An Economic Assessment of Reallocating Salmon and Herring Stocks from the Commercial Sector to the Recreational Sector in Western Australia

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SUMMARY

Many fisheries in Australia and overseas are coming under increasing pressure from a variety of user groups who are demanding greater access to fish stocks and their related habitats. For instance, owing to the growing number of recreational fishermen, there is now considerable community pressure to revise management plans to ensure the needs of anglers are catered for. Other groups such as aquaculturists, miners, indigenous people, and developers are also calling for greater access. These demands come at a time when stocks in some fisheries are becoming scarce, thereby limiting the extent to which total effort can be allowed to grow. As a consequence, fisheries managers are being forced to consider how to best allocate limited fishery resources among multiple users.

Procedures for objectively assessing allocation decisions are not well defined. Instead, the political process usually determines allocation, resulting in groups with the greatest lobbying power gaining the largest share of access. Efforts are now being made by government to allocate fish stocks in a less arbitrary manner by granting access to those groups who obtain the highest value from using the resource. This approach is consistent with the goal of maximising economic benefits to society. Unfortunately, these efforts are being impeded by insufficient knowledge about the non-market benefits associated with activities like recreational fishing, and the methods by which accurate measures of these values can be obtained.

This study focuses on the Australian Salmon (*Arripis truttaceus*) and Australian Herring (*A. georgianus*) fisheries of Western Australia which are fished jointly by commercial and recreational fishers. Conflict over resource sharing is a major issue in these fisheries, and in response the government has considered a range of policies for partially reallocating fish stocks to the recreational sector. The main purpose of this project was to quantify the economic gains and losses from a shift in allocation. A related objective was to define the strengths and limitations of survey techniques designed to elicit recreational benefits.

Economic performance of the commercial fishery was assessed using data from an earlier survey conducted by McLeod and McGinley [1]. In this survey, data on the costs and revenue of salmon and herring fishing was obtained for seven out of twenty six active operators. Average short run profit for 1991/92 was estimated to be $24,239 per operator, or $630,227 across the whole industry (1996 dollars). Allowing for the seasonal variation in prices, catch, and differing levels of efficiency among operators, it was estimated that profits vary between $10,000 to $30,000 per licence. Alternatively, 1991/92 profit expressed in terms of per unit catch was approximated to be $260 per tonne of salmon and $240 per tonne of herring (1996 dollars). Economic rent is likely to be substantially lower than short run profit, and in some years will be negative. The relatively low profits per licence holder indicates that there is more effort in the industry than is needed to take the current level of harvest. It is suspected that some of the potential economic rent form the fishery is being dissipated due to an excessive number of small operators.

[1] McLeod, PB and C. McGinley (1994) Economic Impact Study; Commercial Fishing in Western Australia. Fisheries Management Paper No. 61, Fisheries Department of Western Australia.

The economic benefits from a day of recreational fishing over and above fishing costs were elicited using two non-market valuation techniques. The primary method used was contingent valuation, which asked individuals to nominate their maximum willingness to pay for a particular day of fishing and how much they would be prepared to pay for an increase in catch. Payments were in the guise of extra trip costs. The travel cost method was adopted as a secondary technique and used to validate the estimates produced by contingent valuation.

Data for the two valuation methods was collected from a sample of ninety seven anglers using a face-to-face interview which was conducted during February to May, 1995. On average, anglers spent $21 per day or $902 per year on fishing, which represents a minimum value for recreational fishing. In addition to expenditures, anglers obtained between $15 and $33 per day economic surplus from their fishing experience. The aggregate value of these benefits amounted to between 1.5 to 3.4 million dollars. This provides a measure of the net welfare generated by recreational fishing in southern Western Australia.

It is difficult to determine how sensitive these benefits are to changes in the availability of salmon or herring, but the results do provide some economic justification for shifting the allocation of salmon away from the commercial sector and towards the recreational sector. This conclusion was reached by comparing the marginal value of salmon as a sport fish, estimated to be $5.55/fish, compared to the marginal value of salmon in its commercial use, estimated to be $0.84/fish. The results for herring are less conclusive, as the survey was unable to elicit marginal values for this species. Owing to the asymmetrical properties of recreational and commercial fishing activities, the task of obtaining valid comparisons of economic value for each sector at the margin is extremely complex. Therefore, the numerical values presented in this study should be regarded as approximations only.

BACKGROUND

Competing demands by various user groups for coastal and fishery resources in Australia is becoming a major issue in fisheries management. Increasing pressures on fish and their habitats has led to conflict over the extent of access that should be allocated to each interest group. For example, the growing number of anglers has raised concerns about over-fishing in some fisheries, and managers are faced with the option of reducing either angler catch, commercial catch, or both. In other fisheries there is sufficient quantities of the resource for both users but conflict still exists because one group may be prejudiced toward another group's use of the resource or to its social behaviour. Similar dilemmas arise when fisheries become subject to growing pressures from tourism, aquaculture, and mining interests.

The salmon and herring fisheries in Western Australia are two fisheries for which there is considerable community pressure to revise allocation of stocks between recreational and commercial fishers. The commercial sector is relatively small, producing between 1500 to 2500 tonnes of salmon and 800 to 1500 tonnes of herring annually. 34 licensed fishermen and their crews operate in the fisheries, providing part-time employment for approximately 125 people[2]. The sector also involves eleven

[2] Western Australian Fisheries Department, 1992/93 Annual Report.

local processing firms who carry out first stage processing of the catch. Most processors also handle other species of fish.

Each of the licensed operators hold rights to fish for salmon and/or herring on one or two specific beaches. Both fisheries are limited entry and operators are restricted by the type of gear they can use and the length of season over which to harvest fish. Owing to the seasonal nature of salmon and herring fishing, people engaged in these fisheries have other occupations or hold licences for other fisheries. Some licensees have been operating since the mid 1940's and a strong sense of property has developed over time as a salmon licence conveys exclusive fishing rights to an assigned beach[3]. They also attach a high value to professional fishing as a way of life.

The recreational sector in southern Western Australia is estimated to constitute over 100,000 active anglers[4], many of whom regard salmon and herring to be very important angling species. Recreational fishermen are thought to take approximately 10 to 15 per cent of the total salmon catch, while for herring the proportions are as high as 25 to 30 per cent[5]. Because commercial fishermen are restricted to the shoreline, anglers frequently witness netting activities. This no doubt aggravates the tensions between the two sectors, especially in years of low catch. The strength of the recreational sector's conviction to reduce commercial harvesting was recently demonstrated by the Western Australian Recreational Fishing Advisory Committee's proposal to buy back several commercial salmon licences. A variety of other management options have also been proposed by the recreational sector to increase its share of the resource. These include zoning, prohibiting the transfer of commercial licences, and restricting the size of commercial catch.

From an economic efficiency viewpoint, fish stocks should be allocated to those groups who gain the greatest marginal value from using the resource as this is consistent with the goal of maximising economic benefits to society. However there is presently no formal framework in place to facilitate the efficient allocation of resources.

NEED

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 the gross value of commercial production with the total expenditures of recreational fishermen. This is usually done within an economic impact framework, which does not provide adequate information for making allocation decisions. What is needed is information on the average net economic benefits of angling, and the marginal value of a fishing day or an extra fish caught. But only a handful of Australian studies have produced this

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[3] Monaghan, PJ (1991) A study into the feasibility of establishing a system for the buy-back of salmon fishing authorisations and related endorsements. Fisheries Management Paper No. 44. West Australian Fisheries Department.

[4] Australian Bureau of Statistics (1989). Recreational fishing in Western Australia, July 1987.

[5] West Australian Fisheries Department 1994 Salmon and Herring Creel Survey, (unpublished).

information. 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 of what influences angler's satisfaction from fishing.

Efforts to formulate allocation policy based on the principle of economic efficiency is being impeded by insufficient knowledge about the non-market benefits associated with recreational fishing and the methods for obtaining accurate measures of these values. This study sought to overcome these deficiencies by producing comparable estimates of economic value for the recreational and commercial sectors of the salmon and herring fisheries.

OBJECTIVES

The project had three main objectives:

1. To estimate the economic value of recreational fishing for salmon and herring in Western Australia, and to determine the extent to which catch rates influence this value.

2. To estimate the economic value of the commercial fisheries for salmon and herring in Western Australia, and to assess the economic efficiency of current operations.

3. To quantify the economic gains and losses from reallocating salmon and herring stocks from the commercial to recreational sector.

Another aim, which is associated with objectives 1 and 3 above, was to define the strengths and limitations of survey techniques designed to elicit non-market benefits, with a view to making some statement about their suitability for inclusion in future resource allocation studies.

The completed study has partially fulfilled these objectives. For salmon, the results are sufficiently robust to indicate the direction in which access should be shifted to improve allocative efficiency, however for herring the results are inconclusive. A more complex model is needed to identify the optimal allocation of access between the two sectors.

METHODS

Evaluation of Commercial Sector

The economic performance of commercial salmon and herring fishermen was evaluated using survey data collected by McLeod and McGinley in 1992.[6] This survey was conducted as part of a wider economic impact study of commercial fishing in Western Australia. Data on income and expenses was collected using a postal questionnaire. Seven out of the twenty six salmon licence holders who were thought

[6] McLeod, PB and C. McGinley (1994) Economic Impact Study; Commercial Fishing in Western Australia. Fisheries Management Paper No. 61, Fisheries Department of Western Australia.

to be actively fishing in 1991/92 returned usable survey forms. As the majority of salmon fishermen also fish for herring, the costs and incomes of both operations were combined.

Demand and supply curves were not estimated for the fisheries because of data limitations. Instead, demand was assumed to be perfectly elastic, owing to the existence of many other species of fish which can be substituted for salmon and herring in their end products of pet food, bait and canned fish for human consumption. An elastic demand curve implies that the economic surplus accruing to fish consumers is negligible. This assumption may not be entirely reasonable, especially if there is scope for value adding. On the supply side, there is only limited data on the biology of salmon and herring fish stocks, and the relationships between catch and effort. This makes it difficult to estimate parameters of the production function, which is necessary for estimating marginal costs. Further work is needed to define the supply and demand curves.

No effort was made to quantify the non-market 'lifestyle benefits' that are associated with commercial salmon and herring fisheries, although some account was taken of these benefits by assuming the fishermen's own labour costs to be zero. While it is acknowledged that lifestyle benefits are substantial, it is argued that operators may be able to obtain similar benefits by continuing to fish for salmon and herring on a non-commercial scale.

The economic value of processing operations to Western Australia were not quantified, but in the case of salmon the change in total benefits to processors arising from a reduction in salmon supply are thought to be small because there are many substitutes for salmon. Similarly, for herring there are alternative sources of fish which can be marketed as rock lobster bait, so losses to the processing industry from a reduction in herring should be negligible.

Recreational Survey Techniques

Two well established economic survey techniques were used to value recreational salmon and herring fishing: The contingent valuation method (CVM) and the travel cost method (TCM). Contingent valuation was the primary technique used to value recreational fishing, with the travel cost method providing supplementary estimates of angler benefits against which to check the validity of estimates derived from contingent valuation.

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 method is also referred to as an expressed preference technique because it asks respondents directly what they are prepared to pay for a fishing experience over and above trip costs. 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 access price. The TCM is therefore known as a revealed preference technique.

<u>Sample Selection.</u>

During 1994 and 1995 the West Australian Fisheries Department conducted an extensive creel survey of recreational fishermen along the West Australian coast from Perth to Esperance. The purpose of this survey was to estimate total catch and angler effort in these regions. Boat and shore anglers were intercepted at over 100 fishing sites and were asked if they would be prepared to participate in a more detailed economic survey. Approximately 600 anglers offered to be interviewed at further length. A sub-sample was then obtained from this data base by retaining only those people who live in the Perth metropolitan area and seven major coastal regions. Two hundred contacts were then randomly selected from this sub-sample, such that the number of anglers in the sample from each region were proportional to the total amount of angler effort in each region, where effort was approximated by the number of intercept interviews conducted in each region.

No attempt was made to select anglers who were specifically targeting salmon and/or herring. However, the survey period coincided with the height of the salmon and herring season so one could expect that a reasonably large proportion of the sample would be seeking these species. Prior to conducting the survey, the questionnaire was tested using a focus group comprising club anglers and was also pre-tested with anglers on the beach. After making necessary refinements to the questionnaire, 114 face-to-face interviews were conducted at each angler's place of residence during February to May, 1995. Ninety seven usable questionnaires were obtained from these interviews.

Questionnaire Design

The contingent valuation questions in the survey followed an open-ended format. This entailed asking respondents to firstly estimate their total expenses for a specific fishing trip known to both angler and researcher. They were then asked to nominate how much trip costs could rise to before deciding that the particular trip in question was not worth the expense. Individual responses were analysed statistically by building a linear regression model, called the willingness to pay function, which included a variety of variables to explain the variation in net willingness to pay. The model was estimated by Ordinary Least Squares using the computer package Microfit V3.0[7] and a variety of tests were performed to assess goodness of fit.

The marginal value of salmon and herring was elicited in two ways, both of which utilised contingent valuation. The first method involved asking anglers to state their preferred daily catch of each species and the extra trip costs that they would be willing to pay if their preferred catch was realised. The marginal value of catch was then calculated by dividing the extra willingness to pay figure by the difference in actual to preferred catch levels. The second method involved partially differentiating the net willingness to pay function with respect to salmon and herring catch to derive a demand curve for each species.

An individual travel cost model was developed to provide an alternative estimate of recreational benefits. The number of visits per year by each individual to a particular site were regressed on the direct costs of fishing and travel to the site, the attributes of the respondent, and quality attributes of the site. The model was statistically analysed

[7] Pesaran and Pesaran, (1991). Microfit Version 3 User Manual. Oxford University Press, Oxford UK.

in the same way as the contingent valuation model. A consumer surplus measure of angler benefits was obtained by setting all variables, other than trip costs, to their mean values, then integrating the travel cost function between mean trip costs (derived directly from the sample) and the level of trip costs that corresponded to zero visits.

Aggregation of Benefit Estimates

The contingent valuation survey produced estimates of individual benefits per angling day. These benefits were aggregated to the whole recreational sector using an estimate of total angler effort per year of 104,000 angler days. This was obtained from the 1994 Fisheries Department creel survey. The travel cost method provided an estimate of individual angler benefits per annum. This figure was converted to benefits per day in order to make it comparable to the contingent valuation estimate. This involved dividing annual benefits by the sample mean number of visits (8.36 visits/yr), then dividing this result by the sample mean number of days per visit (1.84 days/visit) to obtain benefits per angling day.

RESULTS

Value of Commercial Fishing.

The mean income and costs of commercial salmon and herring fishing operations in Western Australia are summarised by Table 1. Survey data indicated that, on average, the short run profit for commercial operators in 1991/92 was $24,239 which equates to a whole sector profit of $630,227 (both estimates in 1996 dollars). These figures are not necessarily representative of the profitability of commercial salmon and herring fishing because 1991/92 was a poor year for salmon, with prices and catch being below their long term averages by 7.5% and 40% respectively. For herring, however, prices and catch were 4% and 24% higher than their long term averages. Allowing for the seasonal variation in prices, catch, and differing levels of efficiency among operators, it is expected that profits range between $10,000 to $30,000 per licence.

Table 1: Economic performance of West Australian commercial salmon and herring fishermen in 1991/92, based on a sample of seven operators. Aggregate values assume the sector comprises 26 active operators. All values expressed in 1996 dollars. (McLeod and McGinley, unpublished).

	Mean per Active Licence	Aggregate for Sector
Gross Income	$58,136	$1,511,542
Operating Costs	15,935	414,315
Vehicle Overheads	5,936	154,339
Office Overheads	1,600	41,596
Capital Costs	10,426	271,066
Total short run costs	33,897	881,315
Operating Profit	$24,239	$630,227

It must be emphasised that the profit values in Table 1 refer to the short run and do not equate to economic rent. This is because the opportunity cost of capital invested in fishing operations has not been accounted for. For this reason economic rent is likely to be substantially lower than short run profit, and in some years will be negative.

The survey also does not provide any information on the marginal net benefit of commercially catching salmon and herring. However, based on the cost structure identified in Table 1, net profit expressed per tonne of combined salmon and herring catch was estimated to be $252/t for 1991/92.

The relatively low profits per licence holder indicates that there is more effort in the industry than is needed to take the current level of harvest. It is suspected that some of the potential economic rent from the fishery is being dissipated due to an excessive number of small operators. The industry would possibly be more efficient if all the beach licences were replaced with only two or three larger operators, fishing off the coast with several purse seine vessels. While restricting fishermen to beaches is a good mechanism for protecting the biological resource, alternative regulations could be devised to limit effort.

Value of Recreational Fishing

The sample selected for this survey had number of distinguishing characteristics, some of which are summarised in Table 2. There was a roughly even split between metropolitan and country residents, but most people in the sample fished in country regions. About 30% of the sample were specifically targeting salmon, while a similar proportion were targeting herring. Only 10% were fishing for both salmon and herring. These results contrast with a survey conducted by the Australian Bureau of Statistics in 1987 which found that 12% of anglers were seeking to catch salmon and 39% were targeting herring.

Expenditures made by anglers in the pursuit of fishing provide a measure of the minimum value that recreational fishermen place on their sport. This study found that, on average, fishermen spent $21 per day, or alternatively $902 per year. These estimates compare favourably with an earlier study undertaken by McLeod and Lindner in 1991[8], who found that anglers spent between $575 to $1008 per annum (1996 dollars) on gear, travel, and other fishing inputs.

Table 2: Some of the sample characteristics of the recreational economics survey. Standard error in parenthesis.

Demographics	*% of sample*	*Target Species*	*% of sample*	*Expenditure*	
country residents	57	Salmon	29	mean daily	$21 (20)
metro. residents	43	Herring	32	mean annual	$902 (1170)
country fishing site	19	Salmon and Herring	10		
metro. fishing site	81	Other fish	30		

[8] McLeod, PB and RK Lindner (1991) The Economic Impact of Recreational Fishing in Western Australia. Fisheries Management Paper No. 38, Fisheries Department of Western Australia.

In addition to expenditures, anglers obtained a surplus value from fishing which represents the maximum they would be willing to pay for a fishing experience net of trip expenses. This value is termed consumer surplus. Table 3 lists four comparable estimates of consumer surplus which were elicited by the survey. The first measure is simply a sample mean of net willingness to pay. Of the 97 people interviewed, 13 were unable to provide a bid, and a further 10 gave zero bids. With the inclusion of these zero bids the sample mean was calculated to be $27.36 per day with a standard error of $48.96. A frequency distribution plot of the data (Figure 1) shows that there is a large amount of variation about this mean and that the distribution is skewed towards zero, with approximately 85% of the bids being $45 or less. Because several high bids lift the mean, it is possibly more informative to use the second measure of consumer surplus, which is the median bid of $15.00 per day.

The two other estimates of consumer surplus presented in Table 3 were obtained from the contingent valuation and travel cost models. The contingent valuation model consisted of a willingness to pay function which sought to explain the variation between individual's dollar bids. Of the explanatory variables included in the contingent valuation model, only two were statistically significant. These were TRIP COST, which was shown to positively influence the size of bids, and SATISFY, an index which captured the level of importance that anglers associate with catching fish. The actual number of salmon, herring or any other fish caught on the trip did not significantly influence the amount people were willing to bid.

In the case of TRIP COST, it is suspected that bids may have been biased by the actual cost of the respondent's trip. Theoretically, one would expect that net willingness to pay should be less for those who incur an expensive trip, yet the survey data indicates that the opposite was true. It is thought that respondents either confused net value with total value, or alternatively gave a bid which was an arbitrary proportion of their trip costs. With respect to SATISFY, results suggest that for those anglers who are dissatisfied with a fishing trip unless they catch something, they also have a low willingness to pay. The opposite is true for those who place more emphasis on non-catch aspects of fishing. This is a notable result because 65% of the sample regarded catch to be non-essential for making the fishing experience satisfying.

Based on the contingent valuation model, mean net willingness to pay was estimated to be $17.97 per day. This estimate needs to be interpreted with caution as the regression model had a very poor adjusted R squared value of 0.128. The most likely explanation for the low explanatory power is that the chosen variables did not capture all the important attitudinal and lifestyle characteristics of the individual. 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 biased the bids, 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, despite repeated reminders that we were only interested in the specific trip. This could account for why site quality and catch rate variables were non-significant. As a comparable measure, the travel cost model yielded a consumer surplus estimate of $504.12 per year per angler, which was converted to a daily benefit of $32.77.

Aggregate benefits to society from recreational fishing in southern Western Australia are estimated to be somewhere between 1.5 and 3.4 million dollars, net of fishing expenditures. As these benefits apply to the general fishing experience, and not just to salmon and herring fishing, they cannot be compared directly to benefits generated by the commercial sector.

Figure 1: Frequency distribution plot of net willingness to pay for a day of fishing. Taken from a sample of 84 anglers.

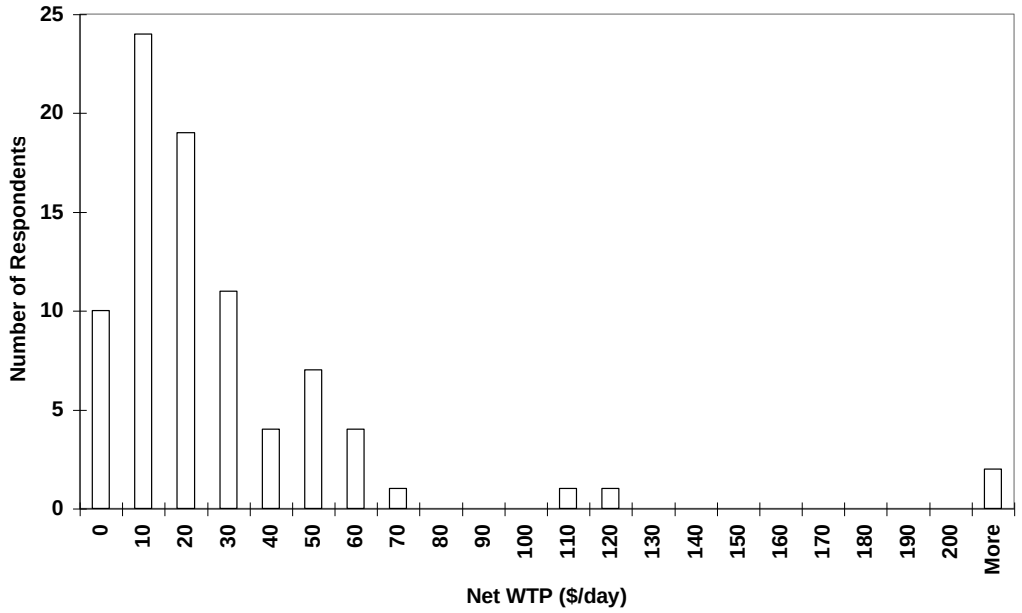

Table 3: Net economic benefits from recreational fishing in southern Western Australia. Individual benefits were aggregated using data from the WA Fisheries Department's creel survey which estimated angler effort in 1994 to be 104,000 angler days per year.

	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
Contingent Valuation Model	17.97	1.87
Travel Cost Model	32.77	3.41

Marginal Value of Catch.

The size of benefits directly attributable to recreational catches of salmon and herring could not be estimated from the survey data because the catch variables in the contingent valuation model were not significant. This meant that a recreational demand curve for each species could not be obtained. Instead, a mean value for salmon and herring at the margin was elicited by asking respondents directly about the value they placed on catching a preferred number of fish. 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 where 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. This estimate has a high standard error of $13.02 and is therefore not a very reliable measure of salmon's marginal value.

In the case of herring, only one respondent was willing to pay for a preferred increase in catch rate. 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 satisfactions 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. In light of this observation, the use of a contingent valuation survey for eliciting the marginal value of catch is questionable, at one based on the format adopted by this survey.

BENEFITS

The results from this type of research are 'public interest' in nature rather than specifically benefiting any one sector. Society benefits from this research because it provides managers with information about how resources should be allocated so that they are placed in their highest value use or uses. Members of the fishing industry also stand to benefit from this research because it provides a foundation for policies aimed at removing some of the uncertainty that currently exists regarding resource sharing. A more certain environment should enhance stability in the industry and improve fishermen's security of access.

This study has shown that the welfare generated by recreational fishing is significant, being in the order of 1.5 to 3.4 million dollars annually. It is difficult to determine how sensitive these benefits are to changes in the availability of salmon or herring, but the results do provide some economic justification for shifting the allocation of salmon away from the commercial sector and towards the recreational sector. This conclusion is reached by comparing the marginal value of salmon as a sport fish, estimated to be $5.55/fish, compared to the marginal net value of $0.84/fish in its commercial use[*] . The results for herring are less conclusive, as the survey was unable to elicit marginal values for this species.

[*] Calculated by assuming that 50% of net profits are derived from salmon and that the average weight of salmon is 3.2kg.

It is acknowledged that due to the asymmetry of recreational and commercial fishing, the task of making valid comparisons of economic value at the margin is extremely difficult. As such, the numerical values presented in this study need to be interpreted with caution. There is still some uncertainty about the marginal value of commercially caught salmon and herring as the non-pecuniary benefits of fishing and the benefits accruing to consumers were not measured. It is thought that these latter benefits are small at the present time, but there may be scope for increasing their size if salmon and herring products could be value added.

Another important result, which is related to the asymmetry of the two sectors, is that recreational benefits are not entirely a function of catch rate, or the fish resource itself. For a fishing trip to take place there needs to be an expectation of catching something, but if nothing is caught anglers still reap benefits from going fishing. This is because the fishing experience is a multi-dimensional 'good', having both catch and non-catch attributes. From an objective viewpoint the benefits from reallocation are contingent upon more fish becoming available to the recreational sector subsequent to a reduction in commercial effort. The corollary of this is that the quality of recreational fishing, as perceived by anglers, may improve irrespective of catch rate if commercial activities were scaled down or removed. This proposition is particularly relevant to the West Australian salmon and herring fishery where it appears that the main debate does not revolve around limited stocks, but rather entails a philosophical conflict over how the resource should be used.

INTELLECTUAL PROPERTY

There is no intellectual property associated with this research.

FURTHER DEVELOPMENT

While the results from this study adequately demonstrate the direction in which salmon and herring stocks should be allocated to improve economic efficiency, the model developed is not capable of determining the optimal allocation or of simulating the economic consequences of various management strategies available for reallocating fishery resources. In addition, the recreational benefits from increasing catch rate will be influenced by both changes in the value per trip, and the number of trips taken per year. In light of this, four main areas of further development have been identified:

1. Four decisions that confront recreational fishermen need to be modelled. These decisions are: (a) whether or not to go fishing, (b) how frequently to go fishing, (c) which sites to go fishing at, and (d) how long to stay fishing at each site.

2. Quality attributes of the fishing experience, particularly catch rate, need to be modelled as an expectation function for each individual. Expectations of the fishing experience will influence each of the four participation decisions listed above.

3. The resource allocation model should be dynamic so that changes in effort, catch and benefits can be tracked over time for each sector.

4. The impacts of changing allocation need be linked to a biological model of the fishery.

A modelling approach along these lines would allow us to simulate the economic and biological effects of resource reallocation. Some recent studies in the United States have taken this approach, and have had some encouraging results. It is the intent of the authors to expand on the work completed in this study by developing an analytical framework of fisheries resource allocation which can be applied to numerous fisheries.

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FINAL COST

A statement of receipts and expenditure for the period ending 31 March 1996 is appended to this report. Contributions in kind by the University of Western Australia are shown below.

1993/94	1994/95	Total
$35,456	$35,456	$70,912

DISTRIBUTION

This report has been distributed to the following organisations:

West Australian Recreational and Sportfishing Council Inc.

South West Licensed Salmon Fishermen's Association, Western Australia.

South Coast Licensed Salmon Fishermen's Association, Western Australia

West Australian Recreational Fishing Advisory Committee

West Australian Fisheries Department.

Australian Bureau of Agricultural and Resource Economics, Canberra.

Australian Seafood Industry Council, Canberra.

National Fishing Industry Training Council, Victoria.

CSIRO Division of Fisheries, Tasmania and Queensland.