Estimation of the Recreational Use Value Gained from Recreational Fishing of Southern Bluefin Tuna at Portland, Australia

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ABSTRACT *Southern bluefin tuna (Thunnus Maccoyii) is a global resource which is critically endangered. The Committee for the Conservation of Southern Bluefin Tuna (CCSBT) sets commercial quota levels for member nations, including Australia, each year. However, southern bluefin tuna is also a popular "trophy" fish with recreational anglers and the size of the total recreational catch in Australia is unknown but thought to be significant.*

This study focuses on the recreational southern bluefin tuna catch at Portland, in southwest Victoria and is based on data collected during the 2010 fishing season. The results indicate that the size of the recreational catch at Portland is significant in terms of the management of the fishery. A travel cost study was undertaken to estimate the recreational value of the fishery. The on-site recreational use value (consumer surplus) per person per visit is estimated to be between $33 and $132 and the on-site annual recreational use value of the fishery for this one season is estimated to be between $449,533 and $1,325,124.

KEY WORDS *Travel cost method, recreational fishing, southern bluefin tuna*

Introduction

The objective of this study is to estimate the recreational use value gained from the recreational fishing of southern bluefin tuna at Portland, Australia. To obtain this objective the travel cost method is used. This study is considered to be a pilot study.

Southern Bluefin Tuna

Campbell, Herrick and Squires (2000) in their article describe the modern history of southern bluefin tuna (*Thunnus Maccoyii)*. Southern bluefin tuna spawns in southwest Indonesia. The species then migrates down the west coast of Australia until it reaches the Tasman Sea. By the time the fish is between three to five years old it will be approximately 20 kilograms in weight and 100 centimetres long (Phillips, Begg & Kurtotti 2008). The fish can live to over 40 years of age and grow up to 200 kilograms. The species does not breed until it is around 10 years of age (Campbell & Kennedy 2007).

According to Campbell, Herrick and Squires (2000) in the early 1980s it became apparent that southern bluefin tuna was endangered due to overfishing. The Committee for the Conservation of Southern Bluefin Tuna (CCSBT) was created to manage the resource for member nations. The convention came into force in May 1994 (CCSBT 2009). Current member nations of the CCSBT include Australia, New Zealand, Japan, Korea, Taiwan, and Indonesia. Current cooperating non-member nations include the Philippines, South Africa and the European community.

Before the CCSBT quotas were introduced the fishery was heavily overfished. For example in 1961 the worldwide catch of southern bluefin tuna was estimated to be 81,169 tonnes (Campbell, Herrick & Squires 2000). This is well above the current worldwide quota which is 9449 tonnes per year (CCSBT 2010). Australia's commercial quota has recently been reduced to 4270 tonnes per year.

Ninety nine percent of Australia’s commercial catch is caught using the purse seine method near Port Lincoln, South Australia. Once the fish are caught they are farmed until they are of a suitable size to be sold (Phillips, Begg & Kurtotti 2008).

Australia’s entire quota is allocated to commercial operators. It is unknown how much southern bluefin tuna is taken by recreational users (including the charter boats) each year (DEH 2003). In the 2009 CCSBT convention Australia did not provide an estimate of its recreational take (CCSBT 2009). It is estimated that 140 tonnes of southern bluefin tuna was pulled in from Portland alone during the 2010 season (O’Toole, 2010). If this amount of fish was included in the Australian commercial quota of 4270 tonnes per year the Portland recreational take would amount to 3.3% of the quota.

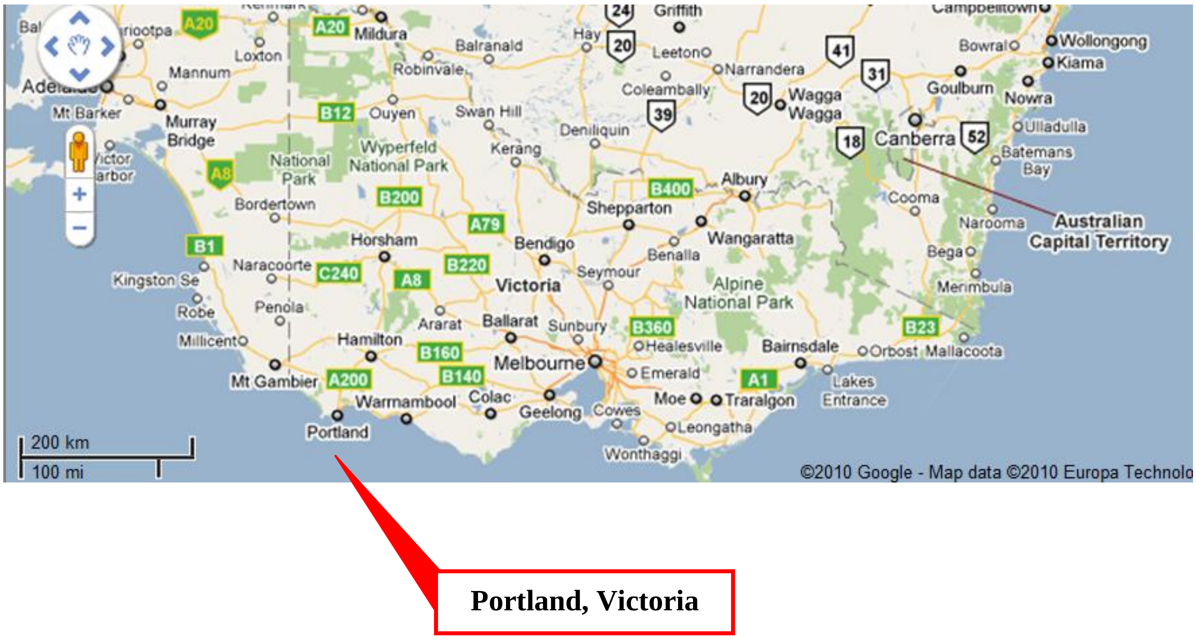
Portland

Each year traditionally between April and June, recreational anglers descend to Portland to fish for southern bluefin tuna. Portland is approximately 350 kilometres southwest of Melbourne (Figure 1). The southern bluefin tuna fishery accessible from Portland is for recreational anglers only. Ninety nice percent of Australia’s entire commercial quota is caught out of Port Lincoln, South Australia (Phillips, Begg & Kurtotti 2008).

Southern bluefin tuna can be caught in many different locations along the lower Australian coast. Portland is popular among anglers because boats have to travel a significantly shorter distance to get to the continental shelf than other nearby locations like Warrnambool, Port Fairy and Port MacDonnell. Portland also has good protection in the harbour for boats from wild weather and swell (McPherson 2006). Portland locals report that the last three years, 2007 to 2009 have been better than average seasons.

Southern bluefin tuna are recreationally fished in South Australia, New South Wales, Victoria, Tasmania and New Zealand. The current Victorian fishing regulations (DPI 2009) allow licensed recreational anglers to catch two southern bluefin tuna per day (or only one if the first southern bluefin tuna caught is equal to or greater than 120cm in length).There are approximately ten charter boats which take people out fishing from Portland. Most of these charter boats are from Melbourne and operate in Portland only for the extent of the tuna season.

FIGURE 1. Portland, Victoria



An Explanation of Recreational Use Value and the Travel Cost Method

The recreational use value people gain from using the southern bluefin tuna fishery accessible off Portland is estimated in this study. The total economic value of a good or resource is "...all values associated with the resources, whether from their use or existence in a particular state, and regardless of whether those values are recorded in a market transaction or not" (Kerr & Greer 2004, p. 140).

Total economic value can be summarised as (Tietenberg & Lewis 2009, p. 38):

$$Total\ Economic\ Value = Use\ Value + Option\ Value + Nonuse\ Value$$

In this study the total willingness to pay for the recreational use of the southern bluefin tuna fishery accessible off Portland is estimated. People may be willing to pay to preserve the fishery (non-use value) or be willing to pay so they can use the fishery in the future (option value). Neither non-use value nor option value can be calculated using the travel cost method.

It is difficult to value a person's willingness to pay to visit a public resource like a national park or a fishery. This is because people do not have to pay to enter a fishery and therefore do not reveal their willingness to pay. A central assumption of the travel cost method is "...that the incurred costs of visiting a site in some way reflect the recreational value of the site (Turner, Pearce and Bateman cited by Whitten & Bennett 2002)". If this assumption holds the travel cost method allows researchers to estimate the demand to visit a recreational site by finding out how much people spend to travel to the site (Garrod & Willis 1999).

Bateman (1993) outlines the process of how a demand curve is estimated in a travel cost study. Once the data has been collected from the recreational site of the study respondents are allocated into zones surrounding the site by their postcode. After the allocation of zones a trip generation function is estimated. A trip generation function is a relationship between the visit rate per head of population (V/N) in each zone and the travel cost per person (TC) in each zone.

To estimate the trip generation function a regression is performed with the visit rate being the dependent variable:

$$(V/N) = f\ (TC)$$

As the "...rate of participation ... is expected to fall as the costs of travelling, potentially including the travel time (TC) increase" (Whitten & Bennett 2002, p. 210) the trip generation function is "...essentially a demand curve" (Garrod & Willis 1999, p. 58). As the trip generation function is a demand curve consumer surplus estimates the "...value for the whole recreational experience of a trip to a site rather than an evaluation of the site alone" (Bateman 1993, p. 197) can be estimated.

In contrast the on-site demand curve "...estimates the maximum amount which people would be willing to pay for the recreational use value of a site once they have paid the cost of travel to the site" (Bateman 1993, p. 200). The on-site demand curve tests how "...visitors react to admission fees" (Bateman 1993, p. 198) that are hypothetical, instead of how they react to travel costs in the trip generation function.

As the hypothetical admission fee is increased the visit rate from each zone will decrease and approach zero. When a visit rate from a zone approximately equals zero the corresponding admission fee and number of visitors is plotted on the on-site demand curve. The hypothetical admission fee will be raised to such a level that the visit rate from all zones will approximately equal zero. At this point there will now be no visitors to the recreational site as given their travel costs they are not prepared to pay the admission fee to visit the site.

Application of the Travel Cost Method

Some recent travel cost results are discussed below. Results are most commonly presented in five different forms:

1. *Consumer surplus per person in each zone*
2. *Consumer surplus per person per visit in each zone*
3. *Consumer surplus per person per visit*
4. *Total consumer surplus*
5. *Net present value of consumer surplus*

Whitten and Bennett (2002) estimated the recreational use value of duck hunting in the upper south east of South Australia. Using NLSQ (non linear least squares) they estimated the consumer surplus per hunter per trip to be between $42.31 and $62.03. Whitten and Bennett performed a sensitivity analysis which included the opportunity cost of time to calculate their upper estimate ($62.03). In their base estimate ($42.31) the opportunity cost of time was not included. Whitten and Bennett estimated the consumer surplus per duck shooting event to be between $12,439 and $18,238 and the net present value over a 30 year horizon to be between $606,945 and $889,874. To calculate the net present value they used a discount rate of seven percent.

Carr and Mendelsohn (2003) estimated the recreational use value gained by travellers who visit the Great Barrier Reef in Queensland. Their study included both domestic and international travellers. They found that consumer surplus per person per visit to be between $USD 350 and $USD 800. They estimated the annual recreational benefits to be between $USD 700 million and $USD 1.6 billion. There is large difference in their estimates because they used two different functional forms to estimate the trip generation function and three different methods to measure travel cost. The estimated net present value of the reef was between $USD 18 billion and $USD 40 billion. To calculate the net present value a discount rate of four percent was used.

Driml (2002) estimated the recreational use value travellers gained from visiting the Wet Tropics of Queensland. She found that the average consumer surplus estimate was $49 per visitor per day.

Fleming and Cook (2008) measured the recreational use value Australian visitors gained from visiting Lake McKenzie on Fraser Island. They found the consumer surplus per person per visit to Lake Mackenzie was between $146.29 and $339.38. These estimates were the upper and lower 95 percent confidence intervals. The annual recreational use value of Lake McKenzie ranges from $19.2 million to $44.4 million.

Kerr and Greer (2004) estimated the recreational use value people gained from using the Rangitata River in the South Island of New Zealand. They found the benefit per angler per trip to the river to be between $NZD 40 and $NZD 103. Their lower estimate included car fuel costs only. Their upper estimate included car fuel costs plus other vehicle related costs such as insurance and depreciation. Both estimates included the opportunity cost of time which was set at 35% of the average wage rate. They estimated the annual recreational use value of the fishery to be between $NZD 1.8 million and $NZD 4.5 million.

Rolfe and Prayaga (2007) investigated the recreational use value people gained from the recreational fishing of three freshwater dams in north Queensland. The upper and lower estimates of their consumer surplus measures were obtained using 95 percent confidence intervals. They found in their assessment that the consumer surplus per person per visit to the Bjeke Peterson Dam to be between $32.13 and $84.16. For the Boondooma Dam the consumer surplus per person per visit was found to be between $248.85 and $448.57. For the Fairbairn Dam the consumer surplus per person per visit was found to be between $528.56 and $1059.

Stoeckel and Mules (2006) estimated the recreational use value people gained from visiting the Australian Alps which are located in Canberra, New South Wales and Victoria. The average consumer surplus per person per visit across seven different regions of the Australian Alps was between $280 and $860. The lower estimate was obtained when travel costs were measured at ten cents per kilometre travelled and their upper estimate was obtained when travel costs were valued at 30 cents per kilometre travelled. They found the net present value of the Australian Alps to be between $10 billion and $200 billion. To obtain their lower estimate of net present value they used a ten percent discount rate and to obtain their upper estimate they used a two percent discount rate.

Survey Design

Data was collected during four randomly selected weeks between April and June.
Twenty three days of data was collected from Portland. On data collection days interviews were conducted from 11am to 6pm. Generally anglers were interviewed at the boat ramps once they had removed their boats from the water. The questionnaire took about 10 minutes to complete. One fisherman per boat was interviewed.

Anglers were only interviewed once over the entire 23 days even if they fished multiple days. To account for multiple trips in the data survey respondents were asked how many further days that season they planned to fish for tuna.

FIGURE 2. Fish Cleaning Facilities, Portland

Survey Response

In total 257 surveys were completed. Of these 200 were usable in the travel cost analysis. Some surveys were not useable in the travel cost analysis because the respondent was from a charter boat or the questionnaire was incomplete. Charter data was not included in the travel cost analysis as it was thought it would bias results. The weather influenced boating activity. Some days were total washouts where there were no tuna boats out, and no surveys conducted.

During busy periods at the Portland boat ramp multiple tuna boats were missed. Table 1 displays information regarding the response rate. During the 2 pilot days the data on missed boats was not collected.

TABLE 1. Response Rate of Anglers (including charters)

	Complete	Previously Surveyed	Declined to Participate	Missed
Pilot	38	N/A	N/A	N/A
Week 1	39	9	6	19
Week 2	134	35	15	181
Week 3	46	19	2	25
Total	257	63	23	225

The response rate was 40%. This was calculated by dividing the number of completed (non-charter) responses by the total number of potential responses:

$$(200) / (257 + 23 + 225) * 100 = 40\%$$

Individual and Zonal Method

The two commonly used ways of conducting a travel cost study are the zonal travel cost method (ZTCM) and the individual travel cost method (ITCM).

The two variants differ in "...the definition of the dependent variable" (Rolfe & Prayaga 2007, p. 162) in the trip generation function. In ZTCM the "...dependent variable is the number of visits made from a particular zone, over a specific period of time, divided by the population of that zone" (Rolfe & Prayaga 2007, p. 162). In contrast in the ITCM the dependent variable is "...the number of visits to a site made by each visitor over a specific period of time" (Rolfe & Prayaga 2007, p. 162).

In this study following Whitten and Bennett (2002) the zonal travel cost method is used. During interviews respondents were asked for their postcode. Respondents were allocated into zones depending on the distance of the postcode by road to Portland. To calculate the population of each zone, local area population data from the Australian Bureau of Statistics (2010) was used. Table 2 displays the total population of each zone.

TABLE 2. Zone Population Statistics

Zone	Distance from Portland(km)	Victorian Population	South Australian Population	Total Zone Population
1(includes Portland)	0-100	47500	46422	93922
2	100-200	62990	0	62990
3	200-300	368432	19556	387988
4	300-350	429494	0	437515
5	350-400	2902815	8021	2902815
6	400-450	836603	0	2086474
7	450+	780818	1249871	780818

In Zones 2, 4 and 6 the population recorded from South Australia was zero. It is likely that people do live in these regions but it was too difficult to separate these regions in the data.

Travel Cost Calculation

There is debate between economists on how to measure the costs of travel in a travel cost study. Whitten and Bennett (2002) in their study of duck hunting in South Australia asked respondents what their perceived vehicle costs were. They followed the method outlined by Bateman (1993). The intuition behind asking respondents for their perceived costs is it provides a more accurate measure than asking respondents for their fuel, insurance and depreciation costs. This is because some respondents may consider depreciation of their vehicle and insurance a sunk cost and it wouldn't come into their calculation of their travel cost. The argument follows that in some cases these additional motoring costs are included when they shouldn't be which would cause recreational use value to be overestimated.

To calculate car expenses Fleming and Cook (2008) asked their respondents what type of car they were using. They separated cars into seven different categories ranging from light cars up to large SUVs. Fleming and Cook then assigned an average cost per kilometre travelled to each type of car. Instead of asking respondents to estimate their fuel costs Fleming and Cook calculated car fuel costs by multiplying the average cost per kilometre by the return distance travelled.

Rolfe and Prayaga (2007) in their study considered the costs of vehicle capital, boating expenses and fishing equipment expenses in calculating travel costs. In their study respondents were asked to estimate annual boating expenses, fishing costs for the trip and vehicle expenses.

Rolfe and Prayaga (2007) commented that the costs of groups travelling together need to be separated into individual costs. In the survey conducted in this study respondents were asked how many people they travelled to Portland with. This question enables the travel cost per individual of travelling to Portland to be worked out. If there was a group that travels to Portland together it was assumed that their costs were split evenly between them.

The choice of how to measure travel costs is open to researcher interpretation. Stoeckel and Mules (2006) compare the choice of how to measure travel costs to the choice of a discount rate. They claim that a discount rate will not necessarily be accurate but this doesn't mean that economists discard the methodology. The same logic can apply to the choice of how to measure travel costs.

To calculate travel costs in this study each respondent was asked what their costs of tuna fishing for their trip to Portland and back were in terms of:

- *Car Fuel*
- *Boat Fuel*
- *Boat Value*
- *Fishing Equipment (tackle, bait, rods, reels)*

Table 3 displays the cost and the population data. The key figures in this table, that are used to estimate the trip generation function, are the average travel cost per person for each zone and the annual visit rate per 1000 head of population (V/N) in each zone. Table 3 is based on a example demonstrated by Bateman (1993).

The third column in Table 3 (Refined Total Visits) was adjusted to take the following three factors into account:

- *The average number of people in each boat was 3.05 (adjusted up)*
- *The response rate was 40% (adjusted up)*
- *That the visit rate needed to be for the total 3 month season and not just the 23 days of the data collection (adjusted up)*

The fifth column (Average Car Cost Per Person) was adjusted to take into account:

- *Data was collected in the form of total fuel costs per car Therefore data needed to be adjusted into individual costs (adjusted down)*

The sixth column (Average Boat Fuel Cost) was fixed at the total average across all zones due to some inconsistencies in the data. The average boat fuel cost was adjusted to account for:

- *The average total boat fuel costs needed to adjusted into per person boat fuel costs (adjusted down)*

The seventh column (Average Gear Cost) was fixed at the total average across all zones due to some inconsistencies in the data. The average gear cost was adjusted to account for:

- *There was on average 6.67 tuna fishing days made per anglers each year and only 1.8 of these days were for the particular trip the respondents were interviewed for (adjusted down)*
- *Gear was estimated to last for three years (adjusted down)*

TABLE 3. Travel Cost Zone Statistics

i	ii	iii	iv	v	vi	vii	viii
Zone	Total Zonal Population (N)	Refined Total Visits from Zone	**Visit Rate (V/N)**	Average Car Costs per person	Boat Fuel Costs	Gear Costs	**Total Average Travel Cost**
1	93922	821	**8.74**	$8.04	$66.34	$133.08	**$207.45**
2	62990	122	**1.93**	$21.83	$66.34	$133.08	**$221.25**
3	387988	456	**1.18**	$39.21	$66.34	$133.08	**$238.63**
4	437515	791	**1.81**	$64.30	$66.34	$133.08	**$263.72**
5	2902815	2555	**0.88**	$57.88	$66.34	$133.08	**$257.29**
6	2086474	1004	**0.48**	$91.49	$66.34	$133.08	**$290.91**
7	780818	304	**0.39**	$77.63	$66.34	$133.08	**$277.05**

Opportunity Cost of Time

As part of measuring travel costs researchers need to decide how to treat the opportunity cost of time. Bateman (1993) claims that researchers should consider the travel time of getting to the site and back, and the time spent at the site.

In relation to the opportunity cost of time related to travelling to the site "...travel time utility (Bateman 1993, p. 210)" could be either positive or negative. If there is little enjoyment from travelling to the site (negative utility) then total travel costs should include an opportunity cost of time or consumer surplus estimates would be undervalued. Bateman recommends asking respondents on a scale of 0 to 1 their enjoyment of travelling to the site. From these results an aggregate weight can be obtained and applied to every respondent's travel time. Bateman claims the travel cost of time per hour should reflect the respondent's wage rate.

The opportunity cost of time in relation to the hours spent at the recreational site can be included as a cost. However "...time spent on-site is expected to generate utility equal to that from alternative activities (Whitten & Bennett 2002, p. 210)" and therefore shouldn't be included.

In their study Whitten and Bennett calculated 3 different consumer surplus estimates. Their base estimate of consumer surplus per person per visit didn't allow for any opportunity cost of time for travelling to the site and back. Their middle estimate included the opportunity cost of time set at 50% of the mean male wage rate. The third estimate allowed the opportunity cost of time spent travelling to the site and back to be included at 100% of the mean male wage rate.

Kerr and Greer (2004) in their calculation of travel cost included the opportunity cost of time spent travelling to the Rangitata River. They valued travel time costs per hour to be 35 percent of the hourly wage rate.

In this study to gain an estimate of the opportunity cost of travel the opportunity cost of time was set at the average non-managerial full time employee wage rate of $30.10 per hour (Australian Bureau of Statistics 2009). The hours of travel in each zone to Portland and back was calculated by using the average distance travelled in each zone and assuming respondents travelled at 100 kilometres per hour.

TABLE 4. Travel Cost Zone Statistics (Sensitivity Analysis)

Zone	Total Zonal Population (N)	Refined Total Visits from Zone	**Visit Rate (V/N)**	Average Car Costs per person	Boat Fuel Costs	Gear Costs	Average Hours	**Opportunity Cost of Time**	**Total Average Travel Cost**
1	93922	821	**8.74**	$8.04	$66.34	$133.08	0.29	**$8.80**	**$216.25**
2	62990	122	**1.93**	$21.83	$66.34	$133.08	2.51	**$75.70**	**$296.95**
3	387988	456	**1.18**	$39.21	$66.34	$133.08	5.64	**$169.68**	**$408.30**
4	437515	791	**1.81**	$64.30	$66.34	$133.08	6.51	**$196.02**	**$459.74**
5	2902815	2555	**0.88**	$57.88	$66.34	$133.08	7.19	**$216.32**	**$473.61**
6	2086474	1004	**0.48**	$91.49	$66.34	$133.08	8.23	**$247.86**	**$538.77**
7	780818	304	**0.39**	$77.63	$66.34	$133.08	9.73	**$292.84**	**$569.88**

Multiple Sites of Recreation

In relation to a travel cost study substitute sites can have a significant impact on the demand to visit the recreational site of the study (Bateman 1993).

Kerr and Greer (2004) in their study considered the effect that other New Zealand rivers had on the demand for recreational fishing trips to the Rangitata River. They found that some rivers were complements and others were substitutes. They also comment that if the price of other rivers was omitted from the demand equation to visit the Rangitata River then the demand would be likely overestimated.

In the survey for this study respondents were asked whether they have fished at any other areas for southern bluefin tuna in the last 12 months. The quantitative effect of substitute sites on the demand for fishing at the southern bluefin tuna fishery off Portland was not investigated. However the qualitative effect of substitute sites was investigated.

In Table 5 the alternative southern bluefin tuna fishing sites to Portland and the number of respondents who have fished these sites is listed. It could reasonably be expected that fishing at Port MacDonnell, Port Fairy and Warrnambool would have an effect on the demand to fish for southern bluefin tuna at Portland. These nearby alternative sites could have either a substitute or a complement effect. For example one of the main attractions to anglers of fishing for southern bluefin tuna is the lure of catching a 100 kilogram plus trophy fish. It is conceivable that if trophy fish are being caught off Port MacDonnell more anglers would travel to all of these nearby sites. If this was the case then Port MacDonnell would be acting as a complementary recreational site. It is also conceivable that fishermen could move away from Portland to fish at Port MacDonnell because of a greater chance of catching a trophy fish there. In this scenario Port MacDonnell would be acting as a substitute recreational site.

TABLE 5. Multiple Sites

Place	Alternative Site	Distance from Portland
SA--Port MacDonnell	19	94.5km
NSW-- Bermagui, Narooma	13	1042km
Port Fairy	6	72.5km
East Tasmania	3	Overseas
Warrnambool	1	100km
NZ	1	Overseas

Multiple Destination Trips

A common question for researchers in travel cost literature is how to proportion travel costs if the respondent's sole reason for their trip isn't to visit the recreational site of interest. Whitten and Bennett (2002) discuss that it is an assumption of the travel cost method that hunters make the trip to their destination for the sole purpose of hunting. If this assumption is breached it could "undermine the basis of the travel cost procedure (Fleming and Cook 2008, p. 1199)". This is because the price of visiting the recreational site is meant to be negatively related to the quantity of visits to the recreational site. If some travel costs are proportioned then this relationship could potentially become diluted.

Fleming and Cook (2008) in their study modified their consumer surplus estimates to account for multipurpose trips. They needed to do this because they were conducting a travel cost study into finding the recreational use value people gained from visiting Lake Mackenzie on Fraser Island. They found visitors did not visit Fraser Island just to see Lake Mackenzie and therefore consumer surplus estimates needed to be adjusted.

Rolfe and Prayaga (2007) in their study into the recreational fishing at 3 north Queensland dams partitioned their consumer surplus estimates to take multiple destination trips into account.

In this study of the 257 surveys completed only 3 respondents had not made the trip for the sole purpose of fishing for southern bluefin tuna. Therefore the variable multiple destination trips was regarded to be insignificant.

Functional Form

There are several different functional forms researchers can consider for the trip generation function. The most common type of functional forms for the trip generation function are (Bateman 1993):

TABLE 6. Functional Form

Linear	(V/N)= a(TC) + b
Quadratic	$(V/N) = a(TC^2) + b(TC) + c$
Log-Log	Ln(V/N)= a(LnTC) + b
Semi Log dependent	Ln(V/N)= a(TC) + b
Semi Log independent	(V/N)= a(LnTC) + b

Bateman comments that researchers should be wary that these different functional forms can produce significantly different estimates of consumer surplus. Bateman also discusses that the quadratic and semi log independent functional forms are vulnerable to heteroscedasticity.

Whitten and Bennett (2002) in their study estimated 3 different functional forms to test the relationship between the visit rate (dependent variable) and travel cost (independent variable). They estimated a semi log dependent model, semi log independent model and a double log model. Their primary preference in selecting between these models was choosing the model that reacted most realistically to changes in admission costs. To check the difference between the models they compared R-squared values and they also did a likelihood ratio test. After analysis they selected the semi log dependent model.

Table 7 displays the results of OLS regressions when the opportunity cost of time is excluded. It can be seen the log-log and the quadratic are the best fitting regression lines because they have the highest R-squared values. However it is difficult to compare the different functional forms as they '...involve different dependent variables (i.e., log log or non-log) (Hanley and Spash 1993, p. 90)".

In the next section the semi log dependent trip generation function is used for further analysis because the consumer surplus per person can be simply calculated and it is not "...dependent on the zone from which the visit is made (Whitten & Bennett 2002, p. 221)".

TABLE 7. Functional Form

Functional Form (Y, X)	TGF estimation	R^2
Linear-Linear	VR = -0.073(TC) + 20.45	0.55
Linear-Log	VR = -18.47LOG(TC) + 104.15	0.58
Log-Log	LOG(VR) = -7.497 LOG(TC) + 41.63	0.77
Log-Linear	**LOG(VR) = -0.030 (TC) + 7.81**	**0.76**
Quadratic	VR = -1.025(TC) + 0.0019 (TC)^2 + 137.24	0.77

Consumer Surplus Estimates

Table 8 displays the consumer surplus estimates for the whole recreation experience. The estimate on the left in each cell is for when the opportunity cost of time is not included and the estimate on the right is for when the opportunity cost of time is included.

TABLE 8 – Whole Experience Consumer Surplus Results Summary

	CS per head of Population	CS per Zone	CS per Person per Visit
Zone 1	$0.1569–$0.7243	$14,734–$68,029	$17.94–$82.83
Zone 2	$0.1030–$0.3490	$6,486–$21,984	$53.30–$180.67
Zone 3	$0.0603–$0.0956	$23,410–$37,108	$51.30–$81.32
Zone 4	$0.0275–$0.0340	$12,025–$14,871	$15.20–$18.80
Zone 5	$0.0337–$0.0211	$97,828–$61,220	$38.28–$23.96
Zone 6	$0.0112–$0.00	$23,410–$0	$23.32–$0.00
Zone 7	$0.0179–$0.00	$13,949–$0	$45.85–$0.00
Total	$191,841–$203,212		

Table 9 displays the onsite consumer surplus estimates. One problem of the log-log functional form is that when there is a zero visit rate the admission price approaches infinity. This problem creates biased consumer surplus estimates. To solve this problem Fleming and Cook (2008) introduced a choke point on their visits in each zone. Usually the point on the demand graph isn't marked until the visits (or visit rate) from a zone reaches zero. Fleming and Cook plotted each point of the demand graph when the amount of visits in each zone reduced to one. The same method was used in this study.

The maximum hypothetical admission fee was $238 (when the opportunity cost of time was excluded) to access the southern bluefin tuna fishery, after paying for travel costs. This fee is plausible. Some of the charter boats operating in Portland were charging well above this price to take people out fishing for southern bluefin tuna for the day.

TABLE 9. On-site Consumer Surplus

	Lower Estimate (0% OC included)	Upper Estimate (100% OC included)
Consumer Surplus Per Person Per Visit	$33.19	$131.70
Annual Recreational Value of the Southern Bluefin Tuna Fishery	$449,533.24	$1,325,124.04

Net Present Value

The net present value of a resource is the worth in the current period, of the net benefits received across a defined set of time periods (Tietenberg & Lewis 2009).

Whitten and Bennett (2002) in their study used a discount rate of seven percent and a time horizon of 30 years. In this study a discount rate of seven percent and a ten year horizon (not including 2010) was selected. The 10 year horizon was chosen because the future of southern bluefin tuna is highly unpredictable. The estimates in Table 10 assume that the fishery will remain at its current health. The annual benefit values used in Table 10 were an average between the whole experience consumer surplus and the on-site consumer surplus.

TABLE 10 – Net Present Value Estimate

	Lower Estimate (0% OC included)	Upper Estimate (100% OC included)
Net Present Value	$2,089,350.22	$4,978,733.30

Study Limitations

There were significant time constraints in completing the study because the research was for an honours project. There were a significant number of tuna anglers who declined to be interviewed, or were missed by the interviewers and not asked to be interviewed. Surveys took at least 10 minutes to complete. If the survey length was reduced more interviews could be conducted. Also if the survey was shorter in length more anglers might be willing to participate.

During busy times on the boat ramp many tuna anglers were missed. If there were more interviewers then more tuna anglers could be asked to be interviewed. The researchers did not get paid to conduct the interviews. Therefore unless the project had greater funding it would be very difficult to increase the number of interviewers above 2.

Questionnaires were limited to one angler per boat. If every person on the boat was able to be interviewed the results would be more accurate.

It is thought that one way this data could be made more accurate is if in a future survey it was strongly emphasised that the particular car costs of concern were for the return journey and not just for one way. Another way in which this data could be improved is if respondents were asked for their type of car and return distance travelled not their fuel costs. This method was used by Fleming and Cook (2008) and was outlined above.

The depreciation of the boat for the particular trip to Portland was not calculated but it would likely have been significant to the average travel cost per person, for those respondents who owned the boats.

It was shown that there were substitute sites to fish for southern bluefin tuna other than Portland. More research would need to be conducted to calculate the quantitative effect these alternative sites have on the demand to fish for southern bluefin tuna at Portland. One thing to note from the data is that there was not one respondent from South Australia. Port MacDonnell is only 94.5 kilometres away from Portland. It is likely that Port MacDonnell is affecting the demand to fish for southern bluefin tuna at Portland.

Ordinary Least Squares (OLS) is used to estimate the trip generation function in this study. Garrod and Willis (1999) comment that if OLS is used there is a censorship problem. They comment that "...less than one visit cannot be possibly observed...this implies the dependent variable is censored at one" (Garrod & Willis 1999, p. 90). They comment that the effect of this censorship is biased results if OLS is used. They recommend maximum likelihood (ML) be used instead of OLS.

Travel Cost Method Limitations

The travel cost method assumes that the travel cost a respondent incurs represents their recreational value of the site. This would mean that as respondents who live closest to the site have the lowest travel cost also gain the lowest recreational values from using the site (Bateman 1993). Those respondents with a lower recreational use value will be the first respondents not to come as the hypothetical admission fee increases. In reality this scenario may not be the case. It is conceivable that a recreational angler values the fishing of southern bluefin tuna so high that they bought a house in Portland. It is also conceivable that the Portland locals value the fishery just as much if not more than those anglers from places such as Melbourne.

Final Conclusions

The on-site consumer surplus per person per visit is estimated to be between $33 and $132 and the on-site consumer surplus of the fishery for 2010 is estimated to be between $449,533 and $1,325,124.

Campbell and Kennedy (2007) predict that if southern bluefin tuna continued to be fished at the 2008 CCSBT quota levels the species would be practically extinct in 30 years time. In the coming years as the species becomes scarcer, Australia and other member nations of the CCSBT face difficult decisions on how to fish for the species in a sustainable, efficient and equitable manner. Currently the CCSBT is not aware how much southern bluefin tuna is being caught by recreational anglers on a global level. Recreational catch is not included in the commercial quotas.

O'Toole (2010) estimated that the 2010 recreational catch for Portland was approximately 140 tonnes of southern bluefin tuna. If this one recreational site was included in Australia's commercial quota of 4270 tonnes it would equate to being 3.3 percent. If the national recreational catch was included as part of Australia's total commercial catch Australia would be well over its quota. Therefore it is apparent that further research needs to be done regarding the total recreational catch.

For an allocation of a resource to be efficient the marginal social benefit across all users must be equal (Freebairn 2003). Therefore in theory for the allocation of southern bluefin tuna to be efficient it should be allocated in such away across nations and between recreational and commercial anglers that the marginal social benefits all receive are equal.

Further research needs to be done to estimate the marginal net benefit of the recreational fishing of southern bluefin tuna at different recreational sites around Australia compared to the marginal net benefit of the commercial fishing of southern bluefin tuna in Australia.

To do this comparison would be very difficult. Firstly the marginal net benefit received by the recreational anglers is different to the marginal net benefit received by the commercial anglers. In relation to the recreational anglers the marginal benefit is measured by the amount of on-site recreational use value anglers get from visiting a southern bluefin tuna fishery. In relation to commercial anglers the marginal net benefit to a fisherman would equal the marginal revenue he or she would get from fishing for an extra tonne of southern bluefin tuna minus the marginal cost.

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