Toward an Analytical Framework for Resource Allocation in Fisheries with Multiple Users *

M. S. van Bueren #, R. K. Lindner #, and P. B. McLeod 0

A paper presented at the 40th Annual AARES Conference, Melbourne, 1996

Introduction

Many fisheries in Australia and overseas are being placed under increasing pressure by a diverse range of user groups. These groups, which include commercial fishers, anglers, aquaculturists, miners, tourist operators, indigenous people and developers, all compete for a share of access to fish stocks and their associated environments. Owing to society's changing values and demands, and the relative scarcity of fish, conflicts over the use of fishery resources are becoming complex and acute. This has led to the question of what constitutes an equitable and efficient allocation of resource to each user group.

Although economics is a useful discipline for assessing policies dealing with fisheries resource allocation, very few empirical studies have been undertaken in Australia. Most researchers have limited their efforts to comparing commercial operator's gross value of production with total expenditures of recreational fishermen via an economic impact analysis. Only a handful of studies estimate the average net economic benefits of angling, and even fewer attempt to elicit the marginal value of a fishing day or an extra fish caught. A more comprehensive suite of studies have been undertaken in the United States, but it is generally recognised that more research is necessary to improve our understanding what influences angler's utility from fishing.

This study focuses on resource sharing in the West Australian Salmon and Herring fisheries. Both of these fisheries are subject to considerable community pressure to reallocate access from commercial fishermen to anglers, as demonstrated recently by the WA Recreational Fishing Advisory Committee's proposal to buy-back commercial salmon licences on behalf of the wider angling fraternity.

The primary objective of the study was to assess the net economic benefits of allocating a greater quantity of salmon and herring to the recreational sector, and what this action would cost in terms of lost commercial value. A related aim was to define more clearly the strengths and limitations of a variety of survey techniques for eliciting recreational values. A secondary objective was to develop bioeconomic models of the commercial salmon and herring fisheries for examining their economic

---

* This study is funded by a grant from the Fisheries Research and Development Corporation.

Dept. of Agricultural and Resource Economics, University of Western Australia, Nedlands WA 6907.

0 Department of Economics and Commerce, University of Western Australia, Nedlands WA 6907

efficiency under current management arrangements, and to assess the merits of alternative management strategies.

This paper deals solely with the valuation of recreational fishing, as this is the more difficult and interesting component of the cost-benefit study. Only 'use' values are estimated, thereby neglecting the values that non-users in the community, such as conservationists, may hold for the resource. While the results from this study are not conclusive, they have provoked some new questions and insights that require further research.

Background to the WA salmon and herring fisheries.

Australian salmon (*Arripis truttaceus*) and Australian herring (*A georgianus*) are caught on the south and lower west coasts of Western Australia (WA) as they migrate on their spawning run from eastern Australia (Figure 1). The commercial fishery is a limited entry fishery comprising 34 licences, each of which is allocated to a specific beach. Each operator is restricted to fish at the shoreline with beach seine or trap nets. Stocks can only be fished over a limited season during which time licensed operators have exclusive use of the beach. The size of each commercial fishery, both in terms of catch and gross value of production is small, relative to other finfish fisheries in WA (Figure 2). Stocks of salmon are thought to be in good condition, but there is some doubt about the health of herring stocks due to significant increases in recreational and commercial catch over the last 15 years (Lenanton, 1994).

Salmon is regarded by anglers as a 'prize' fish, because it is relatively difficult to catch and also puts up a good fight. Herring is a much more common fish, but nevertheless is good eating and it tends to forms the 'backbone' of recreational fishing in southern WA. Recreational fishermen currently have open access to both fisheries, and bag limits are the main restrictions in place. The West Australian Fisheries Department has recently completed a creel survey of anglers, which has estimated the total size of recreational effort and catch associated with the salmon and herring fishery. For salmon, recreational catch is small relative to commercial harvest but for the herring fishery, the recreational catch comprises a significant proportion of total catch in the metropolitan region (Figure 1).

It is thought that commercial fishing is unlikely to be having much impact on the abundance of salmon stock available to the recreational sector. Instead, it is considered that stocks are more greatly influenced by environmental factors such as the Leeuwin Current (Lenanton *et al*, 1991). In the case of herring, it is unknown what impact commercial harvests on the south coast have on recreational catches further north towards Perth.

The competition between anglers and commercial operators therefore appears to arise mainly out of misconceptions and distrust of each other's activities rather than true competition for catch. This is not to say that commercial fishermen do not reduce angler's utility from the fishing experience. It is well acknowledged in the literature that catching fish is only one aspect of the recreational fishing experience, so it is conceivable that commercial fishing may conflict with some of the other goals of recreational fishermen.

Figure 1: Map showing the regions in Western Australia where salmon and herring are fished commercially. Estimates of commercial and recreational catch for the south west, southern, and south east coasts are also shown.

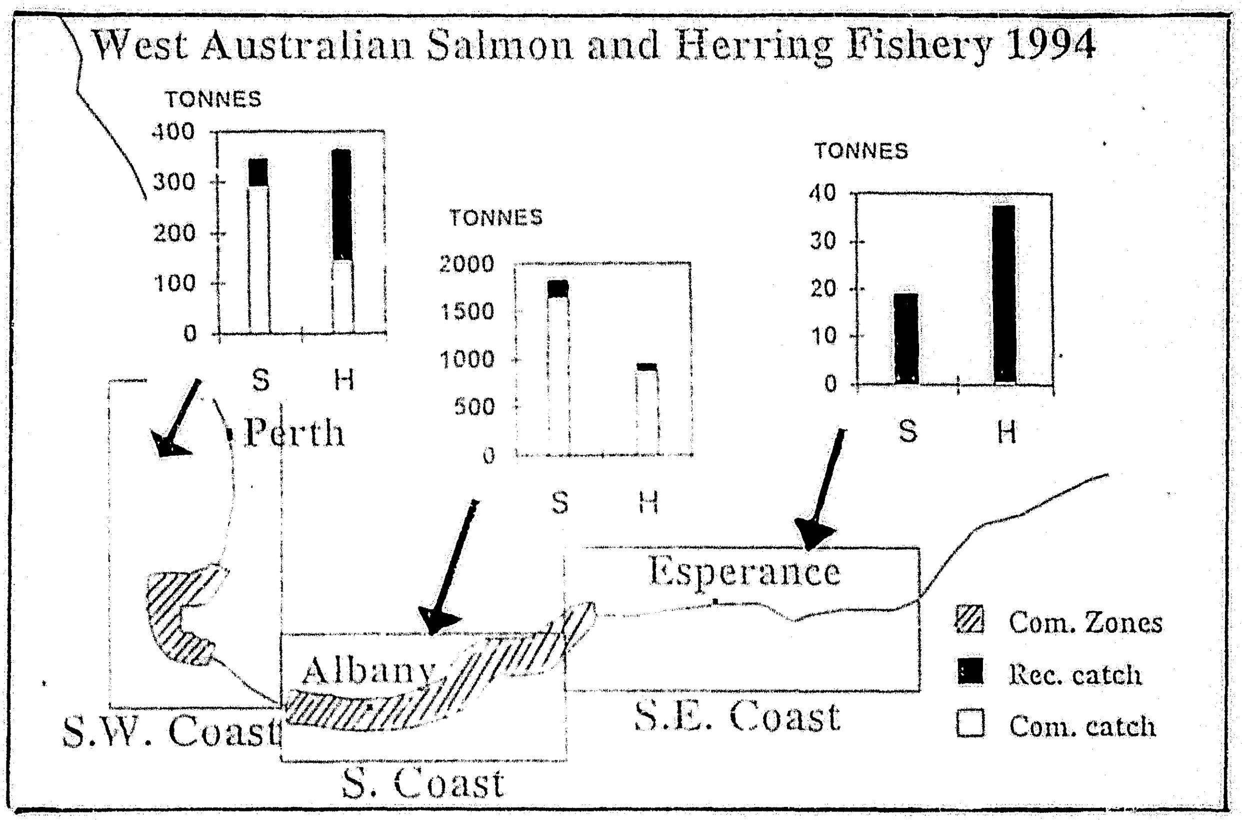
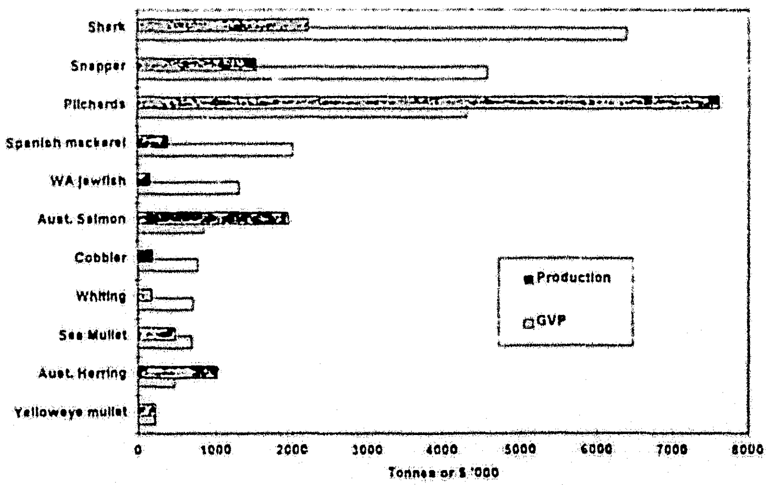


Figure 2: Production and gross value of Western Australia's main finfish fisheries. Data are three year means (91/92-93/94) from ABARE (1994).



A Theoretical Model of Recreational Fishing

It is easy to observe that the net economic benefits of **commercial fishing** are directly related to the size of harvest and the cost efficiency with which fish are caught. For **recreational** fishing, the relationship between stock size, catch and economic benefits is not so obvious. It is not sufficient to use expenditures associated with recreational fishing as the sole measure of economic benefit, because these only represent the minimum value that anglers attach to their sport. In cost-benefit analysis it is necessary to quantify the economic surplus net of what people spend to go fishing. The size of aggregate benefits, or consumer surplus, is then determined by multiplying benefits per angler by the total number of angler days.

Anderson (1983) provided a theoretical base for analysing the size of economic surplus from recreational fishing. He proposed that an individual's marginal value for the total fishing experience, measured in $/day, decreases with each additional day that he/she goes fishing over the course of a year (Figure 3). For simplicity, the marginal costs of fishing are assumed to remain constant across all days fished. In a more complex model, where anglers have a choice of fishing sites to visit at varying distances from their place of residence, this assumption would no doubt be violated. Anderson's simple model of individual demand for fishing days can be expressed by the following equation.

$$P = P(d, h(D), q, p) \qquad (1.0)$$

where

- P = individual's net marginal willingness to pay for a fishing day ($/day).
- d = days spent fishing by the individual
- D = sum of angler days by all individuals, such that $D = \Sigma d_i$
- $h(D)$ = the relationship between the average number of fish caught per day and the total amount of recreational fishing effort by all individuals.
- p = a vector of cost, price, and income parameters, including fishing expenses and the price of fish if available on the market.
- q = a vector of environmental and social factors concerning the fishing experience.

In equation (1.0) above, catch rate is treated as a quality aspect of the fishing experience and is incorporated as a "demand shifter". It is a function of the total number of days fished by all individuals in the fishery. The shaded area in Figure 3 represents the consumer surplus from "d" days of recreational fishing with a catch rate of 1 fish per day. An improvement in catch rate to 2 fish per day shifts the demand curve upwards and increases net benefits accordingly.

Fig. 3: Demand curve for recreational fishing days.

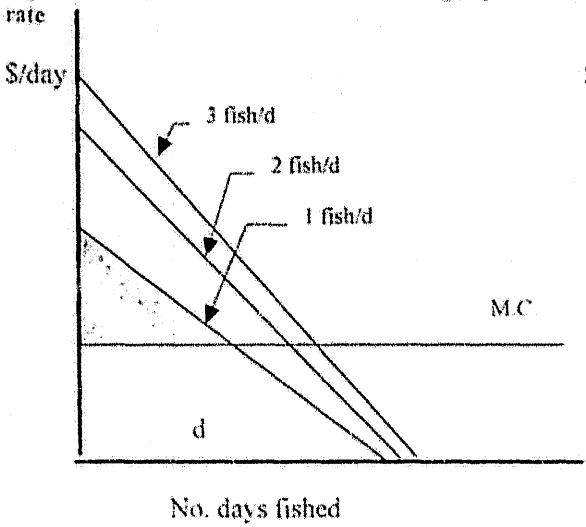
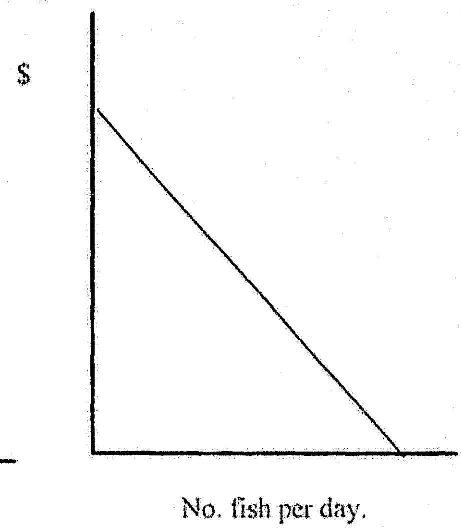


Figure 4: Demand curve for catch rate



Anderson points out that it is impossible obtain a market demand curve for fishing days by summing individual demand curves because aggregate effort in the fishery impacts upon the catch rate experienced by the individual. The adverse impact of each individual's effort on fishing quality is known as a congestion or stock externality. He overcomes this problem by developing a family of market demand curves Each curve represents aggregate demand for fishing days when all individuals assume a fixed level of aggregate effort in the fishery, and therefore a fixed catch rate. This model adequately demonstrates the stock externality, because with an expansion in effort, extra benefits from higher participation in fishing are traded off against fishing days with lower catch rates.

For the purposes of resource allocation, policy makers are particularly interested in the recreational value of incremental changes in fish catch. Other quality aspects of the experience are no doubt important in determining the size of angler benefits, but catch rate is of primary interest to managers because of biological considerations and the impact that a reallocation policy may have on the welfare of commercial operators. Most of the published theory on marginal values for fish examines the benefits from incremental improvements in **daily catch rate.** For example, Lal *et al,* (1992) hypothesise that for the *n*th fishing day of the season, the marginal value of catch rate will decline with successively higher levels of catch per day. The demand curve for catch rate is dependent upon the cumulative number of days an individual has fished in the season (Figure 4).

A related, but quite different hypothesis, is that the marginal value of fish caught on the *n*th fishing day of the season declines with **each additional fish** caught over the duration of that day. This value is likely to depend not only on the number of days fished so far in the season, but also upon the number of fish caught on previous days of the trip. There is little theory in the literature on this aspect of recreational fishing.

Samples and Bishop (1985) and Johnson and Adams (1989) extend our conceptual understanding of how anglers value fishing at the margin by expressing angler preferences for catch rate and number of trips in a utility maximising framework. Using this approach, the angler's optimisation problem is to:

$$\text{Max } U\,[S\,(F,W,Q),\,T,\,Z,\,X] \qquad (2.0)$$

subject to:

$$(P_Q * Q) + (P_X * X) + (P_T * T) <= Y$$

where:

U(.) = the angler's utility function

S = daily catch rate which is a function of F, W and Q.

F = stock size, treated as an exogenous variable

W = a vector of other exogenous variables affecting catch rate e.g. weather and regulations.

Q = a vector of goods and services purchased by the individual that are used as inputs in producing a fishing trip (endogenous factors).

T = the number of fishing trips per year

Z = the vector of factors that influence other quality aspects of the fishing experience besides catch rate (e.g. scenery and congestion)

X = a vector of other goods and services

P_Q, P_X, and P_T are the price vectors associated with Q, X, and T respectively and Y is angler income.

The indirect utility function associated with equation (2.0) is given below by equation (3.0). The zero superscript indicates that all parameters are initial values. V(.) gives the maximum utility achievable at any particular set of prices, exogenous inputs, exogenous quality factors and angler income. Catch rate does not directly enter into the function but is determined by F and W.

$$V^0 = V(P_Q^{\,0}, P_X^{\,0}, P_T^{\,0}, F^0, W^0, Z^0, Y^0) \qquad (3.0)$$

The cost minimising outlay to achieve V^0 is given by an expenditure function E, where $E^0 = E(P_Q^{\,0}, P_X^{\,0}, P_T^{\,0}, F^0, W^0, Z^0, V^0)$. The welfare effects of an exogenous shift in catch rate can be measured using a Hicksian compensating measure of welfare which is defined as the amount of compensation, paid or received, that will maintain the individual at his initial utility level, V^0, given that the individual is allowed to adjust his consumption bundle after the change. Willingness to pay for an improvement in catch rate, affected through a change in F or W, is equivalent to a compensating variation (CV) measure of welfare and can be defined in terms of the expenditure function as follows where the new levels of F and W increase catch rate:

$$CV = E(P_Q^{\,0}, P_X^{\,0}, P_T^{\,0}, F^0, W^0, Z^0, V^0) - E(P_Q^{\,0}, P_X^{\,0}, P_T^{\,0}, F', W', Z^0, V^0) \qquad (4.0)$$

The challenge for empirical research is to develop valuation methods for eliciting the size of consumer surplus or compensating variation received by anglers from a day of fishing, and the size of welfare gain brought about by incremental improvements in quality aspects of the fishing experience.

Non Market Valuation Methodology

As there is no market for recreational salmon and herring fishing, the economic value of these species to anglers cannot be easily estimated. Two techniques have been used extensively in the literature for valuing recreational fishing; the **contingent valuation method (CVM)** and the **travel cost method (TCM)**. Each technique has several variants, but essentially the contingent valuation method uses a hypothetical market to elicit an individual angler's willingness to pay for a day of fishing or an improvement in fishing quality. The value proffered by the respondent is therefore contingent upon a hypothetical market.

In contrast, the travel cost method imputes a demand curve for fishing days by regressing the number of visits an individual makes to a fishing site over the course of a year against the travel cost incurred by the individual, which acts as a surrogate price. A number of other explanatory variables, such as site quality and income, are usually included in the regression to capture variation in visitation rate. With a multi-site travel cost technique it is possible to estimate an average value of consumer surplus for those angler's who visit the sites in question. Variations in catch rates across sites are often used to value marginal benefits from an incremental improvement in catch.

There is no consensus in the literature as to which method is the most appropriate for valuing recreational fishing. Both techniques are subject to a variety of biases, the relevant ones of which are referred to in proceeding sections of this paper. Contingent valuation has the advantages of not being confined to valuing fishing at specific sites, and of eliciting willingness to pay via direct questioning rather than inferring values from fishermen's behaviour. However, because the technique relies upon a hypothetical market, it may produce invalid benefit estimates if the recreational 'good' is poorly defined, or if the respondent includes a wider range of experiences in his/her valuation than intended by the question.

The travel cost method does not suffer from hypothetical bias, but past studies have shown that consumer surplus estimates are particularly sensitive to the functional form chosen to fit the model. In addition, multicollinearity between regressors has commonly being found to be a problem and this makes it impossible to test the influence that salmon or herring catch may have on the demand for fishing.

To achieve the objectives of this study, a method was needed for valuing salmon and herring catch as distinct from the whole recreational experience. The recreational value of increases in catch rate at the margin have been calculated in a variety of ways by previous studies, and include both travel cost and contingent valuation techniques (Table 1). Owing to the deficiencies of the TCM at valuing particular aspects of a fishing experience, CVM was chosen as the primary method in this study for estimating the recreational value of the salmon and herring resource. A model of total willingness to pay for a day of fishing was constructed, then partially differentiated curve for each species. In addition, CVM was used to ask fishermen directly for their marginal willingness to pay for a preferred catch of salmon and herring.

Table 1: Commonly used procedures for estimating the marginal value of catch rate in recreational fishing studies.

Procedure Used	Example studies
Partial differentiation of a contingent valuation or multi site travel cost regression model with respect to catch rate, which is included as an explanatory variable in the model. This produces a demand curve for catch rate, and assumes average values for all other variables.	Stanniford and Siggins (1991) Milon (1991) Whitehead (1993) Bishop et al (1990) Loomis (1988)
Direct elicitation of marginal willingness to pay for an improvement in catch rate, keeping all other facets of the fishing experience constant, using contingent valuation questions. A mean individual bid curve for progressively higher catch rates can be estimated if a sequence of willingness to pay questions are asked.	Sorg and Loomis (1986) Bishop et al (1990) Johnson and Adams (1989) Loomis and Larson (1994)
Two-stage multisite travel cost model. In the first stage, consumer surplus is estimated for a variety of sites, each with differing catch rates. In the second stage, consumer surplus estimates from fishing at each site are regressed on the catch rate for each site, to produce a demand function for catch rate.	Samples and Bishop (1985)

Many studies adopt more than one technique to value the same good, thereby constituting a test of convergent validity. While this is a sensible approach, estimates obtained by using the TCM and CVM methods can not be compared directly as each method is measuring different underlying theoretical constructs. CVM produces a Hicksian income compensated demand curve while the travel cost method yields a uncompensated Marshallian demand curve. This being the case, the TCM method should produce a larger benefit estimate than CVM (Bateman, 1993). Carson *et al*, (1995) analysed 616 comparisons of the two techniques and his results are consistent with this theoretical expectation. Nevertheless, it is still considered useful to employ both methods for checking the validity of benefit estimates obtained by each method, so our study adopted both an individual TCM and a CVM method for generating welfare values for recreational fishing.

Survey Methods

A face to face survey was administered to a sample of recreational fishermen for collecting the necessary data for use in the TCM and CVM models (Appendix 1). Prior to conducting the survey, the question format was tested using a focus group comprising club anglers. A trial period with anglers on the beach was also conducted before commencing the survey. The survey was designed so as to minimise the variety of biases which are often associated with social survey techniques. In particular, some of the common biases relating to contingent valuation were controlled as follows:

- *Information bias.* Background information about the purpose of the survey was given prior to questioning and all respondents were given identical information.
- *Part-whole bias.* In order to avoid anglers valuing a much wider collection of goods' than desired, they were asked to recall a specific fishing trip, or day of fishing. In most cases this corresponded with the day/trip on which they were previously interviewed by the Fisheries Department.
- *Starting point bias.* An open-ended contingent valuation format was chosen in order to eliminate starting point bias which can be problematic with payment card methods.
- *Payment vehicle bias.* Many anglers in WA are hostile towards the introduction of a general recreational fishing licence. For this reason, trip costs were used as a payment vehicle in the open-ended contingent valuation questions. Trip costs included all expenses which could be attributed to the fishing experience, as nominated by the respondent. Costs included travel, accommodation and direct input costs such as bait and ice. Boat ownership costs were excluded.
- *Budget constraint bias.* Before posing the willingness to pay question, respondents were reminded of their budget constraint by asking what their income was, and what proportion of their income was typically spent on fishing as opposed to other sports and hobbies

Willingness to pay for a day of fishing, net of expenses, was elicited using the following open-ended contingent valuation questions:

1. Recall that on your trip you spent $X on fishing related expenses Based on your enjoyment from the fishing trip, do you think that this trip was worth the expense?
2. If yes, suppose, for whatever reason, that it becomes more expensive to go fishing. Based on your enjoyment from this trip, would you still have taken the trip if costs had been higher?
3. If yes, how much could costs rise to before you decide that your fishing experience on this trip was not worth the expense?

A further three contingent valuation questions were posited to elicit the value of salmon and herring at the margin:

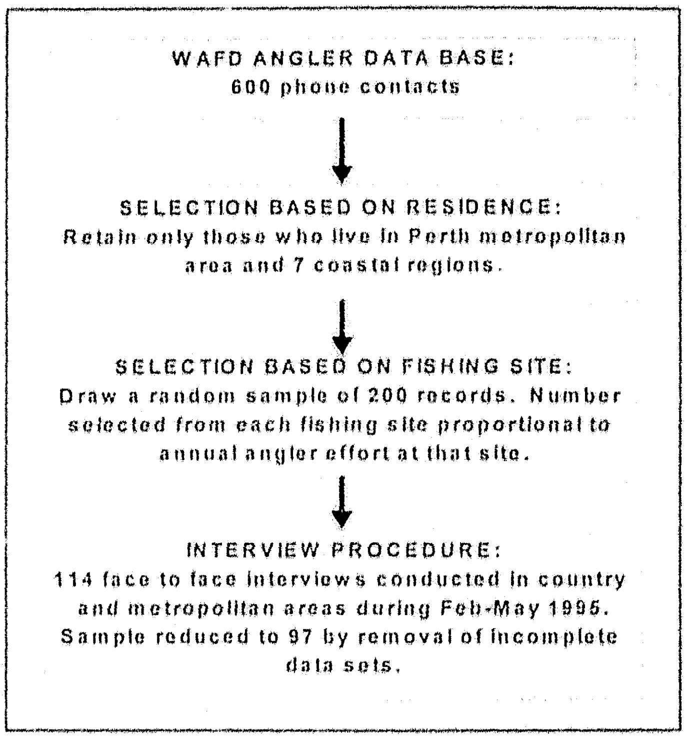
1. Would you have preferred to catch some (more) salmon/herring?
2. If yes, how many in a day would have satisfied you?
3. If you had been fortunate enough to catch this number of salmon/herring, would this have increased the value of the trip above the amount stated previously? If so, how much?

The marginal value of fish was calculated by dividing the change in value of the actual trip by the change in the number of salmon/herring caught.

Sampling Method

Two hundred anglers were randomly drawn from a data base of approximately 600 telephone contacts of individuals who had recently been interviewed by the WA Fisheries Department's creel survey. Details of the sampling procedure are summarised in Figure 5 below.

Figure 5: Flowchart showing how the sampling frame was obtained.



SURVEY RESULTS

Analysis of Willingness to Pay Responses.

The flow chart below (Figure 6) shows how respondents answered the contingent valuation section of the questionnaire. Of the sample of 97 recreational anglers, 13% were unable to give a dollar value for their fishing experience and were subsequently removed from the sample. Nearly the same proportion of people (10%) gave a zero bid which either constituted either a protest at the idea of having to pay for fishing, or a 'true' zero bid . All zero bids were retained in the sample, such that mean willingness to pay was calculated from a sample of 84 fishermen.

Respondents were willing to pay, on average, $27 per day of fishing over and above their mean expenditure of $21/day, giving a total value of $48/day (Table 2). There is a great deal of variation about these means, as illustrated by a frequency distribution plot of willingness to pay bids (Figure 7). The distribution tends to be skewed towards zero, with approximately 85% of respondents bidding $45 or less for a day of fishing. Because several high bids lift the mean it is more informative to use the median bid of $15.00 as a measure of fishermen's net economic surplus. It is not unusual for contingent valuation to yield skewed bid distributions (Mitchell and Carson, 1989).

Figure 6: Flowchart showing how respondents answered the willingness to pay questions relating to the actual fishing experience and those relating to preferences for a greater catch of herring and salmon.

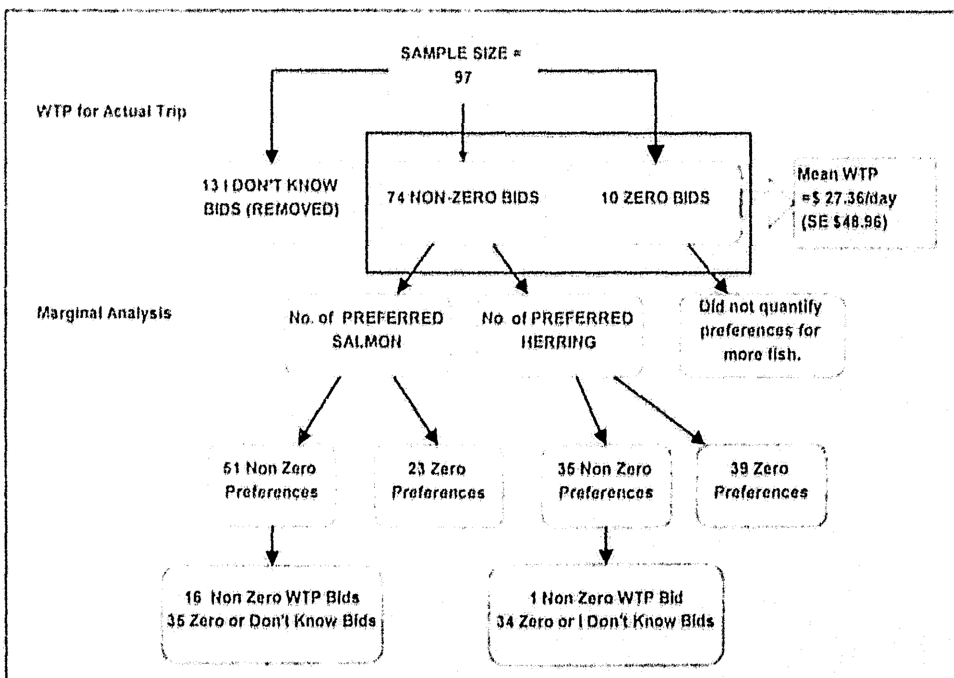
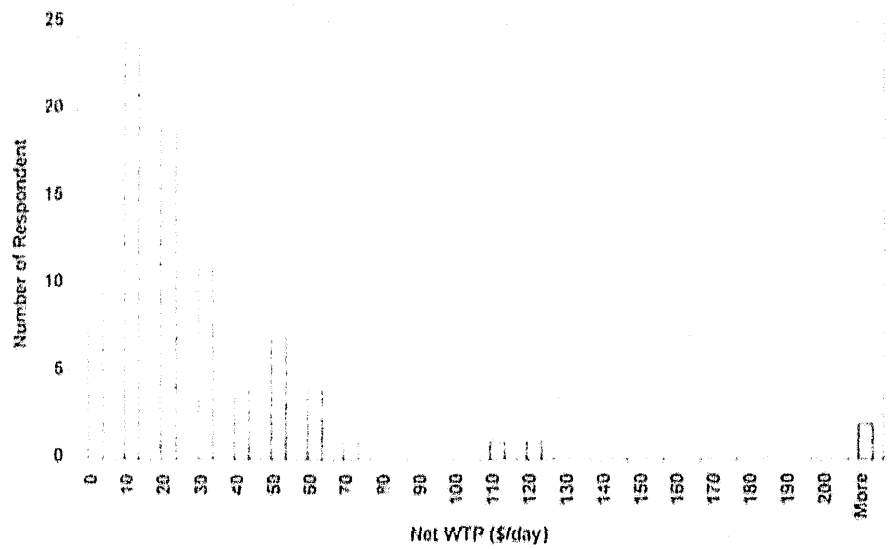


Table 2: Sample means and medians from the contingent valuation survey. Standard errors in parenthesis. (n=sample size)

Item	Mean (SE)	Median	n
Expenditure ($/day)	$21.41 (20.13)	$14.50	84
Net Willingness to Pay ($/day)	$27.36 (48.96)	$15.00	84
Marginal Value of Salmon ($/fish)	$5.55 (13.02)	$0.00	51

Figure 7: Frequency distribution plot of the dependent variable; net willingness to pay. Sample size equals 84 observations.



Respondents who gave a non-zero bid for the 'actual' fishing experience were questioned at further length about their preferences for more (some) salmon and herring. 69% of these people said they would have preferred to catch more (some) salmon and 47% wanted more (some) herring. As expected, salmon were sought after in small quantities, reflecting their status as a prize fish, while preferred catches of herring were much more liberal. Most people were content with only one or two salmon per day (median=1), while the preferred median number of herring was 12 per day.

The relative scarcity of salmon compared to herring also meant that people were willing to pay greater amounts for additional salmon than herring. Of the 51 respondents who said they would have preferred to catch more (some) salmon, only 16 were prepared to pay more than their bid for the actual trip. Including zero and non-zero bids, the mean marginal value of salmon was calculated to be $5.55/fish and the median was zero. This is not a very reliable measure of salmon's value because of the high standard error ($13.02). In the case of herring, only one respondent was willing to pay for their preferred number of fish. The most probable reason for such a large number of zero bids is that anglers are reasonably satisfied with their current catches of herring and further increases in catch may only marginally improve their utility from fishing. This is not to say that herring are not a valuable recreational species. The marginal value of the first few herring caught on a day out fishing may be very high, but this was not measured by the survey.

In general, only a small proportion of the total sample were prepared to pay more for their preferred number of fish. It is suspected that many respondents made an *ex ante* valuation of fishing rather than an *ex post* valuation of their actual trip, despite repeated reminders that we were only interested in valuing the specific trip in question. By making an *ex ante* bid, respondents had already included the possibility of catching more salmon or herring into their initial bid.

<u>Net Willingness To Pay Model</u>

It is postulated that a fisl. rman's total willingness to pay for a day of fishing net of trip expenses is explained by five main groups of variables, including:

1. Wealth of the respondent
2. The average number of fish caught per day of the trip.
3. The respondent's degree of specialisation in the sport.
4. The respondent's consumptive orientation, i.e. whether or not catching fish are an essential part of making a fishing trip satisfying.
5. Quality of the fishing experience other than catch.

Net willingness to pay was the dependent variable in the model, and a description of the independent variables belonging to each of the five main groups listed above is provided in Table 3. An index capturing the consumptive orientation of an individual has been included because previous studies have found that willingness to pay tends to be greater for those fishermen who regard catching fish to be non-essential for making the fishing trip satisfying (Fedler and Ditton, 1986). The logic behind this is that those anglers who gain satisfaction from a wider package of experiences whilst fishing are likely to have their expectations fulfilled more often than those who are only concerned with catching fish. It is debatable whether this attitudinal variable is determining willingness to pay, or whether it is simply another proxy for the dependent variable.

Sociological research has also found that a fisherman's degree of specialisation tends to influence willingness to pay via the effects that specialisation has on an individual's consumptive orientation. Bryan (1977) found that as people become more specialised in fishing, their appreciation of the fishing experience grows beyond just the thrill of catching fish. Hence it is more likely that highly specialised anglers will have a greater willingness to pay, for the same reasons outlined above.

Table 3: Description of explanatory variables in the willingness to pay model.

Dependent Variable:

	WTP =	Net willingness to pay for the whole fishing experience ($/day).

Explanatory Variables and their expected signs:

Wealth Variables:

+ve	INCOME =	Annual income of respondent.
+ve	EMPLOY =	Employment status of respondent (1 is employed; 0 unemployed or retired.)

Fish Catch Variables:

+ve	SALM =	Respondent's mean daily catch of salmon over duration of trip.
+ve	HERR =	Respondent's mean daily catch of herring over duration of trip
+ve	ALLFISH =	Respondent's mean daily catch of all fish over duration of trip

"Specialisation Level" Variables:

+ve	GEAR =	The total estimated value of all fishing gear possessed by the respondent.
+ve	ACTIVITY =	1 if fishing was the primary activity for the respondent on the visit; 0 otherwise.
+ve	CLUB =	1 if respondent is a member of an angling club, 0 otherwise.

Consumptive Orientation Variable:

-ve	SATISFY. =	An index measuring whether or not fish catch is essential for making a fishing trip satisfying or enjoyable. Scale ranging
from		catch being incidental (3) to essential (15).

Quality of Experience Variables (other than catch)

+ve	HRSFISH =	The average number of hours fished at the site per day of the trip
+ve	WEATHER. =	Respondent's recall of the suitability of weather and sea conditions for fishing on a scale ranging from poor (1) to excellent (5).
-ve	CONGEST =	Number of other people on the beach. (From creel survey).
-ve	PROBS =	An index derived from a summation of 5 responses, each of which measures whether or not the respondent perceives there to be a problem at the fishing site. The 5 problems relate to roads, facilities, pollution, crowding, commercial fishermen. index ranges from no problems at all (5) to severe problems (25).

Trip Expense Variable:

-ve	TRIP =	The amount of money spent by the respondent on the fishing trip, including travel expenses ($/day).

Fishing trip expenses were also included in the model, as the dependent variable is net of trip costs. It was thought that net willingness to pay should be higher for less expensive trips, as the individual's fishing costs comprise a smaller proportion of his/her total benefit.

An examination of the frequency distribution plot of the dependent variable (Figure 7) reveals that the majority of respondents gave a net willingness to pay bid of $40 per day or less but there were two bids which exceeded $200 per day. These bids were deemed to be extreme outliers and they were consequently removed from the data set, reducing the total number of observations to 82. Mean willingness to pay for this smaller dataset is $20.57/day with a standard error of $22.18.

Before developing a regression model, correlations between variables were analysed (Appendix 2a.). Willingness to pay appeared to be influenced positively by trip expenses (TRIP) and the number of hours fished (HRSFISH) with correlation coefficients of 0.301 and 0.234 respectively. The sign on trip expenses is contrary to expectations and may indicate that the payment vehicle used in the survey (travel costs) has introduced starting point bias, meaning that people based their bid for the actual trip arbitrarily on the size of trip costs. A weak negative correlation (-0.202) was observed between the fishermen's consumptive index (SATISFY) and willingness to pay, consistent with theory. The catch variables are not strongly correlated to willingness to pay.

A decision was made to remove ALLFISH and EMPLOY from the model as these variables were strongly correlated with HERR and INCOME respectively. This was done so as to reduce multicollinearity in the regression model.

A general linear model of willingness to pay with all 12 explanatory variables was estimated by ordinary least squares using the software package Microfit V3.0 (Pesaran and Pesaran, 1991). Estimates of the general specification (model A) are given in the first column of Table 4. The coefficients of the catch variables, which are of particular interest in this study, do not have significant t ratios. The variables TRIP and SATISFY have significant coefficients at 10% and 5% significance level respectively, but the regression is not significant. The diagnostic tests also indicate that there are problems with functional form, normality and heteroscedasticity. As such the general model is not an adequate specification.

In order to improve the specification, the non-significant site quality and specialisation variables were excluded to produce model B. A nested test of model B against the general model was performed to check the validity of excluding these variables, which yielded a significant F statistic at 10% indicating that it was acceptable to exclude the variables.

Model B proved to be a better specification, with a significant F statistic for the regression, although heteroscedasticity and misspecified functional form are still present (Table 4). As catch rate of salmon and herring did not appear to be influencing willingness to pay, it was decided to remove these variables. A variable deletion test confirmed that this was a sensible decision. The subsequent specification, called model C, had a better adjusted R^2 value of 0.128, but the diagnostic tests reveal that there are still problems with the specification.

Table 4: Estimates of the general specification and three alternative models. Absolute t ratios are given in parenthesis. (n=82)

Regressors	Model A General Specification	Model B Site quality and specialisation variables removed	Model C Model B with catch and wealth variables also removed.
Intercept	16.669 (0.881)	16.668 (1.445)	19.840 (2.216) **
Salm	-0.902 (0.269)	-1.586 (0.506)	
Herr	0.139 (0.366)	-0.216 (0.062)	
Gear	-0.003 (0.738)		
Trip	0.269 (1.867)*	0.326 (2.263)**	0.282 (2.372) **
Satisfy	-1.885 (1.985)**	-1.767 (-2.087)**	-1.724 (2.087) **
Weather	-0.531 (0.214)		
Income	1.130 (0.740)	0.694 (0.501)	
Club	5.201 (0.684)		
Congest	-0.225 (0.942)		
Activity	4.906 (0.486)		
Probs	-0.434 (0.236)		
Hrsfish	2.803 (1.558)	2.355 (1.473)	2.161 (1.528)
Descriptive statistics and Diagnostic Tests.			
R bar squared	0.046	0.099	0.128
SE	21.663	21.058	20.713
F-statistic	$F_{(12,69)}$ =1.328	$F_{(6,75)}$ =2.482**	$F_{(3,78)}$ =4.967***
Functional Form	6.550 ***	6.005 **	4.246**
Normality	69.507 ***	62.219 ***	62.852 ***
Heteroscedasticity	12.632 ***	14.330 ***	14.058 ***

* denotes significant at 10%, ** at 5% and *** at 1% or less.

The diagnostic tests are for functional form misspecification (Ramsey's RESET test), normality (asymptopic chi-squared test), and heteroscedasticity (asymptopic chi-squared test)

It is acknowledged in the literature that contingent valuation and other social survey techniques tend to produce low R^2 statistics. Hanley (1990) recommends that a minimum R^2 value of 0.2 should be used, while Mitchell and Carson (1989) suggest an R^2 value of 0.15 as a minimum. Based on these criteria, the net willingness to pay model reported in this study is not adequate for producing a reliable measure of recreational benefit. The most likely explanation for the low explanatory power is that important variables which capture attitudinal and lifestyle characteristics of the individual have been omitted. In addition, it is suspected that two weaknesses of the survey method contributed to the poor model fit. Firstly, the use of trip costs as a payment vehicle appears to have introduced starting point bias, and secondly, respondents did not seem to confine their bids to a specific trip but rather made an *ex ante* valuation of fishing in general. This could account for why site quality and catch rate variables were non-significant.

Travel Cost Model

An individual TCM was used to estimate the mean value of consumer surplus from recreational fishing across all sites. A trip generating function was built by recording the travel costs and visitation rates for individuals to each site and pooling over all sites. It is postulated that the number of visits per year taken by an angler to a particular fishing site (the dependent variable) is related to the following:

1. the direct costs of fishing and travel to the site.
2. attributes of the respondent.
3. quality attributes of the site.

The trip cost variable (TC) was taken to be the proportion of direct costs which are attributable to the fishing experience at the site as nominated by the respondent, plus the opportunity cost of travel time and the time spent on site. In addition to trip costs, a number of site and respondent attributes were thought to influence visitation rate. The number of visits made to a fishing site per year are expected to be inversely related to the trip cost variable. With respect to site attributes, it was reasoned that anglers are more likely to visit those sites with towns near by and those that they regard as having few problems, as measured by the PROBLEMS index. Several characteristics of the individual may influence their participation behaviour, including wealth, their degree of specialisation in fishing (measured by GEAR, and CLUB) and their consumptive orientation, which is captured by the variable SATISFY. All variables are defined in Table 5, together with the expected signs of their coefficients.

A frequency distribution plot of visitation data revealed there to be an outlier of 150 visits per year (Figure 8). This was deemed to be an unusually large value in the context of the rest of the sample, and as such was removed from the data set. This reduced the sample size to 83.

Figure 8: Frequency distribution plot of the dependent variable, number of visits per year, from a sample of 84 anglers.

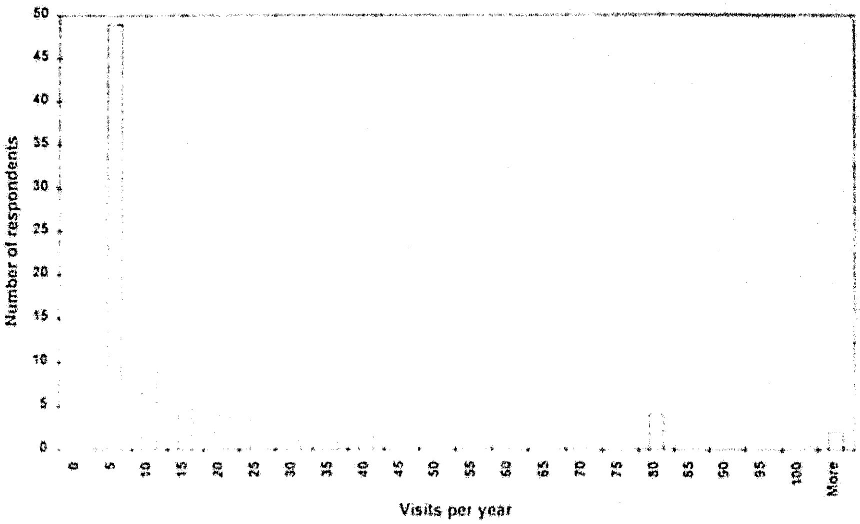


Figure 9: Scatter plot of trip costs on visits, showing an inverse exponential relationship.

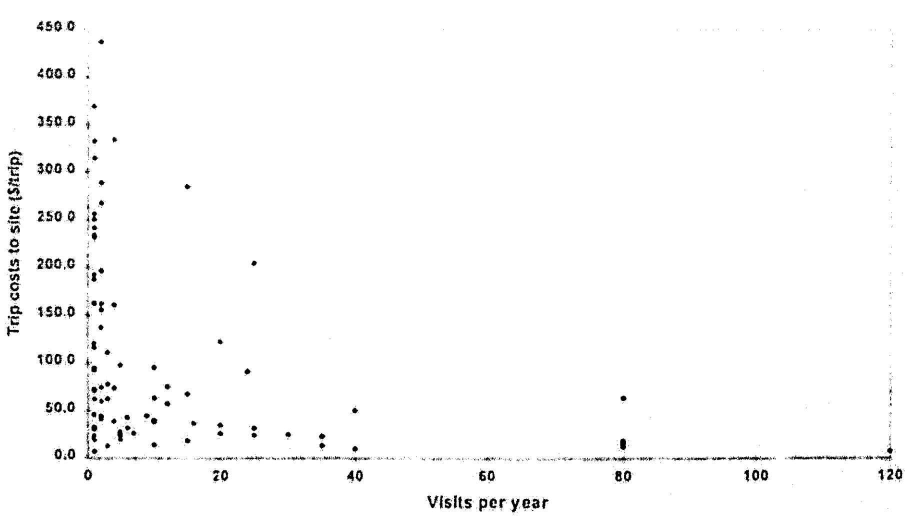


Table 5: Description of explanatory variables in the travel cost model.

Dependent Variable:

VISITS= Number of visits to the fishing site made by the respondent over the past 12 months.

Explanatory variables and their expected signs

Price Variable

-ve	TC	TC is the total costs of visiting a site ($/trip). TC= Σ (a,b,c): a) A proportion of the direct costs of the visit ($/trip) which are attributable to fishing, as recalled by the respondent. b) Opportunity cost of time spent travelling ($/trip) = [(hrs travel time)*0.33*income/2080hrs)] Hours travel time was based on 50km/hr for metro residents fishing at a metro site, and 90km/hr for metro residents travelling to a country site or for country residents travelling to either a country or metro site. c) Opportunity cost of time spent on site ($/trip) = (Av. hrs per day)*(Av. No. days per trip)* (0.5*income/2080)

Respondent's Attributes

+ve	EMPLOY=	Employment status of respondent (1 if employed; 0 unemployed or retired)
+ve	GEAR=	The total estimated value of all fishing gear possessed by the respondent
-ve	SATISFY=	An index measuring whether or not fish catch is essential for making a fishing trip satisfying or enjoyable. Scale ranging from catch being incidental (3) to essential (15).
+ve	INCOME=	Annual income of respondent
+ve	ACTIVITY=	1 if fishing was the primary activity for the respondent on the visit; 0 otherwise.
+ve	CLUB=	1 if the respondent is a club member; 0 if otherwise

Site Attributes:

-ve	TOWN=	Distance of the respondent's chosen fishing site from a major town (km).
-ve	PROBLEMS=	An index derived from a summation of 5 responses, each of which measures whether or not the respondent perceives there to be a problem at the fishing site. The 5 problems relate to roads, facilities, pollution, crowding, and commercial fishing. The index ranges from no problems at all (5) to severe problems (25).

Table 6: Estimates of the general specification and three alternative models. Absolute t ratios are given in parenthesis. (n= 83)

Regressors	Model A General Specification	Model B log trip costs	Model C Log dependent; log trip costs
Intercept	25.710 (1.754) *	54.802 (3.350) ***	4.421 (4.594)***
Gear	0.002 (0.631)	0.004 (1.242)	0.508 $\times 10^{-3}$ (2.637)***
Trip Cost	-0.056 (2.165)**	-9.676 (3.585) ***	-0.867 (5.459)***
Satisfy	0.333 (0.367)	0.561 (0.647)	0.025 (0.488)
Income	2.015 (1.415)	-0.364 (0.248)	0.135 (1.556)
Town	-0.050 (0.668)	-0.011 (0.151)	0.006 (1.329)
Probs	-1.086 (0.636)	-1.236 (0.760)	-1.38 (1.446)
Club	-6.704 (0.941)	-8.238 (1.217)	-0.686 (1.723)*
Activity	6.296 (0.710)	1.774 (0.206)	0.529 (1.046)
Descriptive statistics and Diagnostic Tests.			
R bar squared	0.074	0.161	0.308
SI	21.022	20.010	1.177
F-statistic	$F_{(8,74)}$ =1.820	$F_{(8,74)}$ = 2.969 ***	$F_{(8,74)}$ =5.571***
Functional Form	12.672 ***	14.525 ***	4.454 **
Normality	262.841 ***	206.843 ***	1.772
Heteroscedasticity	10.035 ***	16.764 ***	3.643 *

* denotes significant at 10%, ** at 5% and *** at 1% or less.

The diagnostic tests are for functional form misspecification (Ramsey's RESET test), normality (asymptopic chi-squared test), and heteroscedasticity (asymptopic chi-squared test)

A correlation matrix of the variables (Appendix 2b) shows that visitation rate varies inversely with travel costs with a coefficient of -0.327, which is consistent with demand theory. A scatter plot of these two variables reveals that the relationship is non-linear (Figure 9). Contrary to expectations, the number of visits are negatively correlated with income (-0.259) and employment (-0.249). A likely explanation for this is that unemployed and retired people have more time available to make frequent, short fishing trips to their local fishing site. The variables EMPLOY and INCOME are highly correlated with one another (0.657), so to avoid multicollinearity EMPLOY was removed from the model.

A general linear model of visitation rate was firstly specified and estimated by ordinary least squares using the software package Microfit V3 (Pesaran and Pesaran, 1991). Estimates of this general model which included 8 regressors (model A) is given in the first column of Table 6. The trip cost variable is the only regressor with a significant coefficient, and overall the general model is not adequate for explaining visitatation rate as it has a non-significant F statistic and a low adjusted R^2 value. The diagnostic tests reveal the functional form is misspecified and that heteroscedasticity is present.

In order to rectify these problems, semi log independent and double log specifications were estimated. In model B, trip costs were transformed to logs. This specification yielded a better adjusted R^2 value but the diagnostic tests indicate that there are still problems with functional form and heteroscedasticity. The double log model (model C) has a reasonable adjusted R^2 value of 0.308 and a highly significant F statistic. Coefficients of the variables GEAR, logTC, and CLUB are all significant, however heteroscedasticity is still present and functional form is still a problem. While the double log form produces the best model fit, it does not agree with theoretical expectations because it implies infinite visits per individual at zero cost and generates infinite consumer surplus whenever demand is inelastic. For this reason, model B was used to generate an estimate of consumer surplus.

Estimates of Aggregate Recreational Benefits

Table 7 summarises four different estimates of the net economic benefit from recreational fishing, ranging from 1.5 to 6.0 million dollars depending upon the technique used to derive the estimate. Benefits accruing to the individual angler were aggregated using the West Australian Fisheries Department's 1994 creel survey, which estimated angler effort to be 104,000 angler days (Ayvazian pers. comm.). The benefit estimate from version C of the willingness to pay regression model was obtained by substituting mean values of all variables into the function. A fourth estimate of angler's welfare was calculated from the log independent travel cost model (version B). This was obtained by setting all variables, other than trip costs, to their mean values in order to produce a simplified demand curve for fishing in terms of visits and trip costs. Consumers surplus was then calculated by integrating this function between mean trip costs (derived directly from the sample) and the level of trip costs that corresponds to zero visits.

Table 7: Net economic benefits from recreational fishing in southern Western Australia. Individual benefits were aggregated using data from the WA Fisheries Department's creel survey which estimated angler effort in 1994 to be 104,000 angler days per year.

	Consumer Surplus Estimates	
Source of Estimate	Individual ($/day)	Aggregate ($mill/yr)
Sample mean Willingness to Pay	27.36	2.85
Sample median Willingness to Pay	15.00	1.56
Willingness to Pay (Model C)	17.97	1.87
Travel Cost Method (Model B)	60.30	6.27

Conclusions and Further Research.

Generally, the regression results were disappointing and the welfare estimates produced in Table 7 need to be interpreted cautiously owing to the poor goodness of fit displayed by the models which generated them. In light of the difficulties encountered in this study, together with the problems reported by other researchers working in this area, the future role of survey techniques in estimating recreational fishery benefits needs to be clarified.

While the results to date are inconclusive, they have presented some new insights to recreational fishing economics that need to be investigated further. For instance, anglers appear to base their behaviour on *ex ante* evaluations of the fishing experience, and their utility from fishing is a function of the extent to which these expectations are met. It follows that an alteration to an angler's expectations will influence his/her level of benefits per trip and also his/her future level of participation. It is the intent of the authors to research angler preferences in more detail and to incorporate the findings into an analytical model of resource allocation.

References

ABARE (1994). Australian Fisheries Statistics. Australian Bureau of Agricultural and Resource Economics.

Anderson, L. G. (1983). "The demand curve for recreational fishing with an application to stock enhancement activities." Land Economics 59(3): 279.

Ayvazian, S. (1995) Personal communication.

Bateman, I. J. and R. K. Turner (1993). Valuation of the Environment, Methods and Techniques. The Contingent Valuation Method. Sustainable Environmental Economics and Management. London, Belhaven Press. p72.

Bishop, R. C., S. R. Milliman, et al. (1990). "Benefit-cost analysis of fishery rehabilitation projects: A Great Lakes case study." Ocean and Shoreline Management 13: 253.

Bryan, H. (1977). "Leisure value systems and recreational specialisation: The case of trout fishermen." Journal of Leisure Research 9: 174.

Carson, R. T., N. E. Flores et al. (1995). "Contingent valuation and revealed preference methodologies: Comparing the estimates for quasi public goods." Draft paper unpublished.

Fedler, A. J. and R. B. Ditton (1986). "A framework for understanding the consumptive orientation of recreational fishermen." Environmental Management 10(2): 221.

Hanley, N. D. (1990). "Valuation of environmental effects: Final Report- Stage One." Industry Department of Scotland and the Scottish Development Agency, Edinburgh.

Johnson, N. S. and R. M. Adams (1989). "On the marginal value of a fish: Some evidence from a Steelhead fishery." Marine Resource Economics 6: 43.

Lal, P., P. Holland, et al. (1992). "Competition between recreational and commercial fishers. Management options and economic research". ABARE Research Report 92.11

Lenanton, R. C. (1994). WRFC Annual Report. WA Fisheries Department.

Lenanton, R. C., L. Joll, et al. (1991). "The influence of the Leeuwin Current on coastal fisheries of Western Australia." Journal of the Royal Society of Western Australia 74: 101.

Loomis, J. B. (1988). "Comparative reliability of the dichotomous choice and open ended contingent valuation techniques." Journal of Environmental Economics and Management 18: 78.

Loomis, J. B. and D. M. Larson (1994). "Total economic values of increasing Gray Whale populations: Results from a contingent valuation survey of visitors and households." Marine Resource Economics 9: 275.

Milon, W. J. (1991). "Measuring the economic value of anglers' kept and released catches." North American Journal of Fisheries Management 11: 185.

Mitchell, R. C. and R. T. Carson (1989). Using surveys to value public goods: The contingent valuation method. Washington, D C.

Pesaran, M. H. and B. Pesaran (1991). Microfit Version 3 User Manual. Oxford University Press, Oxford, UK.

Samples, K. C. and R. C. Bishop (1985). "Estimating the value of variations in anglers' success rates: An application of the multiple-site travel cost method." Marine Resource Economics 2(1): 55.

Sorg, F. C. and J. B. Loomis (1986). "Economic value of Idaho sport fisheries with an update on valuation techniques." North American Journal of Fisheries Management 6: 494.

Staniford, A. J. and S. K. Siggins (1992). "Recreational fishing in Coffin Bay: Interactions with the commercial fishery." Fisheries Research Report No. 32. Fisheries Department of South Australia.

Whitehead, J. C. (1993). "Benefits of quality changes in recreational fishing: A single site travel cost approach." Journal of Environmental Systems 21(4): 357.

Appendix 1:

Economic Survey of Recreational Fishing

Part 1: Preliminary data about the respondent determined from the WA Fisheries Department's Creel Survey.

Date of this Interview.	
Date of Creel Interview	
Creel Identification Number	
Site Location	
Distance of site to closest major town	
Congestion (number of anglers on beach)	
Distance of respondent's origin to the fishing site.	
Member of angling club?	
Hours spent travelling (return trip)	

Part 2: The Qusstionnaire.

It is well known that the West Australian community gains a great deal of economic and social benefits from recreational fishing. However, it is difficult to observe how much these benefits are worth in dollar terms because, unlike commercially caught fish, there is no price attached to the experience of recreational fishing. People at the Fisheries Department and the University of WA are currently conducting research to find out more about the recreational salmon and herring fishery. For instance, the research aims to find out how many fish are being caught, what size they are, and to estimate how much anglers spend to go fishing. The purpose of this survey is to estimate the size of economic and social benefits being generated by anglers who fish for salmon and herring.

How many days have you fished over the past 12 months?	<5 5-10 11-25 >=26
How many days did you spend fishing at the survey site?	
At the time of the interview you had caught:	..........salm ....herr..........other
Is this representative of your average daily catch on whole trip? If not what was your catch?	
How many hours did you spend fishing at the site?	
Over the last 12 months, how many visits have you made? If MULTIPLE trips, what is the average duration (days)?	
What is your employment status?	employed, retired, U/E, student.
Weather and Sea conditions at survey site were recorded as: How would you rate the conditions for fishing on the majority of the trip?. Poor, below average., average, above average, excellent.	Wind:.......................... Seas:.......................... Cloud:..........................
Was fishing the primary activity on this trip?	

Catching fish may be only one of a variety of reasons why people go fishing. Using the scale on this card, please indicate to what extent you agree with each of the following statements about your satisfactions from FISHING during the trip on which you were interviewed. *[Show card]*

	Statement No		
	1	2	3
Strongly disagree	(1)	(5)	(5)
Disagree	(2)	(4)	(4)
uncertain	(3)	(3)	(3)
Agree	(4)	(2)	(2)
Strongly Agree	(5)	(1)	(1)

Total Score

1. I would not have been satisfied with the fishing experience unless I caught something
2. The fishing experience would have been successful to me even if no fish were caught
3. I would have been equally happy with the fishing experience regardless of whether I caught some fish or caught nothing

Trip Expenses

For the trip on which you were interviewed, I would like you to roughly estimate how much money you would have spent on each of the following items. [For group trips, ask for the angler's share of expenses]

	Daily cost	Trip cost (daily cost * No days)
Fuel for the return trip		$
Vehicle R & M		$
Lost tackle and gear		$
Bait and ice	$	$
Food and Beverage	$	$
Accommodation	$	$
TOTAL		$

What proportion of the trip expenses was due to fishing?	
…ch do you estimate your fishing gear is worth at today's prices (2nd hand value)	
… following questions refer to what you are prepared to spend on fishing:	
Please use Q 13 on the card to indicate your personal annual income. Call out the letter which corresponds	

How much of this would you spend on entertainment, sport, hobbies etc over 12 months? (% or $).	
How much would you have spent on fishing over the last 12 months? ($)	
Recall that for the trip on which you were interviewed you spent $..............Based on your catch, weather.and enjoyment, do you think that this trip was worth the expense?	
Suppose that it becomes more expensive to go fishing. Based on your enjoyment from this trip, would you still have taken the trip if costs had been higher?	
If yes, what is the most costs could to rise to before you decide that your fishing experiences on this trip were not worth the expense?	
Would you have preferred to catch some (more) salmon?	
How many in a day would have satisfied you?	
If you had been fortunate enough to catch this number of salmon, would this have increased the value of the trip above the amount stated previously? If so, how much?	
Would you have preferred to catch some (more) herring?	
How many in a day would have satisfied you?	
If you had been fortunate enough to catch this number of herring, would this have increased the value of the trip above the amount stated previously? If so, how much?	

There may have been a number of things on the trip which detracted from your enjoyment of fishing. Using the scale on this card, please indicate the extent to which you found each of the following things a problem.

No problem at all	Very slight problem	Uncertain	Minor problem	Major problem.
1	2	3	4	5

A. The quality of the access roads into this particular fishing site.________

B. The availability of facilities such as toilets, kiosk, and steps to the beach at this particular fishing site. ______________

C. The level of pollution on the beach and in the water on this particular day of fishing .____

D. The number of other people at fishing sites on this particular day of fishing.

____

E. The presence of commercial fishermen in the region on this particular day of fishing .

Appendix 2a

Correlation matrix of variables thought to influence willingness to pay. (n=82)

	WTP	SALM	HERR	ALLFISH	EMPLOY	GEAR	TRIP	SATISFY	WEATHER	HRSFISH	INCOME	CLUB	CONGEST	ACTIVITY	PROBS
WTP	1.00														
SALM	0.11	1.00													
HERR	0.01	-0.09	1.00												
ALLFISH	0.01	-0.07	0.78	1.00											
EMPLOY	0.02	0.12	-0.13	-0.18	1.00										
GEAR	0.12	0.25	0.10	0.08	0.01	1.00									
TRIP	0.30	0.45	-0.02	-0.04	0.07	0.10	1.00								
SATISFY	-0.20	-0.06	-0.09	-0.03	-0.01	-0.31	0.03	1.00							
WEATHER	-0.01	-0.08	0.00	0.11	-0.05	0.01	-0.10	-0.04	1.00						
HRSFISH	0.23	0.18	-0.01	0.06	-0.23	0.38	0.30	0.04	0.03	1.00					
INCOME	0.04	0.10	-0.09	-0.07	0.65	0.05	0.07	0.00	0.09	-0.18	1.00				
CLUB	0.11	0.15	-0.15	-0.13	0.13	0.21	0.10	-0.17	-0.09	-0.06	0.07	1.00			
CONGEST	-0.08	0.06	0.13	0.05	0.00	-0.14	0.03	-0.07	-0.21	0.10	0.08	0.07	1.00		
ACTIVITY	0.15	0.05	-0.15	-0.05	-0.10	0.17	0.14	-0.07	-0.09	0.30	-0.14	0.11	-0.09	1.00	
PROBS	-0.02	0.10	0.00	-0.06	0.12	0.18	-0.08	0.08	-0.02	0.24	0.20	-0.04	0.07	0.12	1.00

Appendix 2b

Correlation matrix of variables thought to influence the number of visits to a fishing site (dependent variable in the travel cost model). n=83

	VISITS	EMPLOY	GEAR	SATISFY	INCOME	CLUB	TOWN	RESIDE	ACTIVITY	PROBS	TC
VISITS	1.00										
EMPLOY	-0.20	1.00									
GEAR	0.09	-0.01	1.00								
SATISFY	-0.07	0.00	-0.31	1.00							
INCOME	-0.18	0.65	0.03	0.02	1.00						
CLUB	-0.09	0.12	0.21	-0.16	0.07	1.00					
TOWN	-0.14	0.01	-0.11	0.05	0.06	-0.09	1.00				
RESIDE	-0.29	-0.18	-0.06	0.16	-0.10	-0.06	0.10	1.00			
ACTIVITY	0.13	-0.12	0.19	-0.07	-0.15	0.12	0.04	-0.41	1.00		
PROBS	-0.17	0.13	0.19	0.07	0.22	-0.03	-0.09	-0.15	0.14	1.00	
TC	-0.32	0.15	-0.02	0.16	0.23	0.02	0.29	0.64	-0.15	0.03	1.00