not stay overnight at the Lake, they must drive from their accommodation, and so all trips are day trips. As roads on Fraser Island are either rough and narrow or tide dependent, the amount of time that people can hope to spend at Lake McKenzie is generally limited to a few hours, and this limitation forces the proportion of time spent at Lake McKenzie to be a small proportion of total time spent on Fraser Island, resulting in a smaller consumer surplus. It may be concluded that the higher consumer surplus of $242 per-person per-visit obtained from the respondents' valuation of their satisfaction may be the more accurate value. If there were no limitations for the time spent at the site, the two methods could be alternatives.

What these estimates give is a quantitative measure of visitor's values. Management then has a numeric value on which to base decisions relating to the environment of Lake McKenzie. Prevention of damage is more desirable than trying to fix a problem. These high values may encourage and support management environmental decisions. The management strategy choices that are available are beyond the scope of this paper.

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