

Economic Value of Freshwater Recreational Angling in Otago

A Travel Cost Method Approach

by

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Abstract

Otago is renowned internationally for offering some of the most pristine and exciting trout and salmon fishing in the world. However, many fishing sites in Otago are showing signs of environmental degradation due in part to continuing agricultural development, especially the increasing intensification of land use through dairy farming. Stricter requirements for controlling the flow of contaminants into waterways have been proposed and are under discussion. Implementation of stricter requirements will impact farming costs, but provide benefits for anglers and other recreational users. Estimating the economic values of the freshwater recreational angling is an important input to decisions about rules to maintain or improve water quality. Information about angler travel costs and fishing activities was collected via an on-line survey, and a travel cost method was applied to estimate the economic value of access to Otago freshwater recreational fisheries by anglers in Otago. The estimates of that value in terms of consumer surplus fall in the range of NZ\$63.7 million to NZ\$189 million per annum. In addition, anglers who fished at back-country fisheries enjoyed higher consumer surplus than anglers who fished at river or lake fisheries. These estimates are reasonably consistent with estimates using similar methods with data from other areas in New Zealand and around the world.

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1 Introduction

The freshwater fisheries of Otago provide a spectrum of recreational opportunities for anglers from within the region, elsewhere in New Zealand and overseas. They represent a significant natural, self-sustaining resource of benefit to the regional community both in providing recreational amenity and economic activity arising from recreational fishing. There are 126 discrete fisheries identified in the Otago Fish and Game Region, they are mostly the same fisheries that are used in the National Angler Survey (NAS), conducted by NIWA (National Institute of Water and Atmospheric Research) once every five to seven years. While the NAS provides a reliable and comparable long term reference point for angler use, the number of fisheries may in reality be larger (Otago Fish & Game Council, 2013).



However, the freshwater fisheries in Otago are in decline, there are increasing signs of potential risks for the region's aquatic ecosystems, the economy, tourism, recreation and its international reputation. Strong increasing trends in phosphorous and nitrogen have been observed over the last years particularly in catchments predominantly in pasture. The health of lowland streams, wetlands and several lakes is under pressure from declining water quality (Ministry for the Environment, 2013). According to the Otago Regional Council (ORC)'s State of the Environment (SOE) monitoring programme, the water quality in rivers across the Otago region shows a clear spatial relationship to land cover: Water quality is best in rivers and streams located at high or mountainous elevation under predominantly tussock cover. These sites are usually associated with the upper catchments of larger rivers (e.g. Clutha River/Matau-Au, Taieri River and Lindis River) and the outlets from large lakes (e.g. Hawea, Wakatipu and Wanaka). Water quality is poorer at sites located on smaller, low-elevation

stream reaches that drain pastoral or urban catchments, particularly those characterised by soft sedimentary substrates. The sites with the poorest water quality over the reporting period either drain intensively farmed catchments (e.g. Wairuna Stream, upper Waipahi) or catchments dominated by urban land cover (e.g. the Dunedin urban streams) (Ozanne, 2012). Strong relationships have been found between declining water quality of streams and increasing extent of agricultural development in catchments in rural New Zealand (Smith, 1993).



FGNZ recommends a number of steps that should be taken to improve the declining water quality, including the fencing off of waterways from intensive farmland, better on-farm nutrient management, and the sensible design of agricultural systems based on the carrying capacity of the land (Otago Fish & Game Council, 2013). Implementation of these measures will provide benefits for anglers and other recreational users, but increase farming costs. In order to consider the benefits of measures that will maintain and improve water quality within a cost-benefit framework, it is necessary to estimate the economic value of freshwater recreational angling of Otago. Therefore this paper is intended to estimate the aggregate value anglers place on access to the Otago freshwater recreational angling opportunities, and gain knowledge of the various factors that affect the demand for recreational freshwater angling in the region. This knowledge will be helpful in developing environmental standards, and making fishery management decisions regarding resource allocation in the region.

The study is organized into five sections. This section has provided background information on freshwater recreational fishing and the trend in freshwater quality in Otago. It has also defined the research objectives of the study. Section two presents the conceptual framework of the non-market valuation method applied in the study and reviews some literature on the travel cost method and recreational angling valuations that are undertaken around the world and in New Zealand. The methodology is developed in the third section, including the development and implementation of survey instrument. Section four presents the data analysis and discusses the empirical results derived from the application of the travel cost

method. Finally, the last section summarise the conclusions of the study, addresses the study's limitations, and provides future research recommendations.

2 Conceptual framework and literature review

This section presents the conceptual framework of the travel cost method, at the same time it reviews some empirical studies that value recreational angling around the world and in New Zealand.

2.1 Value of recreational angling

Recreational angling is essentially a consumer good, so every angler has a Marshallian demand curve for angling at a particular site (McConnell, 1992), a simple linear version of which is shown below (Figure 2.1):

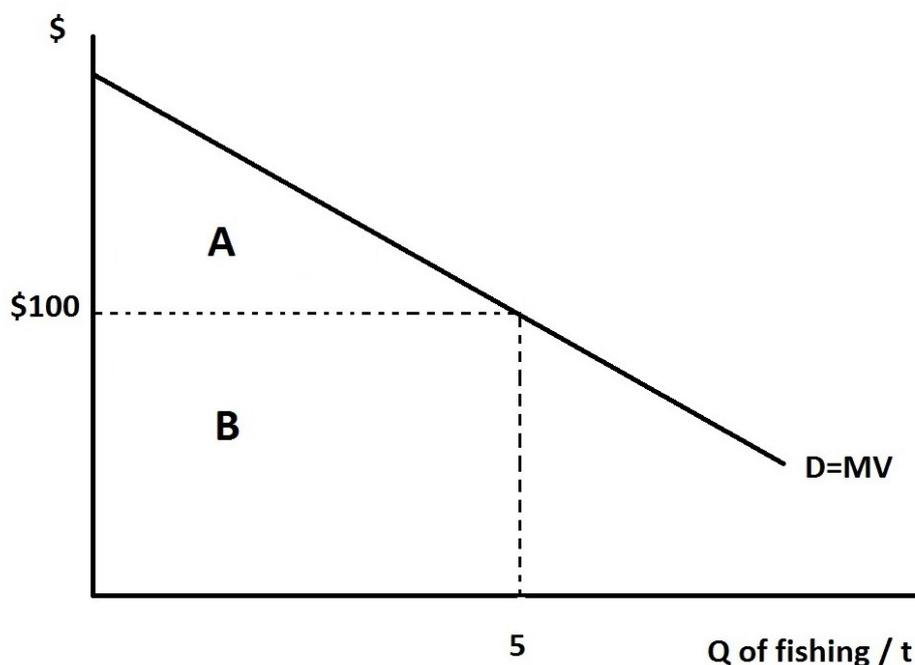


Figure 2.1: an angler's Marshallian demand curve for angling at a particular site

The demand curve shows how the value of an additional unit of fishing falls as the number of trips increases in a given time period. A net-benefit-maximising angler keeps taking trips as long as the value of the trip exceeds its 'price'. In the figure, the price of fishing is \$100, the angler fishes five times at the price in a season. The angler does more fishing as the price goes down. So, read horizontally, the demand curve shows how the quantity of fishing trips demanded per season varies with the price of fishing, holding other relevant variables, such as income and prices of other goods constant.

The area A is the angler's total consumer surplus for trips to the site during the season, it is the difference between the angler's total willingness to pay for fishing trips (area A + area B) and the total expenditure (area B). This is the value of the recreational angling at the site, it is also referred to as the angler's access value for the site. Economists define value as the monetary benefits that remain after the expenses are paid (Loomis et al., 2005). Recreational

angling has economic value in that anglers would be willing to pay more for their opportunities than their actual expenses on fishing (McConnell and Strand, 1994). Therefore, anglers' consumer surplus is used as a measure of economic value of recreational angling.

2.2 Valuation of recreational fisheries

There is a large and growing number of studies that estimate the economic value of angling or recreational fisheries around the world. Some studies take advantage of the fees paid by anglers to access the fishery. For example, in the United Kingdom, many inland fisheries of England and Wales are in private ownership and the fisheries themselves can be bought and sold in the market place. Sale prices can be used to estimate the aggregate market value of these fisheries. Research carried out in 2001 by the Environment Agency (Radford et al., 2001) produced an estimate of the market value of the inland private recreational fisheries of England and Wales to be about £3 billion.

So, what does this mean in an economics context? This can be illustrated in Figure 2.2. Suppose the downward sloping line in Figure 2.2 is the demand curve of UK anglers, and P_{choke} is the choke price at which the fishing trip demand is zero. If the fisheries in the UK are free to the public, anglers would need to pay only the travel cost ($P_0=TC$) to fish in the fisheries, and they fish T_0 quantity of trips. Under this circumstance, the fishery value is the whole area of $P_{choke} P_0 D_0$. But, in fact, the owners of the fisheries charge access fees to anglers, the access fee is P_0P_1 in Figure 2.2. Anglers react to the higher price by taking fewer trips: T_1 . As the demand shifts from D_0 to D_1 , it can be seen that the consumer surplus shrinks, and the lost consumer surplus is the area of $P_0D_0D_1P_1$. Part of the lost consumer surplus accrues to the owners of the fishery as revenue from the access fee. The estimated £3 billion market value of UK fisheries is the net present value of fishery revenue minus the costs of running the fishery as a business. Therefore, the £3 billion market value is only a part of the lost consumer surplus due to private ownership of the fisheries.

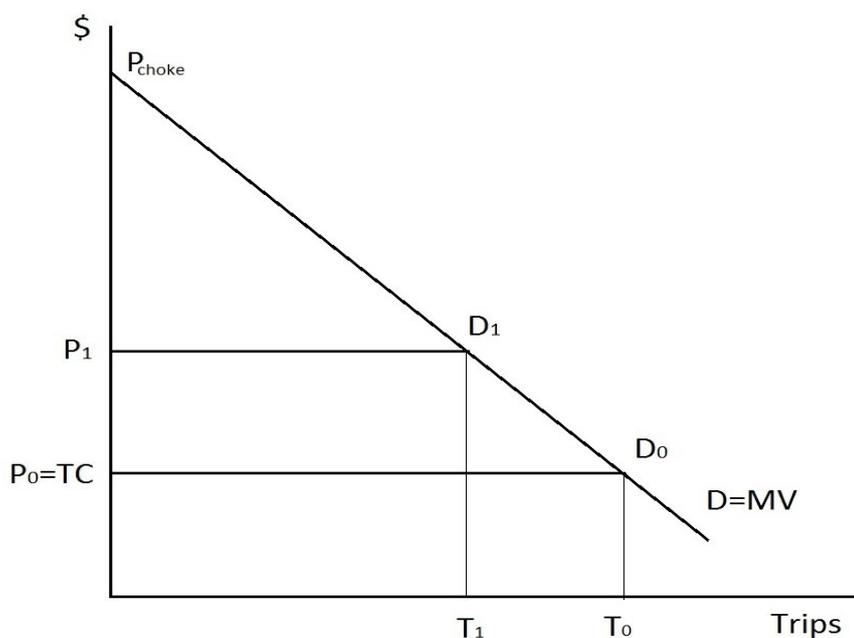


Figure 2.2: illustration of the UK fishery valuation

In many parts of the world, including New Zealand, recreational fisheries are managed by public entities, and are not traded in the open market. Under such circumstances, the fishing licence fees that are charged to the public who wish to access the fishery for fishing are nominal prices that do not reflect the economic value of the fisheries.

Fishery administrators sometimes view the importance of a recreational fishery in terms of its overall impact on local economic activity, i.e., how much fishing activities contribute to total sales, income received, employment generated, and tax revenue received by the local community. Such an approach has been taken in an economic impact analysis of New Zealand's Taupō fisheries, reported in "Taupō Fisheries economic analysis" (APR Consultants, 2012) for the fishery's manager: the Department of Conservation (DOC). The study analysed primary data from an online survey carried out by the DOC to estimate the total net value added, the total net output (i.e., expenditure), and the total net employment created or sustained in the Taupō District's economy. The report also included marketing recommendations for the DOC to increase revenue from the Taupō fisheries and more generally, contribute to the Taupō economy.

In essence, the Taupō study measured the anglers' expenditures: the money anglers have spent in order to engage in recreational angling in Lake Taupō, (in Figure 2.2, this is the rectangle area underneath the consumer surplus triangle) and applied a regional multiplier to expenditure in the region by out-of-region anglers. Such measures can indicate the magnitude of the effects of recreational angling activity, and its importance to the local community, but they do not indicate the value of the Taupō fisheries to anglers. For this study, the Otago freshwater recreational anglers' consumer surplus is estimated to represent the value of recreational angling. To obtain this estimate, non-market valuation methods need to be employed.

2.3 Conceptual description of TCM

The travel cost method (TCM) is one of the most frequently used non-market valuation techniques based on revealed preference, first developed by Harold Hotelling, a noted Harvard economist. He applied the method to calculate the value to tourists in monetary terms of visits to national parks in the United States in the late 1940s. Hotelling conceptualized that the costs incurred while travelling to a recreation site effectively represent the price of the visit to the site. The price of a visit increases as travel costs increase, and the number of trips taken to the site will theoretically decrease (Hotelling, 1947). Therefore the relationship between the number of trips and their corresponding prices, i.e., the demand function for visits to the park, can be estimated. Then, the value of the site (tourists' consumer surplus) is equal to the area under the demand curve and above the travel cost to visit the park. This connects the value of a non-market good (implicit value) to the consumption of market goods (explicit value) that are necessary to enjoy the non-market good. The TCM is now applied frequently to estimate the recreational value of angling, hunting, or hiking at a recreation site or sites. A site may be a river or lake for fishing, a trail for hiking, a park for wildlife viewing, or some other area where outdoor recreation takes place.

The TCM is conceptually simple and easy to implement. The costs of collecting sufficient data to apply the method make the technique especially attractive in the context of this study. The TCM is a well-established technique that has yielded relatively consistent and reliable results (Bennett 1995). A number of studies have used the TCM to generate estimates of recreational angling values including: Shrestha et al (2002), Prayaga et al. (Prayaga et al.,

2010), Rolfe and Dyack (2011), and Dorison (2012). Shrestha et al (2002) estimated the value of recreational fishing in the Brazilian Pantanal, the area is a 138,000 square kilometres tropical seasonal wetland located in the centre of South America, the consumer surplus per trip falls in the range of US\$541 and US\$870, resulting in a total annual economic value in the range of US\$35 to US\$56 million for the area. Prayaga et al. (2010) estimate the value of recreational fishing on the Capricorn coast in central Queensland, also known as the Great Barrier Reef, the study finds the total annual consumer surplus of recreational anglers in the section of the Great Barrier Reef to be AUD\$5.5 million. Rolfe and Dyack (2011) estimated recreational values associated with the Coorong in South Australia. The Coorong is the estuarine region at the mouth of the Murray River in South Australia that includes lakes at the river mouth and a series of lagoons stretching over 100 kilometres southeast along the coast. They estimated aggregate consumer surplus to be AUD\$30.5 million per annum. Dorison (2012) estimates the total economic value of trout angling in the state of Georgia with a TCM. Consumer surplus per trip per person estimates ranges from US\$60.02 to US\$164.57, while annual aggregate estimates of consumer surplus range from US\$72.7 to US\$199.5 million, depending upon the assumed opportunity costs of time.

In New Zealand, the TCM is also regularly applied to value recreational angling in cost benefit analysis. Kerr and Greer (2004) estimate the economic values of the Rangitata River for recreational angling, the result shows the consumer surplus to be between NZD\$2.5 and NZD\$6.2 million per year (adjusted to July 2013 levels using the consumers' price index). The authors find high value of the Rangitata River for recreational angling compared with that of other premier New Zealand fisheries. The results were used as evidence by FGNZ to apply for a water conservation order on the Rangitata River (Kerr and Greer, 2004). The study marked as a case in New Zealand where non-market value estimates (especially the result from a TCM analysis) have been recognized in a formal decision making process.

3 Methodology

This study applies a TCM to the Otago Fish and Game Region. An angling survey is designed to collect anglers' demographic, trip frequency, trip duration, and related cost data in the region. Due to limited data on individual fishing sites and time constraints, other relatively complicated method, such as Random Utility Model was not considered.

3.1 Research design

While the underlying concepts of the TCM are relatively simple, several important methodological issues need to be addressed when applying the method, which include:

- 1) *Geographical considerations;*
- 2) *Defining quantity of fishing;*
- 3) *Specification of travel costs;*
- 4) *Treatment of multiple purpose trips;*
- 5) *Demographics and other demand shifters; and*
- 6) *Statistical analysis issues.*

Each of these issues is discussed below.

Geographical considerations

The Otago Fish and Game Region is about 32,000 square kilometres in area, with 126 discrete fisheries identified in the Region. These fisheries offer opportunities to anglers in five broad categories: urban, rural, natural, backcountry and remote (Otago Fish & Game Council, 2013). More importantly, they are geographically wide spread throughout the region,

posing different travel costs to anglers living in or outside of the region. As described in the reviewed literature, a number of studies have used the TCM to value access to recreation sites spread over relatively large geographic areas such as the Brazilian Pantanal (Shrestha et al., 2002), the state of Georgia (Dorison, 2012), a section of the Great Barrier Reef (Prayaga et al., 2010), and the Coorong in South Australia (Rolfe and Dyack, 2011). In this study, the Otago region is divided into four geographical areas defined based on the suggestions of FGNZ staff. These areas, which are shown in Figure 3.1, are the Southern Lakes (A), Central Otago (B), South Otago (C), and Dunedin/Coastal Otago (D) areas. Each of the four areas represents a group of relatively homogenous opportunities. In addition, each area corresponds roughly to local territorial authorities and boundaries. Each angler's angling behaviour in the Otago region is best represented by his or her typical trip(s) in each area he or she fished in (Parsons, 2003). Each angler was asked in the survey to think of a "typical or average" trip to represent his or her angling efforts in each area and report the number of such trips in each area during the last angling season. The survey thereby provides four sets of data that allow estimation of the angling demand (such as the demand curve in Figure 2.1) for each of the four areas of Otago, respectively. The results readily allow calculation of average consumer surplus (such as area A in Figure 2.1) for an fishing trip in each area. This average can be aggregated to provide an estimate of total consumer surplus for each area. The sum of the consumer surplus of the four areas provides an estimate of the total value of freshwater angling in Otago as a whole, i.e., the total value of access to Otago freshwater recreational fisheries.

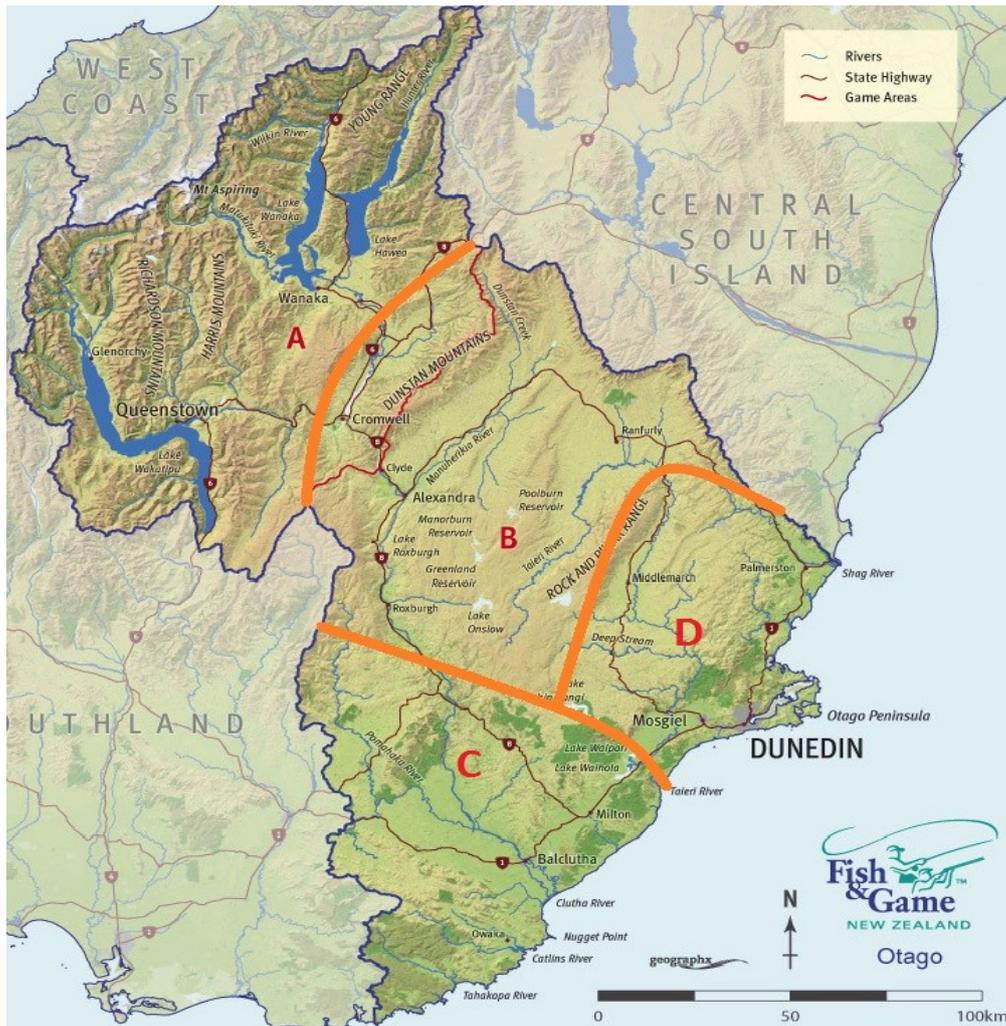


Figure 3.1: four areas of the FGNZ Otago region, A: Southern Lakes; B: Central Otago, C: South Otago, and D: Dunedin/Coastal Otago.

As for international anglers, the Otago region is regarded as one destination, because the transit cost among the four areas in Otago is minimal compared to their international travel cost to come to Otago.

Defining quantity of fishing

The dependent variable in the TCM model is the quantity of fishing over the relevant time period. The most frequently used measure of ‘quantity’ of fishing in the TCM literature is the number of trips per time period. When measured this way, all visits to the site by all anglers are reasonably assumed to be of the same duration. For instance, Kelch et al. (2006) choose to focus only on single-day trips, as their response rate from multiple-day trips respondents is low, so they consider multiple-day trips as insignificant, and use only single-day trip data for the analysis. This assumption makes the TCM model simple, and the data clean. However, according to Otago Fish and Game staff, there are a lot of holiday anglers taking multiple-day trips in the Southern Lakes area, representing a great value to the fisheries, and should not be ignored. Therefore, the Otago recreational angling model needed to be designed to accommodate multiple-day trips as well as single-day trips.

Kealy and Bishop (1986) develop a model in which individuals take travel costs into consideration to choose the number of trips from home and the number of days per trip

jointly. Recreationists take their recreation trips in multiple-day packages which best suit their needs. The implication is that when anglers make their decisions about trips, presumably well in advance, they think in terms of the *average cost* per angling day. If they travel a long way or pay a high cost to reach a fishing site, they tend to fish more days on the site in order to spread the high travel cost over more angling days.

Therefore, the dependent variable in this study is specified as the number of angling days per season, and the corresponding travel cost variable is defined as average travel cost per angling day. Kealy and Bishop (1986) argue that this specification usefully extends the applicability of the travel cost method to allow trips with various durations. They report that failing to do so results in overestimation of the value of Great Lakes fishing by 3.5 times.

Specification of travel costs

Each respondent was asked to respond to questions about his or her typical fishing trip. Answers to these questions were used to construct travel cost, i.e., the price of a trip. These were collected for a typical trip only because collecting them for each and every trip over the season would have lengthened the survey considerably and it would have been difficult for respondents to recall each and every trip. Moreover, there is no logical way to handle separate trip information within a season differently in a single site TCM model (Parsons, 2003). The typical travel costs for a day trip include: transit expenses, time costs and any other fishing-related expenses. As the Otago TCM model needs to accommodate overnight trips as well as day trips, thus accommodation costs are also considered as 'other' fishing related expenses.



Transit expenses include round trip expenses associated with the fishing trip from an angler's permanent residence to the fishing site. For domestic anglers, the most common mode of transportation is by personal vehicle. There are three methods for measuring such transit expenses (Bateman, 1993): The first method uses only estimated fuel costs as a function of distance travelled, while the second method considers estimated full car costs that include fuel, insurance and maintenance as a function of distance travelled. The third method uses the perceived costs as estimated by respondents. Since individuals base trip decisions in part on perceived cost, which may in fact diverge from actual cost, the respondent-reported estimate is compelling (Bennett, 1996, Bateman, 1993). The advantage of using perceived cost is that analysts do not need to construct the cost estimate function. However, objective estimates based on analyst computations as described in the above second method is the most commonly used method in the literature (Rolfe and Dyack, 2011, Kelch et al., 2006), as the data are cleaner in the sense that they are uniform across individuals. For the purposes of comparison, the survey was designed to facilitate both the second and third method of cost measurement. To calculate personal vehicle travel cost as a function of distance travelled, the New Zealand Automobile Association (NZAA)'s 2013 estimate of the average cost of operating a vehicle per kilometre was used. The NZAA estimate includes annual relicensing, insurance, warrant of fitness cost, capital cost, depreciation value, fuel cost, tire cost, repairs and maintenance, adjustments were made to match the age of the vehicle. The distance travelled was asked about directly in the survey, and cross checked by reported residence postal code and reported area of fishing. For international anglers and those who fly in from other parts of New Zealand, only perceived transit expenses reported by the respondents were obtained. Since transit expenses can be shared by several people even if they were not all fishing, respondents were asked to report the number of people sharing such costs with.

Time is a scarce resource, allocating it to a fishing trip incurs a cost in addition to the out of pocket expenses anglers have paid for the trip. Time spent *in transit* to and from the recreation site and the time spent *recreating on site* constitute time that could have been devoted to other endeavours. The value of those lost opportunities is the time cost of the trip, which often accounts for an important portion of the total trip cost and deserves careful attention. Most TCM studies include time cost in the analysis.

Time cost calculation in most fishery valuation applications is related to an angler's wage in some way. This relationship has a theoretical basis as long as the angler has a flexible working hour arrangement and can substitute work time and leisure time at the margin (Parsons, 2003). Under such assumptions, an angler increases the number of hours working until the wage at the margin is equal to the value of an hour in leisure. Multiplying the hourly wage by trip time, in this case, results in a fair estimate of time cost of the trip. However, the simple work / leisure trade-off does not apply to anglers working on a fixed forty hour per week salary job, as these anglers do not have the flexibility to shift the time in and out of work in exchange for leisure. The trade-off also does not apply to individuals who are not in the labour force, such as unemployed people, retired people, homemakers and students. Despite these difficulties, the most commonly applied approach to value trip time in practical applications is still wage-based. For people with fixed work schedules most studies impute an hourly wage using annual income, it is common to see some fraction of the imputed wage used to value trip time, anywhere from one third of the wage to the full wage. This study follows Kerr and Greer (2004), the transit time was valued at 35% of the average hourly wage at the time of the study for those who were employed. For those who were not

employed or retired during the study period, their opportunity cost of time was assumed to be zero, as these respondents were not able to exchange time spent on recreation for any income. Time spent on site fishing has dual effects, i.e., spending more time fishing on site should enhance the value of the fishing experience, but this time also has an opportunity cost as any other time. Overall, on site time is assumed to generate a positive utility and therefore is considered to have zero cost. Similar treatment of on-site time can be found in other travel cost studies: Whitten and Bennett (2002), Kerr and Greer (2004) and Rolfe and Prayaga (2007).

Therefore, the travel cost explanatory variable is the sum of transit expense, time cost, and other fishing-related expenses, then divided by the number of angling days (all on per trip basis).

Treatment of multiple purpose trips

A basic assumption of the TCM in a fishery valuation is that each angler takes the trip solely to fish in the subject fishery. Smith and Kopp (1980) note that the TCM assumes that the recreational trip is intended for the use of the recreation site only and not to serve multiple objectives. Haspel and Johnson (1982) state that the TCM assumes, among other things, that all travel costs are incurred exclusively to obtain access to the single specific recreation site. Kerr and Greer (2004), in their Rangitata River study did not collect information on trip activities other than fishing, assuming that all fishing trips to the Rangitata River are made for the sole purpose of fishing. The assumption appears reasonable given the experience of fishery scientists familiar with the Rangitata River anglers. The authors also state that if multi-purpose trips were significant, the results developed would overestimate angling benefits.

In the Otago angling demand model, assuming all fishing trips are intended only for fishing is not realistic, especially in the Southern Lakes area, where out of area anglers usually take extended holiday trips, and fishing may not be the primary purpose of the trip. These multiple purpose trips complicate the TCM model, i.e., trip expenses and time cost do not relate to fishing experiences alone. Instead, anglers' costs relate to a package of experience. Attempts to apportion trip costs across the different purposes are difficult. There is no logical way to identify the marginal cost of the recreation portion of the trip unless some restrictions are placed on the model (Parsons and Wilson, 1997). Parsons and Wilson (1997) present a theory for analysing incidental consumption in a single site recreation demand model. They argue that incidental consumption on a recreation trip, such as a visit to see friends or a visit to a second recreation site, can be treated as a complementary good and analysed using conventional theory. They also show that the analysis applies whether the side trips are incidental or joint¹. In a simple application, they find that failing to account for incidental consumption appears to create little bias in valuing the recreation site.

Following Rolfe and Prayaga (2007), a question was included in the survey to determine the relative importance of fishing in the whole trip: "Relative to all the other things you did in

¹ Incidental consumption trips are the side trips taken with the main purpose trip, but if the main purpose trip is not made, the side trips are necessarily foregone, but the availability of side trip does not affect the main fishing trip. On the other hand, in a joint consumption situation, the whole trip is taken for dual purposes of both the main purpose trip and the side trip, in which, if neither of the purpose is lost, the trip is not taken at all PARSONS, G. R. & WILSON, A. J. 1997. Incidental and Joint Consumption in Recreation Demand. *Agricultural and Resource Economics Review*, 26, 1-6..

Otago on this trip, fishing was:”, then a scale from 0 to 100% is given with 0 meaning “fishing is only an incidental part of the trip”, 50% meaning “fishing is equally important as other activities”, and 100% meaning “fishing is essentially the sole purpose of the trip”. Respondents’ selections were recorded as a weight value (in percentage terms) of how important fishing is in the typical trip to the area. The portion of travel cost attributed to fishing can then be estimated by multiplying the whole trip travel cost by this weight value.

Demographics and other demand shifters

Demographic variables are necessary in a demand model to control for underlying differences across individuals. These variables are factors other than travel cost believed to influence the quantity of fishing over a season. Some common determinants of demand include income, age, education, race, gender, number of children (Loomis and Walsh, 1997). Although the complete list of possible shifters is long, most analysts are parsimonious in their selection. Studies typically include one to five variables as demand shifters (Parsons, 2003). In order to ensure a full specification for the Otago angling model, various possible demand shifters were considered. Such as gender, age, fishing licence type, level of fishing expertise, angling club membership, boat ownership, household composition, personal income, household income, whether or not choosing primary residence location in consideration of proximity to fishing, education, price of substitutes and employment status.



Most of these variables are commonly seen in previous TCM studies except for the choice of primary residence location in consideration of proximity to fishing. The price of a trip to a fishing site in a TCM model is determined by the distance between an angler’s primary residence to the fishing site. That price is assumed to be exogenous to anglers and is treated

the same as the price in a typical demand analysis. However, if an angler considers proximity to his or her typical fishing site and chooses to live closer to the site, the angler is, in effect, choosing the price he or she will pay for fishing at the site. Obviously, anglers who favour fishing are more inclined to live closer to their favourite fishing sites than anglers that do not, therefore, if they do choose to live closer to fishing, they may fish more in a season than those who did not do so. Whether or not an angler chooses primary residence location in consideration of proximity to fishing can serve as an indicator of how keen the angler is on fishing.

The presence of substitute sites or activities can affect angling demand via their travel cost and their relative quality to angling. Such variables are difficult to include due to data collection difficulty. While inclusion of the substitute has been generally accepted as important, it remains unresolved whether to select an alternative site or an alternative activity as a substitution variable (Bowker et al., 1996). Dorison (2012) uses a categorical variable as the substitution variable. A similar approach is adopted in this study: Respondents were asked: "If the place that you typically fish was for some reason unavailable for fishing, what would you do instead?" three choices were provided: "1. Go somewhere to recreate; 2. Stay home or go to work; 3. Still go to the place, but not fish." For respondents who ticked choice 1, the distance to the alternative places were requested subsequently to construct the prices of the substitute; For respondents who ticked choice 2, their costs of substitute are assumed to be zero; For respondents who ticked choice 3, substitute price is the transit expense to the fishing site, excluding any fishing related costs.

Statistical analysis issues

The dependent variable of the TCM model is by nature a count variable, each angling day in the dataset is at least one, i.e., an angling day count would not appear in the dataset if an angler had not fished in Otago in the season. Thus, the dependent variable is a zero-truncated positive integer. A truncated negative binomial (TNB) count regression model is appropriate when an over-dispersed count variable is modelled: that is, a count variable with a variance that is greater than its mean. As it can be seen from the summary below, the variances of angling days in all four areas and for international anglers are significantly larger than their respective means.

<i>angling days in</i>	<i>standard deviation</i>	<i>variance</i>	<i>mean</i>
Southern Lakes	25.45	648.03	16.19
Central Otago	23.92	572.16	13.98
South Otago	88.76	7879.31	21.86
Dunedin and Coastal Otago	12.34	152.47	11.70
International	16.91	286.09	14.74

Other TCM studies, such as Prayaga et al (2010) and Kerr and Greer (2004), also apply the TNB regression in their analysis. Kerr and Greer (2004) note: "The numbers of trips taken by individual anglers are positive integers, while Tobit and other continuous dependent variable models can account for truncation inherent in the data, they are unable to address the integer choices made by recreationists."

The following regression specification serves as a base model for the estimation of the demand function. The base model includes all the explanatory variables collected through the survey. The dependent variable is the natural logarithm of angling days in count data regression models, so each of the coefficients is interpreted as the percent changes in angling days from one unit change in the explanatory variables.

$$\ln(\text{angling-days}) = \beta_1(\text{average travel cost}) + \beta_2(\text{hhinc}) + \beta_3(\text{endoglocation}) + \beta_4(\text{subprice}) + \beta_5(\text{gender}) + \beta_6(\text{expertise}) + \beta_7(\text{dboat}) + \beta_8(\text{dbach}) + \beta_9(\text{age}) + \beta_{10}(\text{hhsz}) + \beta_{11}(\text{education}) + \beta_{12}(\text{dllicence}) + \beta_{13}(\text{dclub}) + \beta_{14}(\text{dfishoccur}) + e$$

A count data model assumes a semi-log functional form which has the simple and attractive property of allowing the estimation of average consumer surplus per angling day as the negative inverse of the travel cost coefficient (Haab and McConnell, 2002, Prayaga et al., 2010, Dorison, 2012). Individual angler's average per angling day consumer surplus estimate can be obtained using the following equation:

$$CS = -1/\beta_{TC}$$

where β_{TC} is the coefficient on the travel cost variable in the TNB regression. Consumer surplus per trip is then calculated by multiplying the consumer surplus per angling day by the average angling days per trip. Following Zawacki et al. (2000), aggregate consumer surplus estimates are calculated by multiplying the individual consumer surplus per trip by the average number of trips taken and then by the number of anglers who fished in each area in the 2012-13 season.

3.2 Survey design

A strategy needs to be developed to sample the anglers who fished in the Otago region. There are essentially two approaches: on-site and off-site sampling. On-site sampling has the advantage of hitting the target population directly. But it can be difficult to conduct in such a way that a random sample of anglers is obtained, as on-site sampling tends to over-sample more frequent anglers. This is noted in Kelch et al.'s (2006) study, where they point out that the results of their survey were likely biased toward the more frequent and successful anglers, because surveyors typically went out on days when they were more likely to encounter more anglers, which were likely to be better fishing days. The probability of surveyors intercepting anglers who made a large number of trips is higher than that of intercepting anglers who made relatively fewer angling trips. Additionally, In the case of Otago, there are 126 discrete fisheries, it is not possible to cover them all with on-site sampling within the study timeframe of one year.

Given these considerations, off-site sampling was applied. There are two popular off-site survey methods, the conventional mail survey and the modern online survey. Compared to mail surveys, the online survey has obvious advantages, such as elimination of paper, mail out, postage, and data entry costs. It also provides the convenience of overcoming international boundaries as significant barriers to conducting surveys (such as in the present case, where international anglers were also surveyed). In addition, the time required for survey implementation can be reduced from weeks to days, or even hours. Most importantly, online survey methodology offers the potential for dramatically reducing the close correspondence between sample size and survey costs. Once the online data collection system has been developed, the cost of surveying each additional respondent is minimal. These advantages may result in decisions to survey the entire population rather than only a sample

(Dillman, 2011). Based on the above considerations, the survey in this study was online based.

Survey population

A TCM study of recreational angling in the Otago region would ideally involve the collection of data from all anglers over a complete angling season. According to the latest National Angling Survey (Unwin, 2009), angling efforts spent by Otago license holders (licenses issued in Otago) represented 78% of total angling efforts in Otago. The other four major efforts are from the license regions of Southland (8.3%), overseas (4.2%), Central South Island (3.9%), and North Canterbury (2.7%). Angling efforts from these five major license regions represented 97.3% of total angling efforts in Otago in the 2007/2008 season. The final sample was drawn from the licence holders of the Otago, Southland and Central South Island Fish and Game regions who had fished in Otago fresh water during the 2012/13 season, as anglers from these three regions represent most of the Otago fresh water angling activity (Unwin, 2009).

With 41,607 licence holders from these three FGNZ regions, a random sample needed to be selected for the survey implementation. In order to collect sufficient responses for regression purpose, and being mindful about a low response rate, all 19,102 anglers with email addresses on file from the 2012/2013 FGNZ license database were sent the survey invitation email. Users of the e-mail and internet may not be truly representative of the general population. This lack of representativeness has been widely discussed (Fricker and Schonlau, 2002, Grossnickle and Raskin, 2001, Miller, 2001, Ray and Tabor, 2003, Wilson and Laskey, 2003). However, in many nations, this is changing. Fricker and Schonlau (2002) note that the differential between offline and online populations is quickly closing and may be insignificant in the near future. Scholl et al. (2002) state that when most of a society has internet access and savvy, the basic drawback for the use of online survey research – the lack of representativeness –disappears. The internet will then be an even more valued tool to obtain information from respondents living in different parts of a country or around the world, simply and at a low cost. Internet access still varies widely by country. In 2012, four out of five New Zealand homes had access to the Internet (Bascand, 2013), and the internet penetration rate in New Zealand is 84.5% of population, ranked the 12th in the world².

Survey implementation

The survey was designed and implemented through Qualtrics survey software, and was implemented in February of 2014. 1,553 useable responses were received (a response rate of 8.1%). The low response rate was due to the inclusion of Southland and Central South Island Region anglers, because the chance of them fishing across the border in Otago is much lower than Otago anglers fishing in Otago.

4 Data analysis and results

4.1 Data preparation

The TCM requires estimation of the relationship between the travel costs per angling day and the angling days taken per season. Raw data were prepared for the analysis, the preparation

² Internet Penetration Rate Statistics were updated for December 31, 2011, Internet World Stats

involved removing unrealistic and contradictory survey responses, and construction of the various measures of the travel costs.

In Figure 4.1, the angling days are plotted against the average travel costs per angling day for domestic anglers in Southern Lakes area (the area with the most respondents). The figure displays the expected inverse relationship between the number of angling days and travel costs per angling day, also indicates that the relationship between the two is not likely to be linear. Characteristics of over dispersion can be found in the data set with multiple angling day counts for many levels of travel cost, indicating considerable heterogeneity in angler behaviour. At the lower end of the vertical axis (especially when angling day count is one to ten), the associated travel costs vary significantly, which shows that the number of angling days cannot be explained fully by travel costs.

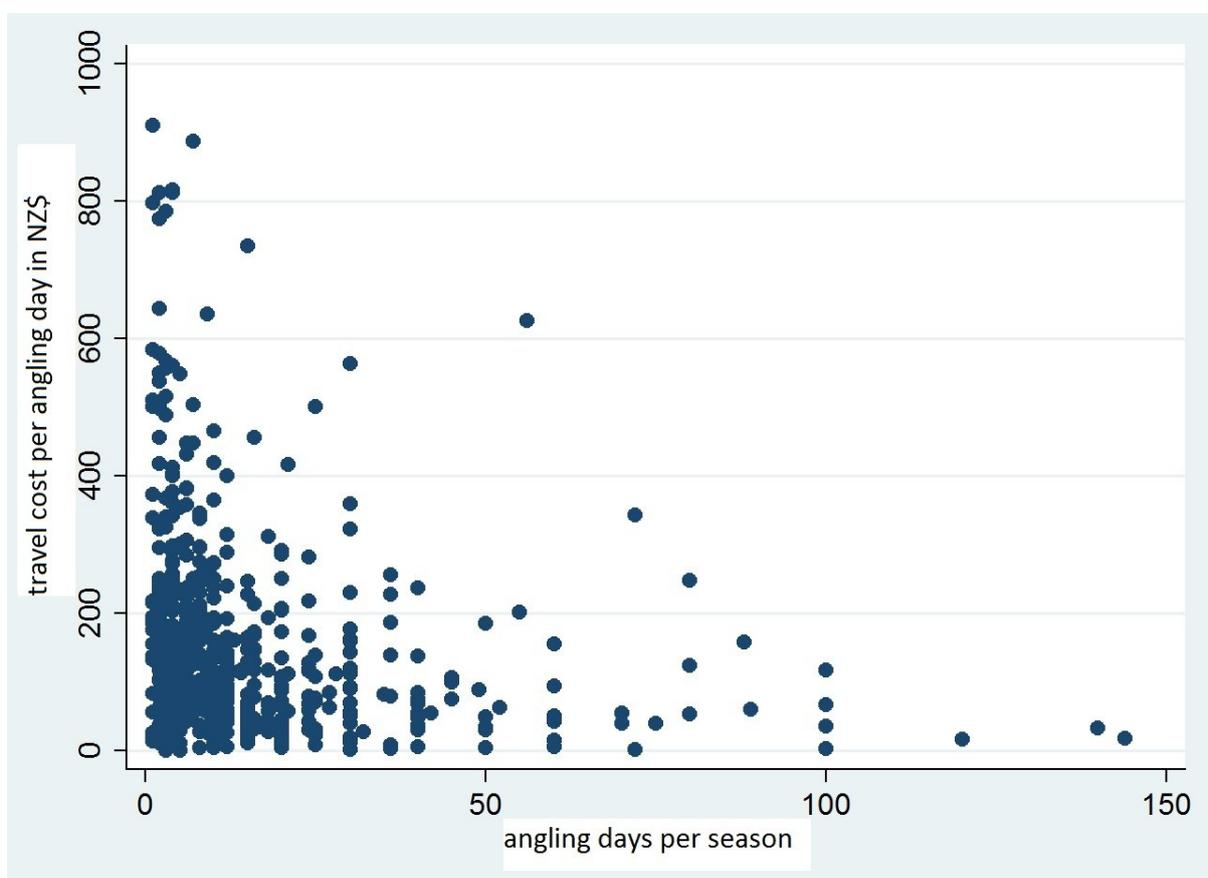


Figure 4.1: relationship between angling days and average travel cost per angling day

4.2 Regression analysis

The base model regression was performed in each of the four areas for domestic respondents, and performed separately for all international respondents treating the whole Otago region as one area. All regressions were performed with a variety of specifications of the travel cost variable. These specifications include perceived and calculated transit cost, each weighted and un-weighted with the importance of fishing in the trip, and then each matched with opportunity cost of time and without opportunity cost of time. To maintain consistency in comparing results across different specification of models, all explanatory variables were retained across the models regardless of the significance of their estimated coefficients.

The AIC and BIC are two popular measures for comparing maximum likelihood models. AIC and BIC are defined as:

$$AIC = -2*\ln(\text{likelihood}) + 2*k$$

$$BIC = -2*\ln(\text{likelihood}) + \ln(N)*k^3$$

AIC and BIC can be viewed as measures that combine fit and complexity. The fit is measured negatively by $-2*\ln(\text{likelihood})$; the larger the value, the worse the fit. The model with calculated travel costs and 35% opportunity cost of transit time consistently yields lower AIC scores (indicating better fit) than other models, therefore, this type of travel cost specification is selected for further analysis. Also the difference between the estimates of consumer surplus with weighted and un-weighted (by the importance of fishing in the trip) travel cost variable models is not significant. This is consistent with Parsons and Wilson's (1997) finding: Failing to account for incidental consumption appears to create little bias in valuing access to a recreation site.

Regression estimates for domestic respondents in each of the four Otago areas and international respondents in Otago are presented in Table 4.1.

³ Where k = number of parameters estimated, N = number of observations

Table 4.1: Regression estimates of the four areas and international respondents

	Southern Lakes	Central Otago	South Otago	Dunedin / Coastal Otago	International
travel cost per angling day	-.0026905* (8.16)	-.0048949* (8.72)	-.0040271* (3.98)	-.0042636* (3.16)	-.0011742* (11.56)
expertise	.0120765* (4.65)	.0116721* (3.51)	.0210834* (2.95)	.0058287 (1.74)	.0096461* (2.84)
endogenous home location	.4586764* (2.71)	.1459741 (0.49)	1.305442 (1.99)	.3216052 (1.62)	
bach ownership	.0371956 (0.30)	.6467259* (3.77)	1.04791* (2.64)	-.1718247 (0.59)	
boat ownership	.1681354 (1.65)	.1656365 (1.22)	.0080929 (0.02)	.2786933 (1.72)	
age	.0020207 (0.45)	.0096291 (1.74)	-.0266611* (2.10)	-.0089859 (1.75)	.0141473* (2.43)
male	.5600224* (3.15)	-.6332223* (2.61)	-.2102 (0.37)	.492663 (1.91)	-.3739322 (1.08)
household size	-.1875169* (4.26)	.0890572 (1.60)	-.1699459 (1.21)	-.0384678 (0.69)	.0012338 (0.03)
employment	.3383142* (2.22)	.1257327 (0.63)	-.428857 (0.92)	.0473125 (0.24)	-.2061776 (1.33)
household income	1.49e-06 (1.09)	-.0001008 (0.05)	-.0163775* (4.02)	-.0004703 (0.23)	2.01e-06 (1.21)
CS per angling day	\$371	\$204	\$248	\$235	\$851
CS per trip	\$890	\$408	\$496	\$287	\$8,510
N	508	360	205	216	152
N= Number of observations; Z-scores in parentheses; and * denotes significance at 5% level.					

In general, the signs and significance of the estimated coefficients in the base models are as expected from economic theory and other recreation demand studies. The coefficient on travel cost per angling day is negative and highly significant at the 5% level or better throughout. This is the main finding of the Otago angling demand model, which means the demand curve slopes downward; as the travel cost per angling day increases, anglers take fewer angling days in Otago, holding other variables constant.

The coefficient on fishing expertise is positive in all models, as expected – anglers with higher expertise tend to fish more angling days. This shows that the self-rated expertise in fishing is an indicator of preference for fishing, i.e., that it indicates that someone who is better at doing something is likely to do it more often.

The coefficient on the endogenous home location variable is positive in all four areas, and significant at the 5% level in the Southern Lakes and the South Otago areas. This shows that those anglers who choose to live closer to fishing tend to fish more angling days than those who did not consider fishing in their choice of where to live, holding other variables constant.

The coefficient on the boat usage variable is positive in all four areas, but not significant. Boat owners tend to fish more days than those who do not own a boat.

The household size variable has negative coefficients in three of the four areas, but is significant only in the Southern Lakes area. It indicates that the bigger the family an angler has, the fewer days he or she fishes, holding all else constant. This is probably because the bigger family an angler has, the less time he or she has for recreation, such as fishing (Taylor and Gratton, 2002).

The coefficient on club membership is not significant. Club membership might proxy for preference, however, local experience from Fish and Game staff shows that the main reason for joining an angling club in Otago is to gain access to back country huts.

The substitute price variable did not perform well in any of the models, the coefficients are insignificant and show unexpected negative signs. This is inconsistent with economic theory. The problem mostly likely is that a variable for the price of substitutes is difficult to construct. First, the specification does not distinguish the effects of a substitute fishing site from a substitute activity, these two types of substitution were mixed in one survey question. Second, only the travel cost of going to the substitute site or of facilitating these substitute activities were collected, but in fact, a substitute activity other than fishing may cost a lot more than its travel cost. Therefore the price of a substitute may have been underestimated. Either or both of these potential problems could have caused the substitute price variable to perform poorly in the regressions.

The coefficients of age, gender, holiday home ownership and household income all show mixed signs and significance across the models, which shows the effects on fishing of demographics varies. However, such results are often encountered in travel cost recreational fishing demand studies (Grogger and Carson, 1991, Du Preez and Hosking, 2010, Loomis, 2003).

4.3 Other modelling issues

Correlations among explanatory variables

In order to avoid multi-collinearity in the Otago TCM model, a correlation test was performed among all independent variables in the initial model specification. Two pairs of variables are found strongly correlated, they are household size / number of kids under 18 years of age and retirement / employment status. Therefore, only one variable in each of these two pairs is included in the same regression.

Functional form

Continuous explanatory variables may affect the number of angling days in a non-linear fashion. As a rough test, squared terms in all of continuous explanatory variables were added to the regression, none of them entered significantly.

Missing variables and interactions

There are likely some factors that affect freshwater recreational angling demand in Otago not being included in this study. Treating such a problem is often difficult ex post as any missing variables remain missing after completion of the survey. However, the study does include a variable that is not typically found in previous TCM studies, such as the dummy variable of whether or not an angler chooses primary residence location in consideration of proximity to fishing.

The survey also included questions on the type of fishery typically fished: backcountry streams, small lakes, or larger lakes. It seems plausible that consumer surplus may vary, on average, with the type of fishing done; e.g., backcountry anglers might enjoy higher consumer surplus than other anglers. To test this, dummies for backcountry and river fishing were added to the regression, and then these dummies interacted with the travel cost variable were added to test for differences in the average consumer surplus across anglers who target these different types of fisheries. The dummies for backcountry and river fishing were not significant on their own, but their interactions with the travel cost variable were significant in the Southern Lakes area data. The significant coefficients on the interaction variables indicate that demand varies across anglers that target different types of fisheries. Holding other variables constant, back-county anglers enjoy the highest consumer surplus, followed by river anglers and lake anglers sequentially. The statistical finding of backcountry anglers enjoying the highest consumer surplus is consistent with the personal communication with Fish and Game staff. Such interaction variables were not significant in the other three areas, which is consistent with the fact that only the Southern Lakes area offers such diverse fisheries in Otago.

4.4 Estimates of consumer surplus estimates

Table 4.2 shows the average consumer surplus per trip in each of the four areas of Otago for domestic anglers and in Otago overall for international anglers. The estimates are the negative inverses of the coefficient on travel cost per angling day multiplied by the average number of angling days per trip. It also lists the lower and upper 95% confidence interval range estimates.

Table 4.2: Average consumer surplus per trip

	Estimated average consumer surplus per trip	statistical range (95% confidence interval)
Southern Lakes	\$890	\$719-\$1,173
Central Otago	\$408	\$333-\$527
South Otago	\$496	\$332-\$977
Dunedin / Coastal Otago	\$287	\$176-\$751
International	\$8,510	\$7,280-\$10,250

Estimating the total or aggregate consumer surplus requires extrapolating the average consumer surplus across all anglers. Total surplus equals average consumer surplus per trip times the average number of trips per season times the total numbers of anglers. To be conservative, the number of Otago licence holders was used as the total number, i.e., population, of anglers. Of these 18,252 licence holders, 15,835 (86.8%) are domestic. The sample proportion of anglers who reported fishing in each of the four areas was used as an estimate of the proportion of the angler population who fished in each area.

The first four rows in Table 4.3 report the estimate of aggregate consumer surplus in each area, as well as the range in estimates due to statistical uncertainty. The point estimate of the annual value of access by domestic anglers to Otago freshwater fisheries is shown in the fifth row: just over \$100 million per annum, with a statistical range of \$80 to \$150 million.

Table 4.3: Aggregate consumer surplus of the four areas and all of Otago

	Estimated aggregate consumer surplus (millions of NZ\$/year)	lower range	upper range
Southern Lakes	\$69.6 mil	\$56.2	\$91.7
Central Otago	\$16.3 mil	\$13.3	\$21.0
South Otago	\$10.1 mil	\$6.7	\$19.8
Dunedin/ Coastal Otago	\$6.6 mil	\$4.0	\$17.1
Total domestic	\$102.6 mil	\$80.2	\$149.6
International	\$32.9 mil	\$28.2	\$39.6
Total Otago	\$135.5 mil	\$108.4	\$189.2
Sum excluding 24 hr licences	\$80.5 mil	\$63.7	\$115.2

Due the relatively small sample of international anglers, the sixth row of Table 4.4 reports only the Otago-wide estimate of consumer surplus, about \$33 million per annum.

The last row in Table 4.3 shows the effect on the estimates of excluding those anglers fishing on a 24-hour licence. About 30% of domestic and 70% of international licences are 24-hour licences. The concern is that many of these licences represent relatively opportunistic fishing; people have come to the area mainly for other reasons and decided once there to enjoy at least part of a day of fishing. Most of these people enjoy the day and gain consumer surplus, but it clearly is just the one day. Excluding them provides an even more conservative estimate of aggregate consumer surplus (though removing them from the statistical analysis has virtually no effect on the estimated average consumer surplus).

Of interest is how these estimates compare to those from the several previous studies of the monetary value of recreational angling in New Zealand waters. These include two studies undertaken on the Rakaia River (Leathers et al., 1985, Gluck, 1974), which is a large braided river supporting salmon and trout fisheries in Canterbury; and a study on the renowned Greenstone and Caples Rivers (Kerr, 1996). Table 4.4 reports the results of these studies along with the previously reviewed Kerr and Greer (2004) study.

These studies, which employ various non-market valuation methods, produced estimates of consumer surplus per angler per trip to be generally lower than in this study, this is in part due to the inclusion of multiple-day trips in this study: trip length of the four Otago areas ranges from 1.2 days in Dunedin / Coastal Otago area to 2.4 days in the Southern lakes area, and is much longer for international anglers at 10 days. However, the overall angling value is comparable to this study, as the Otago region is home to a relatively large number of fisheries.

Table 4.4: New Zealand freshwater angling values from previous studies (Kerr and Greer, 2004)

River	Author(s)	Year of study	Type of study	CS per angler per trip	Annual CS from recreational angling
Rakaia	Gluck (1974)	1973/74	Contingent Valuation	n/a	\$1.7 million
Rakaia	Leathers et al. (1985)	1983	Zonal TCM	\$20 - \$38	\$1.1 - \$2.2 million
Greenstone and Caples	Kerr (1996)	1985/86	Contingent Valuation	\$96	\$48,060
Rangitata	Kerr and Greer (2004)	2000	Individual TCM	\$56 - 143	\$2.5 - \$6.2 million

Note: All money values are in NZD, and have been adjusted to 2013 levels using the consumers' price index

5. Conclusions and discussion

5.1 Key findings

In the best fit models, estimates of consumer surplus per trip per angler ranged from \$176 to \$751 in the Dunedin / Coastal Otago area, and from \$719 to \$1173 in the Southern Lakes area, while international anglers enjoyed consumer surplus from \$7,280 to \$10,250 per trip. The corresponding annual value of Otago freshwater recreational angling is estimated to fall in the range of NZ\$63.7 million to NZ \$189 million.

The study has only measured the use benefits of anglers and not of any other users of Otago freshwater streams and lakes, such as kayakers, rafters, bird watchers, etc. If the cost of maintaining the freshwater recreational fisheries of Otago (e.g., the cost of avoiding pollution of waterways) is equal to or less than the estimated consumer surplus enjoyed by anglers, then such cost is economically justified. However, to conduct a full cost-benefit analysis, the additional benefits enjoyed by other types of users as well as the non-use or 'existence' benefits would also have to be considered. Non-use values are benefits that can be derived from simply knowing that a resource exists in some state other than another, components of such value include existence and bequest values (Freeman, 2003). Non-use values can be significant. For instance, the reductions in non-use values due to the Exxon Valdez oil spill in Alaska were estimated to be in the billions of dollars (Carson et al., 2003).

5.2 Limitations of the study

The survey was implemented with a relatively low response rate, which may be simply because those anglers who are not as keen on fishing did not respond to the survey. If this was the primary reason for the low response rate, then a potential non-response bias could exist. In other words, the sample may have represented a group with higher than average

demand for freshwater recreational angling. Treating this form of bias is difficult, but its potential existence is acknowledged.

An important issue in the study is the way a “trip” was defined in the survey. For anglers who took day-trips from their permanent residences, there was no misunderstanding, the number of trips they took is the number of trips intended for the analysis. However, for anglers who took multiple-day fishing trips may have interpreted the number of “trips” differently than the way the survey intended them to, even though it was specified clearly in the survey what kind of trip number was sought. These anglers may have reported the number of trips from their temporary premises such as a motel, bach, or camp ground in the fishing area, instead of from their permanent residences. If so, their trip numbers could be inflated. This could be the reason that some respondents reported abnormally low travel cost to their fishing area given their location of permanent residence. Should this effect be significant, it would bias the estimates.

5.3 Contribution of the study

This study provided potentially useful estimates of the value of Otago freshwater recreational angling in terms of consumer surplus enjoyed by anglers. The results of the travel cost analysis provided strong evidence that the value of Otago fisheries is high, especially in the Southern Lakes area, the home to the most pristine and important backcountry fisheries in Otago.

The study has also contributed to the application of TCM in recreational angling valuation, particularly in accommodating single-day trips and multiple-day trips in the same model. The practice of dividing a geographically widespread region into separate areas for the application of individual TCM model in a multiple-fishery situation is new and innovative.

5.4 Suggestions for future research

This study has provided an estimate of the net economic value of freshwater recreational angling in Otago for the 2012/13 season. This value is what would be lost to anglers if all the Otago freshwater fisheries were closed for fishing, - an “all or nothing” value of the fishery. However, closing down all the freshwater fisheries in Otago for fishing is extremely unlikely to happen. Future studies could benefit from estimating the potential decline in angling benefits due to a certain degrees of deterioration of water quality, which can be helpful in informing water quality conservation decisions.

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