A Socio-Economic Valuation of Resource Allocation Options between Recreational and Commercial Sectors

FRDC Project No. 2001/065

PART ONE

A GENERAL THEORETICAL FRAMEWORK

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Fisheries Research and Development Corporation

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The Fisheries Research and Development Corporation plans, invests in and manages fisheries research and development throughout Australia. It is a federal statutory authority jointly funded by the Australian Government and the fishing industry.

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The Report

The report is presented in four parts. These parts are as follows:

Part One: The General Theoretical Framework;

Part Two: The Western Australian Cockburn Sound Crab Fishery Case Study;

Part Three: The Perth Abalone Fishery Case Study; and

Part Four: The West Coast Wetline Fishery Case Study

This Part outlines a general theoretical framework for evaluating resource allocation options. Parts Two to Four provide a practical demonstration of this framework in three different case study fisheries.

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- Professor Tor Hundloe, Ross Shotten and Rebecca Metzner who made time in their busy programs to review our general theoretical framework model and to provide feedback; and
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TABLE OF CONTENTS

EXECUTIVE SUMMARY

Apart from decisions relating to access rights, sustainable catch levels and protection of the biodiversity of the marine environment, resource allocation decisions can be enormously contentious. They are politically difficult and are a significant drain on fisheries management agencies resources throughout Australia.

Scope of Project

This project outlines a framework for analysing and measuring the benefits and costs of resource allocation options between ‘extractive’ uses of the commercial and recreational sectors and for optimising the socio-economic benefits from these uses of the fish resources. The framework is applied in three case studies to demonstrate the practical application of valuation methodologies and tools and to provide practical guidance for fisheries management wishing to adopt such approaches to assist with resource allocation discussions.

It addresses economic concepts and frameworks for achieving optimal allocation outcomes rather than management processes for dealing with resource allocation decisions. Actual processes will vary according to the circumstances.

Whilst the focus of this research is on a benefit-cost analysis of resource allocation options in a two-sector model, the outlined framework can be extended to multi-sectoral allocation issues and can be adapted to intra-sectoral allocation issues.

Revenue and Expenditure

The gross value of production of the commercial seafood sector and the gross value of expenditure on recreational fishing are often advanced as arguments in support of allocation decisions. These values are simply financial data and are not comparable values. They are not appropriate economic values to properly compare such uses and allocation options in a benefit-cost framework. Indeed, relying on such information to make resource allocation decisions is not likely to optimise the social and economic benefits intended from the use of the community’s fish resources.

Industry revenues such as the gross value of production of the commercial seafood sector are not the net benefits attributable to production in the strict economic sense of a benefit-cost analysis of resource allocation options. Similarly, its corollary, the gross value of consumer expenditure on seafood is not the net economic benefits attributable to seafood consumption for such an analysis. In purely financial terms, the overall effect of an exchange of money in this symmetry of revenue and expenditure is zero; money has simply been transferred or redistributed.

Likewise, the gross value of expenditure on recreational fishing in a fishery is not a benefit to the recreational fishing sector. Nor is it the net benefit associated with the recreational fishing.

Revenue and expenditure data can be used to help measure appropriate economic values for benefit-cost analysis of resource allocation options only under certain conditions.

What are Appropriate Economic Values?

Economic value is derived ultimately from the tastes and preferences of consumers. The term ‘consumers’ is used here in its broadest sense to include those who buy and those who catch fish. Recreational fishing, regardless of whether the catch is consumed or not, is a consumptive activity.

The appropriate economic values of benefits and costs for a benefit-cost analysis of resource allocation options between competing uses are:

- the benefit enjoyed by seafood consumers or recreational fishers in excess of what was sacrificed to buy or catch fish; and
- the benefits enjoyed by commercial fishermen, and fish wholesalers, distributors and retailers in excess of what was sacrificed to catch and supply fish to consumers.

For recreational fishing, the expectation of catch and experience elements (time spent fishing and catch rates) are often present in recreational values.

Money outlays are not necessarily the best measure of ‘sacrifice’ in the above values. All costs need to be measured in terms of the opportunity cost of committing the resources to the fishing activities.

Money outlays usually require various adjustments before expenditure data become a true measure of the opportunity or resource cost (that is, the value of the labour, boats, petrol, gear, etc in the next best alternative use) and of the loss of economic value used for a benefit-cost analysis. For example, taxes and interest payments redistribute income rather than ‘spend’ resources; they are simply transfer payments of money. Also, prices may not accurately measure resource costs when markets are not structured competitively, or where ‘externalities’ exist, or when the amount of the resource being used affects its price.

Gross revenues are not a benefit in the strict economic sense used in a benefit-cost analysis. Although revenue data can be used to help measure the economic value associated with production, all resource costs must be extracted from revenue in order to measure the economic benefit attributable to production.

An analytical framework for considering comparative economic values of commercial and recreational use is outlined in Chapter 3. This benefit-cost framework can accommodate temporal and spatial factors but this presupposes such data are readily available.

Measuring Appropriate Economic Values

There are a variety of methods and tools that can be used to estimate the economic values of commercial and recreational use. These values are expressed in money terms because money is a generally accepted measuring rod that enables benefits and costs to be measured and compared.

The analytical framework focuses on 'extractive' uses and the values placed on catch. In both commercial and recreational sectors lifestyle benefits may be included in the values placed on catch. These lifestyle values need to be isolated.

Well-established markets exist for fish and fish products where consumers' revealed preferences and the relationship between prices and quantities demanded can be observed. Similarly, industry, which is catching and supplying the fish and fish products sought by consumers, is well established with known relationships between costs and volumes. In the commercial seafood sector it is a case of tapping into this demand and supply data through appropriately structured surveys to determine the net economic benefit as defined above.

In the case of recreational fishing, unlike going to the cinema, theatre or the football, an open market does not exist. Nevertheless, there are surrogate and simulated market approaches that can be used to estimate the economic values in such cases.

Surrogate market approaches use a related market for goods and services to derive a demand for recreational fishing. For example, the published research in this area has typically relied on the number of times a person travels to fish and their expenditure on travel, fishing gear, fishing trip, etc to approximate the demand for recreational fishing.

Simulated market techniques such as contingent valuation involve the creation of hypothetical markets, usually by creating a price for recreational fishing. A fee typically represents this where the funds from which are used for a plausible scenario(s) like preserving and improving fishing stock and their catch. Such stated preference data reflect recreational fishers' intention rather than revealed preferences that have been observed in the market and need to be used with this limitation in mind.

By combining demand and cost data from the commercial sector with surrogate or simulated demand data and cost information from the recreational sector a consistent set of comparable economic value data and indicators is possible.

The outcomes of benefit-cost analyses need to be updated regularly. This is to capture contemporary social and economic values. Also, to take into account dynamic changes in fish stock population, any changes in fish stock size which may impact on resource costs, and any changes in market conditions that may result in expenditure data no longer reflecting the true opportunity or resource costs.

These valuation methodologies and tools have been applied in three fishery case studies based in Western Australia. These studies covered three differently structured management regimes, the Cockburn Sound Managed crab fishery, the Perth Abalone fishery, and a segment of the 'wetlining' (fin fish) fisheries. This provides a practical illustration of their application and a test of the robustness of the outcomes from the various approaches. Also a practical guidance for fisheries management looking to adopt a consistent framework for analysing and optimising the socio-economic benefits from resource allocation decisions.

Optimising the Economic Benefits of Resource Allocation

The allocation that achieves the greatest total net economic benefit from resource allocation between the commercial and recreational sectors occurs where the marginal net economic benefits for the competing uses are equal.

At this point there is little economic significance in the fact that the gross value of commercial seafood sector may be greater than the gross value of expenditures on recreational fishing or vice versa. What is important, from a broader community's perspective, is that the overall net economic benefit of the combined uses is at its optimum. Any other allocation would reduce the overall net economic benefit from society's viewpoint. This may be the case even though one sector or group may be better off with an allocation change, but, unless this offsets the loss of economic value to other sectors or group of users, making the allocation change would reduce the overall economic value of the fishery to society.

An increased net economic benefit could arise in circumstances where some may be better off and others worse off as a result of an allocation change. In such cases the optimality conditions require that those who are better off could compensate those who are worse off and still be better off.

In reality, there are few fisheries where there is scope for de novo share allocations between competing uses or where there are sound 'a priori' reasons for limiting the allocation to one sector because the marginal net benefits of that particular use exceeds others over the full range of allocation options. In such circumstances, the resource allocation debate is mostly about marginal or incremental shifts between competing uses. A framework for determining the direction of allocation changes to move towards the optimisation of economic benefits is outlined in Chapter 4.

Application of the General Theoretical Framework

Three case studies were used to test the application of the framework to determine whether sensible and rational results are produced. The case studies were not intended to support actual resource allocation decision-making processes in the chosen fisheries.

Consistent with the overall project objectives, the case study applications emphasis the methodological and practical issues in applying resource allocation model rather than the actual results.

The case studies chosen were to maximise the exposure of the allocation framework and its methods to a range of valuation and allocation situations. The three case studies were a metropolitan crab fishery (Part Two of this research report), a metropolitan abalone fishery (Part Three) and demersal 'Wetline' fishery (Part Four)

The three case studies demonstrate that the general theoretical framework based on economic principles can be applied. The results in all cases are broadly consistent with economic theory and can be a base for considering and developing allocation policy.

The research demonstrates that the process of applying the framework is valuable in its own right, not just the final allocation results.

Socio-Economic Data Base

A socio-economic database of the kind of information required to measure benefits and cost for a benefit-cost analysis of resource allocation options is not readily available.

If there is to be adequate demonstration that allocation decisions in fisheries are optimising the social and economic benefits from the community's viewpoint, then an appropriate socio-economic database will need to be developed. This will require well-structured surveys and regular updating to capture contemporary values and to corroborate whether intended socio-economic outcomes are being achieved.

The collection of such data would need to be fully integrated into fisheries management, if the objective of optimal resource allocation is to be achieved on an ongoing basis.

Injection of a Dynamic Component

The analytical outputs from the application of the general theoretical framework provided a 'snapshot' at a point in time. However, the analytical results may not be a good guide to socially optimal allocations in the future. This requires the development of a dynamic, multi-period allocation framework. Such a framework was beyond the scope of this research but the subject of a subsequently funded FRDC project.

1. INTRODUCTION

The purpose of this FRDC funded research project is:

- to outline a socio-economic framework for analyzing the benefits and costs of resource allocation options as between 'extractive' uses of the commercial and recreational fishing sectors and for considering the optimization of socio-economic benefits from these allocation decisions; and

- to demonstrate by case studies the practical application of existing valuation methodologies and tools in a two sector analysis.

It extends the value of the current FRDC-sponsored work regarding sector specific socio-economic valuations (Hundloe et al[3]) and inter-sector equity issues relating to ecological sustainable development.

1.1 Objectives

The objectives of this project are:

- to provide a brief explanation of what constitutes appropriate economic values (Chapter 2);

- to outline what are appropriate economic benefits and costs for the purposes of benefit-cost analysis of resource allocation options between commercial and recreational sectors, including a brief description of valuation methodologies and tools and a rational and defensible basis for properly comparing the economic benefits of commercial and recreational use (Chapter 3);

- to provide a framework for considering the optimization of the net economic benefits of resource allocation between commercial and recreational sectors (Chapter 4); and

- to apply these valuation methodologies and tools to three case studies to assess the benefits and costs of resource allocations options in a two sector model, thereby demonstrating the methodologies and certain tools practical use and providing practical guidance for fisheries management.

Whilst this paper provides a framework for analyzing the benefits and costs of resource allocation between the competitive 'extractive' uses of the commercial and recreational sectors and for considering the optimization of economic benefits from these combined uses, **it does not address other (consumptive or non-consumptive) uses or intra-sectoral resource allocation issues.** This is not to

[3] Hundloe, Tor, 'An Economic Framework for Valuing Fisheries Resource Use, Draft for Consideration' (undated). A collection of economic papers prepared by Hundloe (and others) for an FRDC project on how to value fisheries resources in various uses.

say that these other social values and allocation issues are irrelevant or unimportant. Quite the contrary.

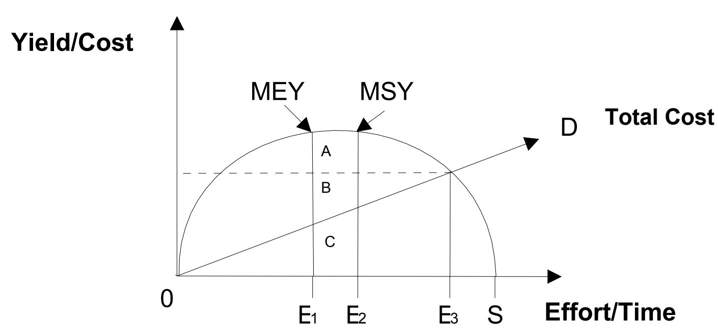
This paper is primarily about economic concepts and frameworks rather than processes for dealing with inter-sectoral resource use. The actual processes used to achieve optimal allocation vary and will reflect the particular circumstances.

1.2 Background Characteristics of Fisheries

Fish are renewable resources, which can be harvested year after year, provided that the rate at which fish are taken from the fish stock or population does not exceed the rate at which the stock replenishes itself. If resource users are constantly allowed to take too many fish from the fish stock then the fishery may become over exploited. Such behaviour may lead to extinction of the fish species in the particular environment.

The maximum amount of fish that can be taken from the stock in any one period without degrading the general population is know as the maximum sustainable yield (MSY). Traditionally, such notions of biological sustainability typically became the basis for defining the total allowable catch (TAC). More recently, concepts of maximum economic yield (MEY[4]) and even the complex notion of optimum or

[4] The 'MEY' is the profit maximization level where the difference between the total revenue and the total cost of fishing is the greatest. This may not correspond to the 'MSY". A simplistic bio-economic model to illustrate this difference is outlined below.



OS is a sustainable yield curve, which can be viewed as a sustainable yield/revenue curve on the assumption that the price of fish is constant. OD is a total cost curve associated with each level of effort. It is a straight line based on the assumption that additional effort units come at the same cost. OE3 is the unsustainable 'open access' equilibrium, that is, without management the number of boats (taking boats as a simplistic measure of effort) in the fishery will increase until the point where costs and earnings for the fishery are equal. OE2 is at the apex of the sustainable yield curve and represents the maximum sustainable yield which can be biologically sustained since the same level of effort will yield the same quantity of catch in following periods because the catch can be replaced by natural increase. By introducing more complicated aspects of bio-economic modelling, OE1 can be shown to be the maximum economic yield. At this point, the net economic gains are at their maximum level. For example, there are two distinct gains from reducing effort from 'open access' (OE3) to MEY (OE1). The reduction in effort from OE3 to OE1 produces a yield effect shown by an increased maximum social yield (OSY[5]) have received attention in the fisheries management literature. These concepts are not new in the economic theory of fisheries, and, more generally, renewable resource management, but have taken a considerable time to gain some recognition in the fisheries management area.

The MSY is finite in any period of time and any regulatory harvest volume based upon it, such as a TAC. There are few (if any) fisheries with explicit TACs or any other explicit resource allocations covering all 'extractive' (and other) uses. In those fisheries where TACs do apply, the TAC is generally confined to the commercial use with the recreational (and other extractive) allocations being implied rather than explicit.

In Australia, fisheries management bodies typically advise governments on resource allocation among and between different competing uses. Experience both in Australia and overseas demonstrates that such allocation decisions can be enormously contentious amongst the different user groups, may be politically difficult, and typically pose significant drain on the resources of the fisheries management agencies. It is not surprising in such matters that socio-economic outcomes receive increasing attention when fisheries allocation decisions are contested.

Fisheries managers are increasingly faced with the need to provide advise on the difficult decision of choosing which resource user groups from the various groups competing for the finite resource will gain a share of the resource and what that share should be. They directly give advice therefore on which group will benefit and which will lose from the allocation of resources.

Clearly, it is not always possible for all resource users to benefit from resource allocation. Indeed, such 'win-win' situations are now a rarity as the pressure on the fish stocks grows. Essentially, therefore, the fishery resource allocation problem will be a balancing act with trade-offs between different resource uses. Governments must manage this trade-off and make the inevitable decision about allocation of the resource between the competing groups.

Economists have always argued that these tradeoffs should be as explicit as possible, based on the best information available as to the relative benefits of allocating the resource to various user groups.

If regulatory bodies addressed the net public benefits or improved social-economic outcomes explicitly, then they may be better placed to defend and support their advice to governments. Government and the general public will be better informed. There will be greater transparency around the intended socio-economic outcomes of allocation decisions made by governments: providing an objective benchmark against which to subsequently measure whether such outcomes have been realized.

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harvest AB. It also produces a reduction in total cost shown as BC. At any point beyond OE1 the net economic gain from increased effort diminishes.

[5] The 'OSY' is usually used to include biological, economic, cultural, social and political factors. Such broad notions are reflected in ecological sustainable development concepts.

General recognition of these principles does exist. The legislative objectives in some Australian jurisdictions (determined by Parliament on behalf of the broader community) include, among other things, an obligation to sustainable management of the marine resources to optimise social and economic benefits. Socio-economic outcomes are recognized among all Australian jurisdictions as key components of ecological sustainable development (ESD).

However, the development of socio-economic indicators within an ESD framework is very much in its infancy. The practical experience in Australia of explicitly applying soundly based socio-economic valuation methodologies and tools to analyse such outcomes from resource allocation decisions has been limited.

Unfortunately, the data most commonly used by fisheries management agencies and user groups to influence allocations are usually focused on purely financial data such as gross revenues and expenditures of commercial and recreational users. Some studies go beyond these direct financial analyses and look at the economic (post harvest) impacts of commercial and recreational activities. However, these analyses usually fail to apply a consistent valuation framework and are often based on incorrect, incomplete and distorted notions of economic value. As Edwards states:

> "At the root of the trouble are basic misunderstandings of what constitutes economic values and of how to properly compare the economic values of competitive uses in the framework of benefit–cost analysis."[6]

These arguments have been extensively critiqued in economic and fisheries management literature (Hundloe[5] and others[6]). Whilst it is not the intention of the project to revisit these issues, except where it is necessary to highlight what constitutes relevant net economic values and what does not for the purposes of benefit cost analysis of resource allocation options. Nevertheless, fisheries managers and user groups are encouraged to review this reference material for a better understanding of shortcomings of these data for considering socio-economic outcomes of allocation options.

Whilst highlighting these typical limitations, we must also recognize that the sort of data needed for a full benefit cost analysis is not readily available in all fisheries. Indeed, the availability of a comprehensive socio-economic database with information of the kind needed for benefit-cost analysis of commercial and recreational use of the fish resource is generally non-existent. This means that any serious attempt to apply valid economic principles to achieving optimal resource allocations will require primary data collection. One important element of this data collection will have to be structured surveys to obtain benefit and cost values required.

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[6]Edwards, Steven F 'A Critique of the Economic Arguments Commonly Used to Influence Fishery Allocations" North American Journal of Fisheries Management (Spring 1991) pages 121 to 129.

[5] op. cit. 1, see Chapter 3, pages 13 to 27

[6] op. cit. 4.

Such data collection is not easy to obtain. As with any survey, there are difficulties in securing participation and in obtaining the information sought, particularly, in the case of the commercial fishing sector, the financial and related economic information required is typically viewed by fishermen as commercial-in-confidence material, relating to their business activities. Nevertheless, unless increased efforts are made to acquire information from both the commercial and recreational sectors that is adequate to allow a soundly based benefit cost analysis of resource allocation decisions, there can be no confidence that the actual allocations decided are optimal and in the best interests of society.

When applying the economic framework outlined in this report, it is important to keep in mind the distinction of the quality of the economic analysis and its appropriateness. The quality of benefit-cost analysis is constrained by available data (and other things). No amount of data or no methodology – no matter how accurate or sophisticated – can shed light on resource allocation when they are inappropriate.

The misuse of purely financial information such as revenues and expenditures to assess comparative economic values of commercial and recreational use in fisheries will give misleading indications regarding allocation. It will ultimately result in resource allocation decisions that may not optimise the social and economic benefits intended to be derived by society from the use of the fish resource.

Economic value is one of many human values. There is no assumption in this paper that economic values are necessarily pre-eminent values. It simply explains and applies what is meant by economic value for the purposes of benefit-cost analysis of resource allocation options.

As the paper is designed to provide a better understanding among non-economists involved in fisheries, it has meant on occasions a degree of sacrifice of economic precision in favour of a practical presentation of concepts and principles.

While the primary focus of this paper is on allocation between commercial and recreational use, the economic framework outlined may be extended to analyse 'multi-sectoral' uses. The framework may also be adapted to address intra-sectoral allocation issues.

2. ECONOMIC VALUE, REVENUE AND EXPENDITURE

The starting point for the analysis of socially optimal resource allocation between competing groups must be an understanding of the correct economic value concepts to use. This is true for all resource allocation not just fisheries. In this regard the fisheries allocation problem is like any other in economics. The resource needs to be allocated so as to maximize its value to the community and must be based on sound concepts of economic value in the alternative uses.

Applied to fisheries, economic value is defined in terms of what consumers are **willing to pay** for fish and what the commercial sector is **willing to accept** as compensation for the supply of fish to those consumers. Demand and supply are simply opposite sides of the same market. Further, in the case of the fish resource, the value in relation to the recreational fisher must also be considered. For the recreational fisher, economic value is defined in terms of what the recreational fisher is **willing to pay** for the expectation of a recreational catch.

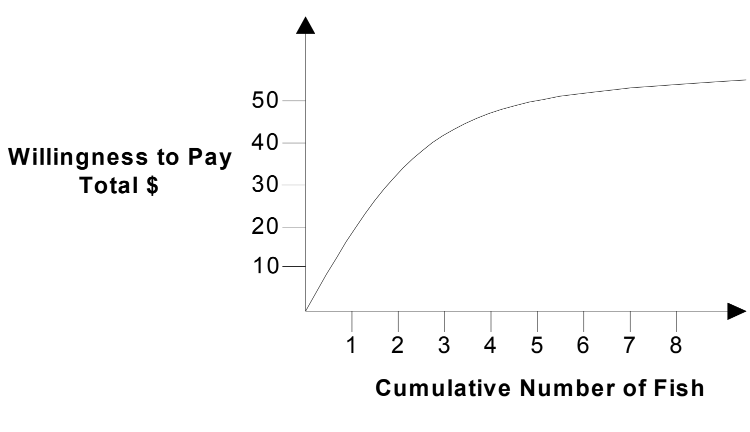
Application of this valuation approach leads economists to the critical concepts of consumer and producer surpluses. These valuation concepts are very well established in economics and are the basic values needed for a benefit cost analysis.

Economic **value** is derived ultimately from the tastes and preferences of consumers. The term 'consumers' is used here in its broadest sense to include those who buy their fish and those who are recreational fishers (regardless of whether the catch is eaten or not).[7] For recreational use, the expectation of a catch and the experience elements are often present in 'consumptive' use.

2.1 Economic Value and Consumer's Willingness-to-Pay

The total economic value of fish is defined and measured in terms of what someone is **'willing-to-pay'** for fish – either as seafood or to pursue recreational catch – rather than spend the same amount of money on other goods and services which satisfy preferences as reflected in individual consumer's needs and wants. This assumes someone will only buy fish or go recreational fishing if the benefits of doing so exceed the costs.

A generally accepted proposition is that most consumers' willingness to pay for each additional fish consumed or caught (what economist refer to as the marginal or extra unit) diminishes as the number of fish consumed or caught increases. (This assumes that factors that influence consumption such as income and preferences for seafood or recreational fishing remain unchanged.) This is because the additional satisfaction (utility or well being), from each additional fish consumed or caught provides less and less satisfaction.



[7] Current allocation between 'consumptive or extractive uses; of commercial and recreational sectors, is the focus of this paper. Other categories of socio-economic value related to "non-consumptive uses', preservation value and inter generational (or bequest) value are not addressed, although these multi-sectoral uses could be handled in the framework outlined in this report.

Figure 1

Figure 1 is a hypothetical case where, for example, the second fish purchased for the week is not as satisfying as the first. Alternatively, the recreational catch of the second fish is not as enjoyable as the first fish caught. This shows consumers' willingness-to-pay for the second fish increases the maximum amount willing to be paid but at a proportionally less amount than for the first fish. Similarly, the most that the consumer is willing to pay for the third fish is positive but less than what was paid for the second fish, and so on until the consumer is willing to pay little (if anything) for another additional unit.

This basic relationship between a consumer's willingness to pay and economic value has a number of important implications.

First, the maximum a consumer is willing to pay for fish has an economic value and this value can be measured in dollar terms. Money is used in this context, as a measuring rod, to indicate gains or losses in utility or welfare as it is the basis on which all of us express our individual preferences every day.

Second, the total value curve in Figure 1 answers general questions such as "What is the total economic value of say all four fish?" This total willingness to pay curve implies a **demand** curve such as that shown in Figure 2 below. The demand curve captures the marginal willingness to pay and can therefore be used to answer related questions such as "What is the economic value of the fifth fish?"

The demand curve simply traces the most a consumer or recreational fisher is willing to pay for each **additional** fish (or recreational catch). It follows then the entire area under this demand curve up to the consumption level is equivalent to the total economic value. If, in the hypothetical illustration in Figure 2, the 'extractive' use were four fish per week, then the shaded area under the demand curve would represent the total economic value for the four fish.

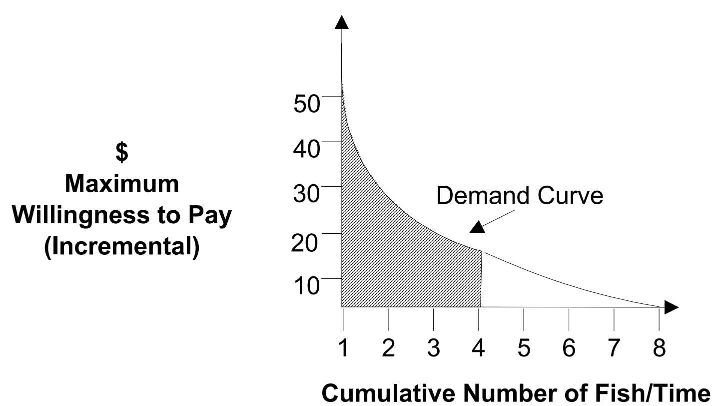


Figure 2

Third, in lay terms, the word 'demand' is generally used to refer to the frequency of use, the number of consumers or recreational fishers, the number of fishing trips. In economics, **'demand'** is a **behavioural relationship**. It portrays how seafood consumers (and recreational fishers) alter the quantity of fish used for food (or caught recreationally) in response to changes in price of fish (or cost of recreational fishing) and other factors which affect the willingness-to-pay. These other factors include income and wealth, catch rates, the cost of other goods which might substitute for fish or the amount of leisure time (for recreational fishers). For example, under normal circumstances, an increased income could be expected to increase a consumer's ability and willingness to pay for fish (or recreational fishing). But social values and attitudes such as time spent fishing and lifestyle may be as important factors as purely financial considerations in explaining the behavioural relationship.[8]

Fourth, the **aggregate demand reflects the sum of the individual demand curves where the willingness to pay is as diverse as individual tastes and preferences**.

Fifth, Figure 1 implies that **economic value and demand exist even when markets and prices are non-existent**. Markets and prices typically emerge from collective behaviour of buyers (consumers) and sellers (businesses) when property rights are well defined. Prices **reveal** the maximum that consumers are willing to pay. However, prices do not, contrary to a generally held perception create demand or economic value. In fact, the opposite is true; demand, or willingness to pay, is necessary for markets to work and prices to emerge.

Consumers derive economic value even where property rights and markets are not well defined and even when access is not rationed. For example, recreational fishers derive economic value from fish stock even where access is not rationed.

Finally, where the consumers pay for fish, the amount they choose from the demand curve depends on price. In this case, the **total economic value** is subdivided into two components as shown in Figure 3.

[8] Time spent on recreational fishing trips and catch rates may be utility maximization variables.

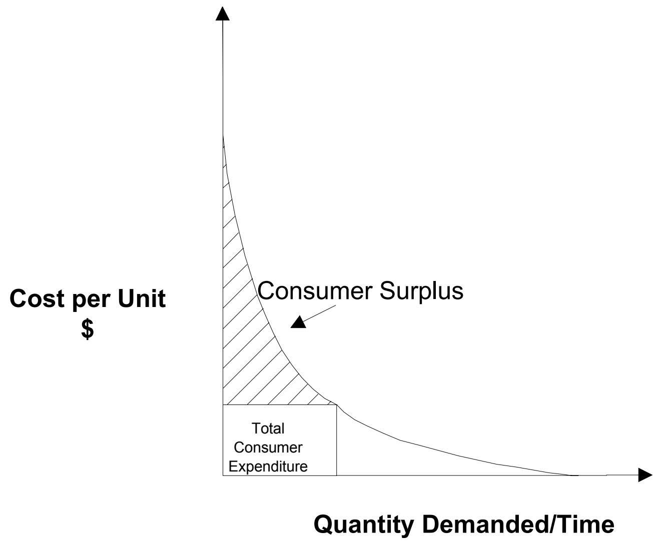


Figure 3

Demand captures consumer surplus and determines consumer expenditure.

The rectangle depicts the total consumer expenditure. For seafood consumers, total expenditure is the money spent by consumers on seafood in retail markets (cost per unit x the quantity purchased over a given time). For recreational fishers, total consumer expenditure is represented by outlays on petrol, bait, tackle, boats, pots, nets, charter boats and other fishing supplies that recreational fishers use to catch fish over a given time.

The triangular area above total expenditure is what economists refer to as the **net economic value** of fish to the consumer or the recreational fisher. This component of total economic value is referred to as the **consumer surplus**. Consumer surplus is the net worth of the fish to the seafood consumer or recreational fisher after expenditure is subtracted from the total economic value. That is, **the value enjoyed by the consumer or recreational fisher in excess of what was sacrificed to buy or catch fish**. Similar to business profit, consumer surplus is the benefit in excess of costs.

The consumer surplus concept is difficult for fishing managers and policy makers to comprehend and interpret because, unlike expenditures and revenues, which involve the exchange of money, it is not seen to be tangible. The concept is theoretically sound and has long been accepted as the **fundamental measure of the net benefits** required in benefit-cost analysis of projects and policy. It is not arbitrary. Typically, consumer surplus is measurable as the area under the demand curve and above price as shown in Figure 3. This presupposes the ability to estimate a demand curve. Where this is not possible, economists have developed a range of alternative techniques for measuring consumer surplus, most notably techniques based on surveys of consumers.

2.2 Economic Value and Businesses' Willingness-to-Accept Compensation

When we turn to the supply side of a market for fish, an economic value can be defined in terms of a business' willingness to accept **compensation** for the supply of seafood to the consumer.

Like consumers, businesses have to compete in the market for goods and services to produce and then to sell their product. For their efforts, they expect to be compensated for the capital (human and other) invested, for the labour they engage and the material they acquire to produce the products wanted by consumers. Business will only remain going concerns, if they paid for these factors of production. As individual consumers make judgments about their willingness-to-pay to achieve satisfaction (utility) from something they purchase, so do individual businesses make their individual judgments about the cost to them of the capital, labour and other factors of production to supply products wanted by consumers and the net benefit of supplying at various prices.

Businesses' willingness-to-accept compensation defines the price they will require in order to supply extra fish to consumers. This price increases as the supply quantity increases. That is, in order to supply more fish to the market, producers will require a higher price for fish. Figure 4 below shows the total cost of supplying various quantities of fish.

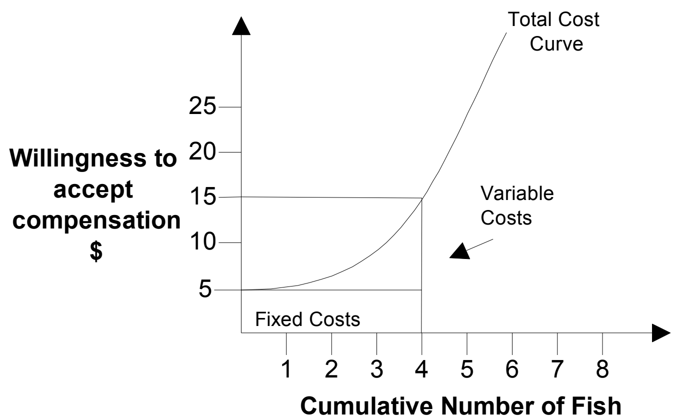


Figure 4

Willingness-to-accept compensation as the quantity supplied increases.

Figure 4 can be translated into a supply curve that shows the quantity that will be offered at various prices. The basic supply curve is shown in Figure 5 below.

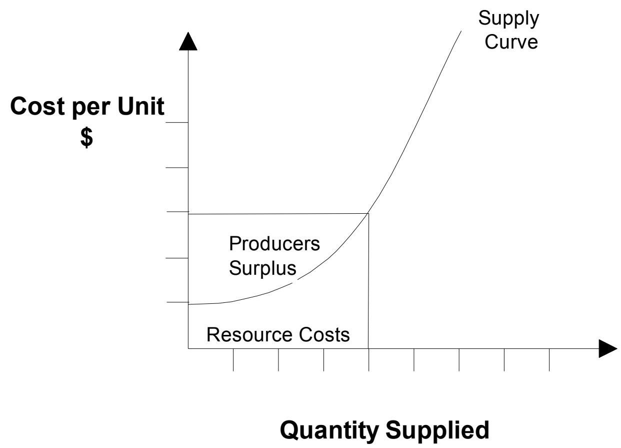


Figure 5

Supply captures producers surplus and determines total resource costs.

The total revenue received by the firm is the rectanglar box representing price times quanity sold. There are two components to this. First, there is the resource cost of actually producing the quanity of fish supplied. This is the area under the supply curve. Second, there is the producer surplus, representing the net economic value attributable to production. This is the area above the supply curve and under the price line. This arises because the firm receives market price for all fish even though the first, second and third fish, etc, cost less to supply than the last fish supplied.

The producers surplus is not profit in the accountants sense of this measure (i.e. revenue less expenditure) even when expenditure on factors of production measures the opportunity cost in other uses. That is, the value of the businesses assets must also be deducted from revenue when estimating producer surplus.

2.3 Summary

Economic benefit is defined and measured by way of the maximum that the consumers are willing to pay to buy or catch fish. This total economic value can be sub-divided into two components: expenditure which must be forgone to buy or catch the fish and the benefit in excess of the sacrifice (expenditure) to buy or catch fish, that is, the consumer surplus. Consumer surplus is an essential component of the value the consumer receives from publicly owned fish resources.

Similarly, the ‘producer surplus’ is the benefit received by the individual businesses in excess of resource or opportunity cost to supply the fish to consumers.

As explained in the next section, the net economic benefit comprises the consumer surpluses and producer surpluses or the net economic value attributable to consumption and production respectively.

3. BENEFIT AND COST ANALYSIS: OPPORTUNITY AND RESOURCE COSTS, NET ECONOMIC VALUE, ECONOMIC EFFICIENCY AND MEASUREMENT

The above foundation in economic value is preparation for defining what consititues a **benefit** and a **cost** in **benefit-cost analysis of resource allocation options and how these net economic values may be measured**. In the context of benefit-cost analysis, a benefit is a gain of economic value, whereas a cost is a loss of economic value. The more familiar notions of revenues and expenditures are not necessarily benefits and costs per se and must be scrutinized carefully before they can be used to *measure* benefits and costs for a benefit-cost analysis.

This section first distinguishes between expenditures and the concept of **resource or opportunity costs**, that is, the foregone economic value of a resource, such as fish, when it is used for one purpose instead of something else. Net economic benefits – the fundamental focus of a benefit-cost analysis – are defined as the difference between total economic value and resource costs that are consumed in order to make fish available to consumers (including recreational fishers).

Total net economic benefits consist of consumer surpluses and producer surpluses, or alternatively, the net economic value attributable to consumption and production. It is a long established principle in economics that the resource allocation is optimised when the the aggregate of consumes and producers surplus is maximised. This is the point of maximum economic efficiency.

3.1 Opportunity and Resource Costs

Expenditure on goods and services is such a well understood concept that it is hardly worth mentioning except to make a comparison with resource costs (i.e. foregone economic value). Payments for goods and services purchased in markets and taxes for public services that are not supplied by markets (such as fishery management) are familiar to everyone. **Expenditures are simply financial outlays, or money costs that commercial operators and recreational fishers incur to obtain resources. They are reflective of the market prices paid for the various resources. They do not necessarily reflect the true opportunity cost of the resource nor is expenditure necessarily a true measure of the loss of economic value.**

Based on the controversy surrounding allocation decisions involving commercial and recreational fisheries, and the associated debate, there appears to be some confusion about the interpretation of revenue and expenditure information.

An industry's revenues are equal to its customers' expenditures on its products and vice versa. Accordingly, in purely financial terms, the overall effect of an exchange of money is zero; money has simply been transferred, or redistributed. On the other side, the property right to the resource passes from the producer to the consumer.

In benefit-cost analyses of allocation options, expenditures are relevant only when they can be legitimately used to *measure* losses of economic value. **Resources** (such as labour, fuel, gear, boats, fish and other natural resources) used to produce one good or service can be used to produce something else. Because opportunities to produce something else valued by consumers are foregone in their next best alternative use, the value of those resources in that next best alternative use is the true measure of the resource or opportunity costs of committing those resources to a particular use. For example, fuel used by a commercial fishing boat in catching fish is also valued by charter operators taking recreational fishers on fishing trips or eco-tourists to experience the wonders of Ningaloo Reef or those wishing to enjoy the pleasure of whale watching. Similarly, fish which are sold to consumers in seafood markets are also valued by recreational or indigenous fishers, as these fishers opportunities to catch and possibly eat the same fish are precluded. The reverse is also true.

Although expenditures could be construed as a purely financial opportunity cost incurred by consumers and businesses (the same dollar cannot be spent on more than one commodity or resource), the focus remains on the lost economic value of resources or opportunity cost. In this context, expenditures imply spending money, whilst resource or opportunity costs imply "spending" resources such as labour, capital and fish stocks.

Whilst the concepts are distinct, the differences between expenditures and the opportunity costs of resource use are blurred when the latter are measured. When markets for productive resources are competitive and 'externalities' (that is, benefits and costs that are not reflected in market prices) are non-existent, market prices (including wages) reveal, or give a good indication of, the economic value to consumers of the goods or services that would otherwise have been produced by the same resources. Also, when a change in the use of a resource is too small to effect a price change, total expenditures reveal, or measure, resource costs. That is, when these conditions involving the prices of resources and resource use are satisfied, payments by businesses and recreational fisheries to hire, buy and rent resources to make fish available for consumption are *mathematically* equal to the opportunity costs of the same resources.

However, such expenditures do not always conveniently measure resource costs – expenditures and resouce costs are conceptually distinct. For example, taxes (such as desiel fuel excise or duties on imported equipment) or interest payments on loans redistribute income rather than "spend" productive resources – they are **transfer payments** of money. Also, prices and expenditures may not accurately measure resource costs when markets are not structured competively, where externalities exist or when the amount of a resource being used affects its price. In these (and other) technical exceptions, expenditures need to be adjusted before they can represent a true measure of a resource or opportunity costs. Methodologies for making the required adjustments are long established in benefit-cost literature.

3.2 Net Economic Benefits

Having covered economic value and resource costs, it is relatively straightforward to define **net economic value**. *In benefit-cost analysis, the net economic value from using fish is the maximum willingness-to-pay (i.e. total economic value) minus all opportunity costs of using resources to make fish available to consumers (including recreational fishers).* Net economic value is illustrated in Figure 6 with the aid of a standard deptiction of demand and supply**.** Assuming that this supply curve traces the incremental resource costs of providing additional fish to consumers (analogous to how a demand curve traces the incremental resource costs of providing additional fish to consumers), then *the area beneath the supply curve is total resource costs, and the area between demand and supply is net economic value or benefit. It is the sum of the consumers and producers surpluses assocaited with the consumption and production of optimal volume of fish.*

From Figure 6 it can be seen that the cost line divides net economic value or benefits into two parts. The top part is consumer surplus.

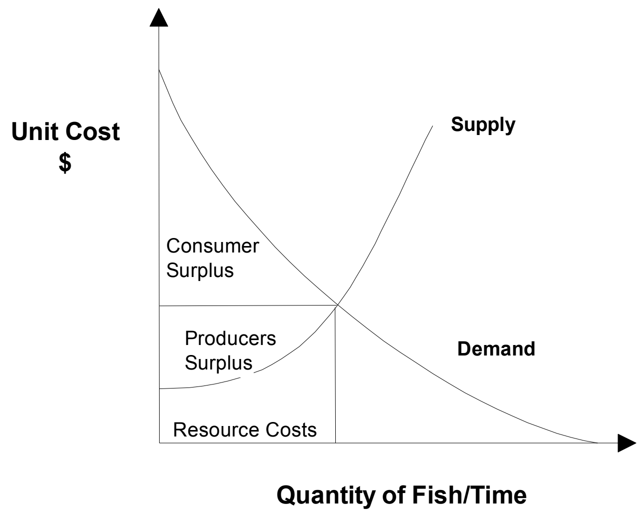


Figure 6

Net benefits (ie net economic value) comprised consumer surplus and producer surplus

The bottom part of the area encompassed in net benefits is producer surplus. These concepts were discussed in Section 2 and the appropriate economic values to be used in a benefit-cost analysis of resource allocation options.

From this discussion of producer surplus, it is clear that **revenues are not a benefit in the strict sense** used in benefit-cost analysis of resource allocation options. Although revenue data can be used to help estimate the economic value which is associated with production, all resource costs must be subtracted from revenue in order to estimate producer surpluses or the net economic benefit derived from production which is in excess of what was sacrificed to catch or supply the fish to consumers. Accordingly, the so-called ‘beach’ or dockside ‘value’ of fish overestimates the net economic value associated with commercial fishing because resource costs are not subtracted.

Similarly, the revenue from commercial seafood sales to consumers, or its corrollary, consumer expenditure on seafood do not measure the benefits derived by consumers from seafood consumption. Like producers’ surpluses, it is value which consumers derive in excess of what was sacrificed to buy or catch the fish. Information on what recreational fishers may be willing to pay to retain their current catch may be interesting information, but this does not identify the value which individual recreational fishers derive in excess of what they are willing to sacrifice to retain their catch.

In the seafood sector, net economic benefits comprise consumer surpluses, producer surpluses in retail markets, and producer surpluses from other suppliers in the marketing chain from commercial fishermen to retailers, because these business activities make fish available to consumers. In the recreational fishing sector, there is consumer surplus enjoyed by recreational fisheries plus, where relevant, producer surpluses from the charter fishing industry. (The economic values for the respective user groups are purposely drawn in Figure 6 to be equal in order to focus on the important concepts and principles and to avoid giving the impression that total net economic value from one use is inherently greater than the other use.)

The basic comparison of the net economic benefits of commercial and recreational use is shown in the following flow chart (see page 16). It is based on the economic surplus concepts discussed above.

This benefit-cost framework can take account of temporal and spatial factors. For example, it would be important to know whether the marginal net benefit of a salmon catch to a recreational fisher in Albany is the same as that of a recreational salmon fisher in Geographe Bay or Esperance. This presupposes temporal and spatial data are readily available.

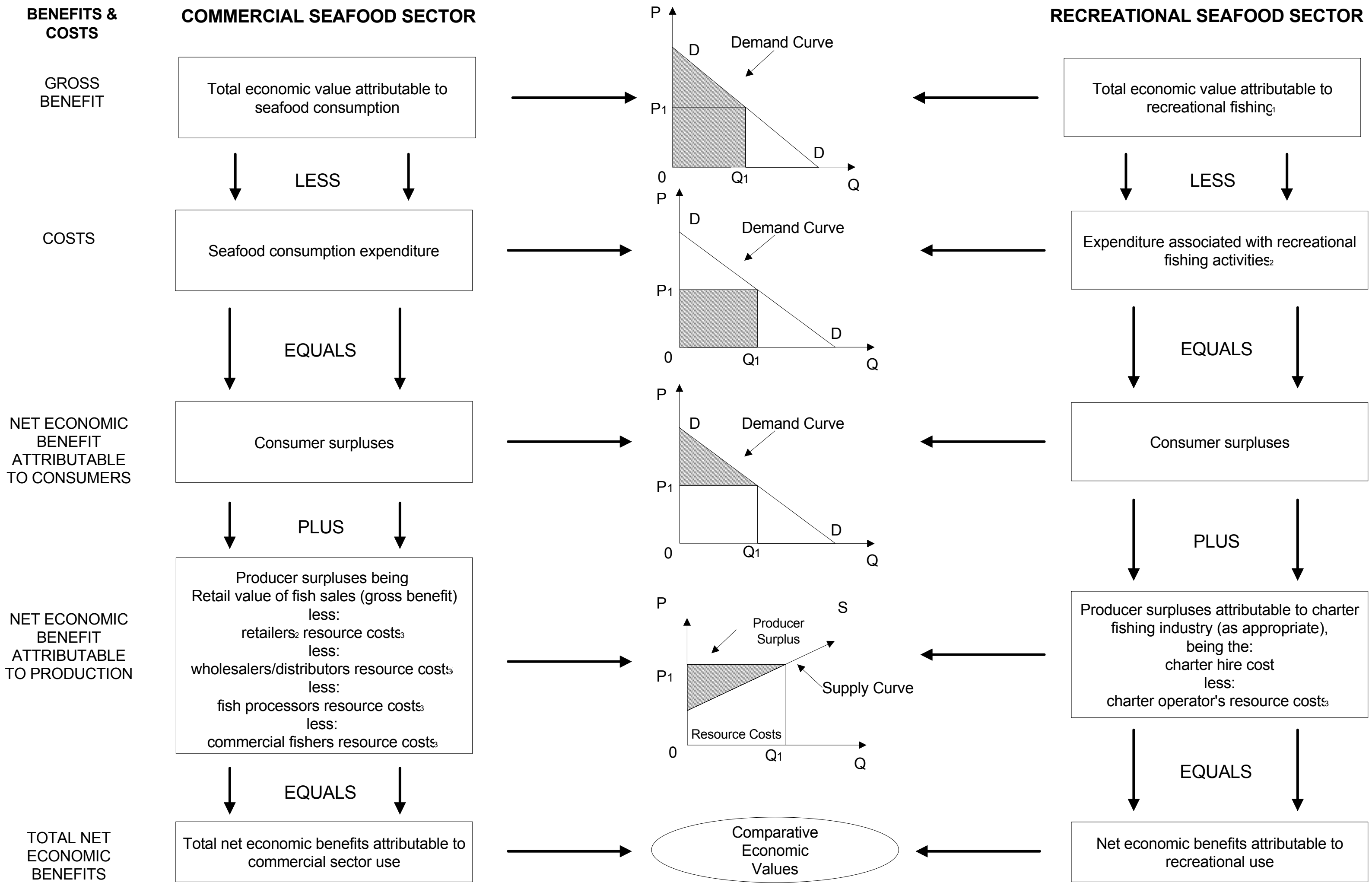
It must be recognised that there has been some debate in the fisheries management literature about this. Some have argued that the 'beach price' is the appropriate value to estimate the economic benefits of the commercial seafood sector for comparison with recreational use. The 'beach price' of freshly landed fish is seen as the closest product for comparison with the fish caught by the recreational sector. They are not focused on the value to recreational fishers of fish when it is filleted and cooked as a meal. Also, it avoids in their view the risk of valuing more goods and services than the fish itself e.g. including fish retailing, distribution and processing.

However, consistent with the wider literature on benefit-costs analysis, this paper takes the view that the valuation of allocation options for the consumptive uses (where leisure or experience value of recreational fishing is a consumptive use and where alternative goods and services exist) of the commercial seafood and recreational sectors. The net economic value reflects consumer surpluses as well as producers' surpluses of those business activities involved in the supply chain that makes fish available to consumers.

3.3 Economic Efficiency

In the context of fishery management, economic **efficiency** relates to the total size of net economic benefits from the collective (consumptive and non-consumptive) use of a fish resource. This is an application of one of the most fundamental propositions in economics. Resource allocation efficiency is achieved when it is not possible to make any further reallocation which increases aggregate net benefit. At this point the sum of consumers and producers surplus is maximised for the allocation of the given resource

ESTIMATING COMPARATIVE NET ECONOMIC BENEFITS OF COMMERCIAL AND RECREATIONAL USE



Notes: 1. The value which recreational fishers are willing to pay for the current catch.
2. Retailer is used in its broadest sense to cover all fish retailing outlets. This includes supermarkets, fish shops, fish & chip shops and restaurants.
3. Resource costs include capital, labour and other factors of production associated with fish retailing, distribution, wholesaling, processing and commercial catching sectors, including charter operators servicing the recreational sector where it occurs

between its competing uses. The marginal net benefit of the resource is the same in all of the competing uses.

Applying this fundamental rule to fisheries means that a management rule which increases total net economic benefits will mean an increase in the efficiency with which the fish resource is used. Following this approach means that there will be an increase in the size of the net economic value that commercial fisherman, recreational fishers, fish wholesalers and retailers, the charter fishing industry, and seafood consumers share from a fish resource. Similarly, a policy which *maximises* net economic benefits achieves the greatest net economic value from a fish resource as is possible given contraints of sustainability and factors which are outside the control of management. In contrast, a loss in economic efficiency implies a loss of net economic benefits, or value.

Losses in economic value experienced by one or more groups would be consistent with increased efficiency provided that total net economic benefits increase. *In other words, the compensation test for judging whether efficiency is increased is whether "winners" of economic value could compensate "losers" and still be better off.* In addition, one or more groups could experience a gain in consumer suprlus and/or producer surplus, even when a use of a fish resource on the whole becomes less efficient. Thus, resource allocation can affect the relative sizes of the shares of net economic benefits between commercial and recreational sectors as well as the total size of the net economic benefits.

3.4 Measuring Economic Values

An important issue in practice is the extent to which the key economic value concepts can be operationalised and what are the appropriate methodologies for doing so.

In the most straightforward cases, there are well specified and estimated demand and supply curves. In this case, the consumers and producers surplus can be estimated directly as the relevant areas as already discussed above. However, where these relationships cannot be estimated readily, usually because well defined markets and market prices do not exist, alternative methodologies must be used. A variety of methodoogies for determining economic values in the absence of classical market data have been developed over the past twenty years. These have now had widespread application and have been shown to be very robust.

The application of these various methodologies to fish resource allocation issues is discussed in this section.

Economic values are expressed in money terms because money is a generally accepted measuring rod which enables benefits and costs of resource allocation between sectors to be measured and compared. As mentioned previously when consumers outlay money to buy or catch fish it is said that they 'reveal their preferences for goods and services'. This willingness to pay and its relationship to net economic benefits has been outlined previously.

Demand and the concept of consumer surplus have been previously discussed. In the commercial sector, there are well-established markets for fish and fish products where consumers revealed demand preferences and the relationships between price and quantities demanded can be observed. Likewise, supply and the concepts of producer surpluses have been previously discussed. In the commercial sector, data on production costs and returns may be collected by directly surveying commercial fishermen and other parties involved in the supply chain to consumers.

If the demand and supply curves can be estimated, the relevant producers and consumers surplus from commercial production and consumption of fish can be directly estimated.

Where this cannot be done, the data needed to calculate consumers and producers supluses must be collected directly. For consumers, the relevant revealed preference data can be collected by directly surveying consumers. For producers the relevant producers surplus data would also have to gained through surveys. However, experiecne shows that there is often unease among commercial fishermen (and others) about supplying what is seen as commercial-in-confidence information relating to their business operations.

Beyond seeking the standard surplus information that is consistent with the market demand and supply curves, there has always been some debate in the economic literature about the use of money to value the commercial and recreational use of the resource. Because there are some aspects of commercial and recreational use which cannot be simply transcribed into money terms. For example, in both the commercial and recreational sectors, a person may participate in the pursuit of fishing because they enjoy the lifestyle and not simply because of the monetary rewards. In the recreational sector, there is no direct market, or prices, for the fish caught by recreational fishermen and it is often difficult to observe movements in demand for recreational fishing.

While lifestyle benefits are difficult to measure in money terms, it is not impossible and a variety of surveys based on other techniques have evolved to do deal with these circumstances.

These methods usually involve one of two types of techniques:

1. A surrogate market approach; or
2. A simulated or experimental market approach.

A surrogate market approach involves the use of a related market for goods and services to derive the demand for recreational fishing. For example, the literature typically uses the number of times a person travels to fish and their expenditures on travel, fishing gear and fishing trips to indicate a consumer's demand for recreational fishing. These expenditures are readily observable and a surrogate measure of their 'revealed preferences' for recreational fishing. The typical surrogate market approach usually involves a travel cost model or a random utility model. The former work best where there is a normal spatial distribution of the population with respect to distance from the fishery of interest.

The simulated or experimental market approach involves the creation of a hypothetical market, usually by creating a price for recreational fishing, typically represented by a fee, the funds of which are used to preserve and/or improve fishing stock and their catch. These methods rely on what people say they would do in a given situation. Such approaches use stated preference data to establish a notional value or price to secure an improvement in fish stock, or alternatively an enhancement of particular characteristics of the fishing experience. The contingent valuation model and consumer choice experiments are examples of this approach.

A common difficulty with these stated preference models is that they require carefully designed surveys and plausible scenarios to be valued in order to maximise the statistical efficiency of the data to be collected.

These stated preference methodologies capture consumer intentions rather than revealed demand preferences that have been observed in the marketplace. The results from these consumer choice modelling approaches need to be used with this limitation in mind.

The methodologies and tools (or techniques) that can be used to value recreational use are outlined below.

Methodologies and Techniques to Estimate Economic Values of Recreational Fishing Values[9]

Revealed Preference Methods

- Basic travel cost method
- Multiple site travel cost models:
  - Single equation demand models
  - Varying parameter model
  - Hedonic travel cost method
- Random utility modelling

Stated Preference Methods

- Contingent valuation
- Choice experiments
- Contingent ranking
- Contingent rating and paired comparisons

Other Methods

- Combining revealed and stated preferences
- Benefit transfer

3.5 Selection of Data Collection Methods

There is often a paucity of relevant socio-economic data sets relating to fisheries to apply the benefit-cost analytical framework outlined in this Paper. The official data sets that are available are either incomplete or misleading.

The lack of relevant data means original data must be collected and this may involve most aspects of both commercial and recreational use in particular fisheries. This was the case in all three of the case studies undertaken to demonstrate the application of this general theoretical framework. The success of surveys in achieving quality data is dependent on the design and execution of the survey.

In the design phase considerable attention needs to be given to the survey content and language, to identification of the survey population as users to be surveyed may not be readily identifiable, and the choice of survey method (for example 'face-to-face' surveys, mail out questionnaire, and telephone surveys). The survey

[9] op. cit. 1, A description of each of these techniques can be found in a paper by Russell Blamey entitled 'Chapter 9: The Recreational Sector' pages 134 to 175 and presented in a collection of papers prepared by Professor Tor Hundloe as part of an FRDC project on how to value fisheries resources in various uses.

methodology, sample and questionnaire should be piloted and evaluated during the design phase before proceeding with the main survey. This together with the involvement of stakeholder groups during the design phase can enhance the chances of a productive survey outcome.

There are different benefits and costs associated with each of these survey implementation methods as well as different statistical and sampling issues. The choice of the most cost-effective method involves trade-offs between data quality and fieldwork costs. For instance, ‘face-to-face’ surveys are typically more costly but achieve better quality data and response rates than other data collection methods. Mail out surveys without follow up action on the other hand tend to be a less costly data collection method although poorer data quality and response rates (typically around 30 per cent) are usually achieved. Telephone surveys can be a cost effective data collection method, particularly for recreational fishers. Such methods need to be carefully monitored for ‘non-response’ levels and statistical bias. This can be particular significant issue where different language speaking groups within the community are major resource users.

The choice of implementation method can also be driven by the survey structure. Contingent valuation questions, for example, seek to simulate the ‘take it’ or ‘leave it’ responses in an unfolding market place scenario do not lend themselves to mail out type survey methods. Mail out surveys enable the respondent to see the end game and this may result in the respondent changing the instantaneous response.

There can be particular difficulties associated with data collection in the commercial use sector. These difficulties often present themselves in two ways. First, in many fisheries there are often few operators. This poses particular problems associated with a ‘thin’ data set of few observations and confidentiality issues.

Second, the commercial data required for the estimation of commercial use values touches on information typically regarded by industry as ‘commercial-in-confidence’ business data. Commercial operators are usually reticent to disclose such information even though confidentiality assurances are made. In such circumstances, the use of surrogate or simulated information may provide a reasonably reliable basis for ballpark estimations.

Commercial survey questionnaires often require data to be captured in a way that business financial data are not normally collected for operational purposes or require apportionment to be relevant to the particular fishery for which data are being sought. This places a burden on respondents that may lead to missing data or non-responses. Involving the relevant commercial stakeholders during the design phase where possible may avoid these issues.

3.5 Summary

In conclusion, several important concepts and principles are worth repeating:

- In the context of benefit-cost analysis, “benefits” are economic value as defined in the Economic Value section in terms of consumers’ maximum willingness-to-pay for fish, and “costs” are the opportunity costs of resources used to make fish available to consumers. In this context, revenues are not benefits and expenditures are not costs (or benefits), although these quantities can be used to help measure producer surplus and resource costs when certain conditions are satisfied.

- In benefit-cost analysis, net economic benefits are total economic value minus total resource costs. Net economic benefits, which are comprised of consumer surplus and producer surplus, are synonymous with net economic value. Such analysis can accommodate temporal and spatial factors.

- Any action which increases net economic benefits from the use of fish resources is said to increase efficiency, even if consumer surplus or producer surplus for some groups decline. Likewise, when net economic benefits decline, efficiency goes down, and Australians suffer a loss of economic value from the use of its publicly owned fish stocks.

As emphasised in this section, data on expenditures and revenues must be interpreted cautiously before they can be used to measure economic value or used to measure social and economic benefits.

- There are a variety of methodologies and techniques which can be used to estimate the economic values of commercial and recreational use. Where revealed demand preferences in an open marketplace are not available (as in the case of recreational fishing), there are surrogate or simulated market techniques that can be used to estimate economic values.

4. A THEORETICAL ECONOMIC FRAMEWORK FOR OPTIMISING NET ECONOMIC BENEFITS

The previous Sections explain economic concepts and identify what constitutes true compararive economic values for the purposes of benefit-cost analysis of allocation options between commercial and recreational use. The limitation of relying on purely financial parameters, like expenditures and revenues in such analyses, has been outlined.

This Section provides a framework for considering the optimization of total net economic benefits from allocations between commercial and recreational use. Climbing the hill to greater total net economic benefits needs to be seen as a snapshot in time. It requires review periodically to ensure the benefit-cost analysis reflects contemporary values. A set of conditions for guiding the direction of allocation decisions between commercial and recreational use to achieve incremental improvements in total net economic benefits is outlined.

4.1 Optimizing Net Economic Benefits

The efficient resource allocation between the commercial and recreational sectors optimises the net economic benefit. This is graphically illustrated in Figure 7.

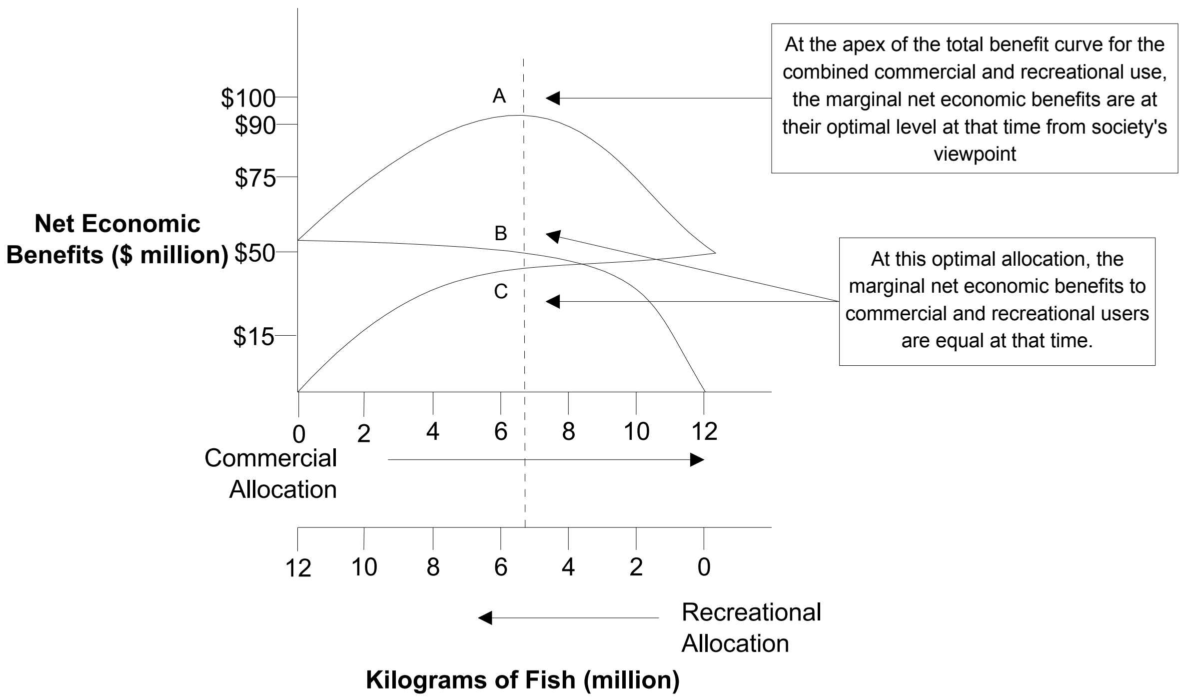


Figure 7

Total Net Economic Benefits from Allocation Options Between Commercial and Recreational Use[10]

The vertical axis records net economic value for the commercial seafood sector, the recreational fishing sector and the two sectors combined. The horizontal axis records total allowable catch. The possible commercial and recreational fishing shares run in opposite directions, such that at any point along the horizontal axis, the sum of the two shares is 12 million kilograms.

The curve that increases steadily *from left to right* traces the *cumulative* amount of consumer and producer surpluses in the commercial seafood sector as the industry's share increases from zero to 12 million kilograms. The curve reflects the underlying assumption of diminishing marginal net value for each additional kilograms, with the aggregate surpluses starting to flatten at around 5 kilograms. Similarly, the curve that increases *from right to left* accumulates the recreational fisheries consumer surplus as their share of total allowable catch increases from zero to 12 million kilograms. Total consumer surplus for recreational fisheries plateaux at about 7.5 million kilograms, because, in this example, the recreational fishers are not willing to pay $5 to catch additional fish.

The "hill" in Figure 7 traces total net economic value in the combined sectors for each possible share allocation. Graphically, this hill is the vertical summation of net economic value in each sector. It is clear from this top curve that total net economic

[10] Edwards, Steven F 'An Economic Guide to Allocation of Fish Stocks between commercial and Recreational Use' (November 1990) NOAA Technical Paper NMFS 94.

value is maximised at the apex, or at about $90 million where, as above, the recreational fisher share is about 5.6 million kilograms of fish and the commercial seafood sector's share is 6.4 million pounds. Any deviation from these shares would reduce total net economic value, including any notion of "fair" allocations such as an equal apportionment or a system that is proportional to historical or current use.

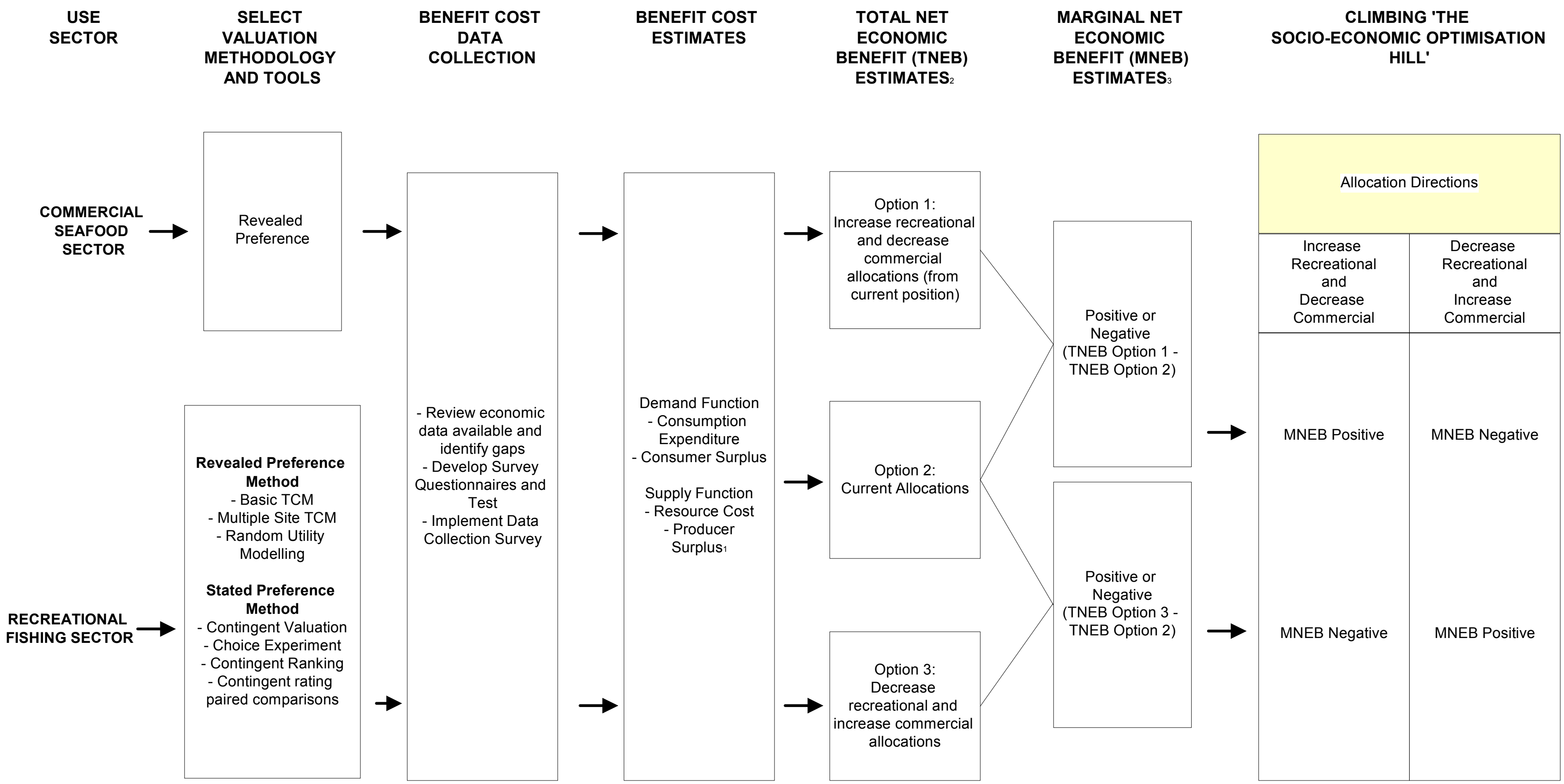
Although not obvious from Figure 7 the net economic value of the 5.6 million*th* fish in the recreational fishery and the 6.4 million*th* fish in the commercial seafood sector are equal at nearly $3.75. This latter property of the maximally efficient allocation illustrates the economic principle that in order to maximise the total net economic value from using fish for food and recreational purposes an allocation must equate **marginal** net economic values from each alternative use of the fish stock.

4.2 Climbing 'the Hill' to Greater Net Economic Benefits

The Figure 7 framework depicts a snapshot in time. The benefit-cost analysis of allocations which underlies it needs to be updated periodically to capture contemporary economic and social values and to take account of any changes in fish population dynamics and the sensitivity of resource costs to any changes in stock size or any change in market conditions which may result in expenditures no longer reflecting the true resource or opportunity cost.

The framework outlined in the following flow chart (see page 22) provides a basis for establishing a set of conditions for guiding the direction of allocations between commercial and recreational uses. The starting point is based on the assumption that there are already pre-existing resource shares in most (if not all) fisheries (although the extent of the recreational share is not always quantified) and that there is no '*a prio*ri' reason to believe

OPTIMISING SOCIO-ECONOMIC BENEFITS OF RESOURCE ALLOCATION BETWEEN COMMERCIAL AND RECREATIONAL USE



Notes: TCM - Travel Cost Methods
1. Producer surplus relates to the fish retailing, wholesaling, distribution, processing and catching sectors, including the charter industry servicing the recreational sector where it occurs
2. The overall Total Net Economic Benefit is the total Net Economic Benefit of commercial use plus the total Net Economic Benefits of recreational use under each of the allocation scenarios.
3. Marginal Net Economic Benefit is the change in the amount of the overall total net economic benefits of shifting from the status quo (to Option 1 or Option 3).

that the optimal allocation rests at the extremes, that is, the marginal economic value to one sector exceeds that of the other over all possible allocation options.

The focus of the framework is on incremental or marginal changes to resource shares and the estimation of the shift in net economic benefits in each of the uses and in total for the combined uses. Such incremental changes may need to be expressed in significant quantities (for say a 200 tonne fishery a shift in allocation of around 10 tonne) to obtain a reasonable measure of the possible movement in economic benefit.

In practical terms, the maximally efficient allocation may be illusive because of data (and other) constraints but is something to progress towards. A key feature of the benefit-cost analysis is not so much the magnitude of the net economic benefits of the competing uses but the assumptions which sit behind the valuation models. A debate on validating the reasonableness of such assumptions among interested groups would at least focus consideration on the variables which constitute the true economic values for benefit-cost analysis of allocation options between commercial and recreational use.

4.3 Summary

This section emphasised the importance of determining efficient allocations of a fish stock on the basis of incremental tradeoffs in net economic values – the difference between total economic value and total resource costs – when different uses are in conflict. If the total value argument (revenue or expenditure arguments) had been applied and the total allowable catch been awarded completely to recreational fishers, total net economic value would be only about $56.25 million instead of the $90 million achieved by the efficient allocation that includes the commercial seafood sector. Indeed, in this hypothetical exercise, the stock would be underutilised if the entire total allowable catch of 12 million kilograms was awarded to recreational fishers and vice versa.

The total net economic value in the regulated fishery (i.e. $90million) is greater than under ‘open access’. Therefore, the regulation would pass the benefit-cost criterion to increase net economic value (provided that the increase in the total resource costs of management – including administrative, scientific assessments and enforcement costs – is less than the increase in consumer and producer surpluses over time).

The maximally efficient allocation will be influenced strongly by the position and shape of the respective commercial seafood and recreational fishing demand curves, as well as by the fish stock’s population dynamics and the sensitivity of resource costs to stock volumes.

The benefit-cost analysis needs to be updated periodically to capture contemporary economic and social values and to take account of fish stock population dynamic changes, any changes in fish stock size which impact on resource costs and any changes in market conditions that result in expenditures no longer reflecting the true resource or opportunity costs.

The framework provides a basis for establishing a set of general conditions to guide allocation decisions in a direction of improved net economic benefits. The maximally efficient allocation, which achieves the greatest total net economic benefit from such allocations, occurs where the marginal net economic benefits for the competing uses are equal.

At this point, it is of little significance in economic terms that the gross value of production of the commercial seafood sector or the gross value of expenditure on recreational fishing for that fishery may be greater than the other. What is important is that, from the broader community viewpoint, the overall net economic benefits of the combined uses are at their optimum and any other allocation would reduce the overall net benefit from a society's viewpoint. This may be the case even though one sector or group may be better off but this does not offset the loss of economic value or benefit to the other sector or group of users.

An increased net economic benefit could arise in such circumstances where some are better off and others worse off. In such cases, the optimality condition requires that those who are better off are able to compensate those who are worse off and still be better off as a result of an allocation change.

5. APPLICATION OF THE GENERAL THEORETICAL FRAMEWORK

Three case studies were used to test the application of the framework.

There were two aspects to this. First, the case studies were used to assess the application of the valuation methodologies outlined in Chapter 3. The objective here was to establish 'like-with-like' values for input into the general model of resource allocation.

Second, the case studies used options to test the value of the General Theoretical Framework itself as developed in Chapter 4. This application focused on determining the socially optimal allocation of the available fish resources between commercial and recreational uses.

The case studies were not intended to support any actual resource allocation decision making process in any of the chosen fisheries. Actual allocation decisions would require further work including some further validation of results.

Rather the purpose was to determine the validity of the approach and assess it's potential to be implemented in way that will assist fisheries managers make informed allocation decisions and develop improved allocation policy.

Consistent with the overall objectives of this project, the case studies applications emphasize the methodological and practical issues in applying the general theoretical framework rather than the actual results.

The case studies were chosen to maximize the exposure of the allocation framework and its methods to a range of valuation and allocation situations.

Each case study fisheries operated under a different management regime (with a varying mix of input and output controls). Commercial use was a mix of domestic and export oriented, and recreational activities spanned use, experiential and options values. However, all three fisheries had one aspect in common, that is, they all face intensifying resource allocation pressures between commercial and recreational users.

The three case study fisheries were the Cockburn Sound Crab fishery (Part Two of this research report), the Perth Abalone fishery (Part Three), and the West Coast 'Wetline' fishery (Part Four). The latter focused specifically on the three species most prized by both commercial and recreational users, namely dhufish, pink snapper, and baldchin groper.

5.1 Underlying Assumptions for Applying Inter-Sectoral Resource Allocation Models

The application of the inter-sectoral resource allocation model is based on certain assumptions. The model assumes that:

- The current combined commercial and recreational take is all that is sustainable and available for inter-sectoral allocation;
- The fish resource being shared between the commercial and recreational uses come from the same stock;

The combined commercial and recreational catch can be taken as an explicitly defined total allowable catch across both sectors;

- A 'zero-sum' game can be played by changing share allocations between the commercial and recreational uses within that defined total allowable catch. That is, an explicit reduction in catch share in one sector is reflected in an immediate and commensurate increase in the catch share taken by the other user groups;
- All recreational participants are subjected to binding constraints (catch limits), that is, there is no spare or unused catching capacity;
- For all commercial operators, it is optimal to take their share of the defined total sustainable catch, that is, there is no unused or spare catching capability; and
- All commercial operators are internally structured to maximize 'producer surpluses' from catches taken from a fishery.

Whilst none or some of these assumptions may be exactly the case in every fishery, and this was certainly the case for the three case studies, this was not found to detract from the insights to be gained from applying the framework. The assumptions proved to be a reasonable starting point for thinking about resource allocation issues in a structured and disciplined framework.

5.2 Availability of Relevant Socio-Economic Data

Comprehensive and relevant socio-economic data was not readily available for either the commercial or the recreational fishing activities in the selected fisheries. The data sets that were available were in incomplete in a variety of ways. Original data collection was therefore required on the commercial and recreational side of each case study fishery.

The lack of data is, in hindsight, not surprising. The sort of evaluation framework proposed in this project is not currently being applied in resource allocation decision making in any formalized or structured way and neither is broad benefit-cost analysis. Hence, fisheries managers, agencies and stakeholders have not had any particular or compelling need to routinely collect the data needed for this sort of analysis.

As the need grows for individual fisheries management agencies throughout Australia to demonstrate that the use of the fish resources is such that it optimizes social and economic benefits, then there may be advantages in formalizing a co-ordinated national approach to the collection of relevant and appropriate socio-economic data. This would assist jurisdictions to adopt and apply a consistent approach to the benefit-cost analysis of intra- and inter-jurisdictional resource allocation options from public policy perspective.

5.3 Discovery of the Relevant Socio-Economic Data

The original data collection encompassed virtually all aspects in all three case study fisheries. Relevant economic data had to be collected from harvest and post-harvest businesses as well as from recreational fishers.

The survey implementation, including design, evaluation and selection of survey method (telephone, mail out or face-to-face surveys) and the associated original data collection issues are discussed in each of the case study reports.

There were different benefits and costs associated with different survey methods as well as different statistical and sampling issues. The choice of the most cost-effective method involved trade-offs between data quality and collection cost. These issues are discussed in each of the case study reports.

The application of the allocation framework to the case study fisheries produced useful and detailed insights in to each of these fisheries and the general usefulness of the framework. However, given that this sort of data collection and resource allocation modeling had not been previously undertaken, it also allowed the identification of many further research possibilities that might add to the quality of the information available in respect of both commercial and recreational fishing behaviour and relevant values in the case study fisheries. Where improvements are possible and how further work might improve the application of the framework is discussed with each case study.

5.4 Valuation Methodologies Used

5.4.1 Commercial Values

In respect of the value of commercial activities, the starting point is the market. For each of the case study fisheries, there are well-established 'seafood' markets where market prices are determined. In this case:

Consumers' reveal their preferences through the prices they pay and we can use the observable price-quantity relationships to estimate these value; and

Industry cost structures and cost-volume relationships are well established, and these can be used to estimate relevant values in harvest and post harvest activity..

The major issue on the commercial side is how best to tap into this information.

The collection of reliable and objective data from the commercial sector turned out to be much more difficult than anticipated. The data required is often regarded as private and commercially sensitive business information and there is a natural and understandable reluctance to provide it without some safeguards regarding confidentiality. Hence, a considerable amount of effort working with commercial operators is needed to access the required data.

Much of this effort with commercial survey respondents involves establishing data collection and management processes that:

- ensure awareness of the project's objectives and the exact nature of the industry information needed and the reasons for requiring it, and
- build confidence in the researcher's assurances to respect and protect the commercial confidentiality of individual returns.

The processes used are outlined in each of the case study reports.

Frequently, and this was the case in two of the three case studies, few commercial operators exist in a fishery. This poses particular practical issues in terms of both data collection methods and the limitations of a thin data set. For example, a mail out survey typically achieves around a 30 per cent response rate and, in a fishery where there is only a handful of operators, two or three survey forms may be all that are returned. In this case a considerable amount of effort is needed to contact and work with each commercial operator to ensure data quality.

5.4.2 Recreational Values

On the recreational side, there are generally no well-established markets where preferences of recreational fishers can be observed. As mentioned in Chapter 3, there are available a number of techniques that are based on surrogate and simulated markets and these can be used to estimate values placed on recreational fishing. The critical issue in this case is the selection of the appropriate valuation approach and technique. Contingent valuation surveys were ultimately selected as the appropriate technique for collection of recreational values in each of the case study fisheries.

In all three case study fisheries data were collected via phone surveys using Computer Assisted Telephone Survey Techniques. The content of the recreational surveys was designed to enable the application of both travel cost method and the contingent valuation method. That is, to illustrate the application of both a surrogate and simulated market approach, respectively.

The travel cost modeling methods turned out to unsuitable in all three case studies. Primarily this was because this method is appropriate where there exists a reasonable spatial distribution of actual and potential recreational fishers that may visit the fishery. In all the case studies the recreational fishers were tightly clustered in terms of both proximity of location to preferred fishing sites and access times. Consequentially, there was no significant variation in travel distances and access time and hence travel cost per trip to derive any meaningful results from the application of the travel cost model.

This meant that for all the case study fisheries the analysis relied on stated preferences and contingent valuation modeling.

5.5 Interpretation of Analytical Outcomes

As Chapter 4 makes clear, the important values for ‘like-with-like’ comparison purposes are the marginal net benefits from the respective commercial and recreational uses. That is, establishing whether the marginal benefit of an extra fish taken by the recreational sector was worth more or less than if that fish were caught by the commercial sector.

5.5.1 Valuing Recreational Use

The survey of recreational fishers in all three case study fisheries was developed and implemented against a widely held community belief that the various existing restrictions (daily bag limits, limits on fishing days and access time, etc) were binding constraints and that there was universally unsatisfied demand for extra catch among recreational fishers. The survey results challenged the validity of these beliefs in all three case studies.

The recreational surveys revealed a positive willingness-to-pay for recreational entitlements among the survey respondents. The responses allowed an assessment of the aggregate willingness-to-pay for various catch limits, and of the marginal willingness-to-pay for extra catches within a defined and combined total catch range covering both commercial and recreational use.

The survey results show that for two of the case study fisheries (Cockburn Sound Crabs and the Perth Abalone fisheries) use values dominated. That is, recreational fisher participation was primarily to catch fish for direct consumption. Experiential and option values appeared to play a more important role in the values recreational fishers ascribed to fishing in the West Coast ‘wetline’ fishery.

The contingent valuation modeling in all three fisheries indicated that, given their current preferences and budget (money and time) constraints, many survey respondents were currently optimizing utility or 'well being' within current catch limits. That is, they chose to cease fishing activity with retained catches less than the proscribed catch limits (and not to fully exercise their entitlements as represented by fishing days and time where appropriate) but yet they were generally satisfied with their actual (retained and released) catch. In the 'wetline' fishery, this may reflect a degree of restrained satisfaction in the belief that the catch levels were all they could reasonably expect to achieve given the pressures on the resource and the need for sustainability. Some fishers-and by far the minority in all three case studies- were constrained by the existing restrictions.

In consequence, it was expected that there would be individual fishers who might place high values on extra retained catch and those who would not. This distribution of recreational values was confirmed by the survey results.

The survey results were used to estimate the mean and marginal willingness-to-pay among the survey respondents. This estimate was taken to be indicative of the marginal values actual and potential recreational fisher placed on an extra catch in each of the case study fisheries. The marginal values declined for each additional unit of catch; a result that is expected in economic theory.

5.5.2 Valuing Commercial Use

In all three case study fisheries, survey returns from harvest and post-harvest businesses provided data that, after various adjustments, allowed the estimation of the relevant supply and demand conditions. For each of the fisheries, the demand and supply functions turned out to be consistent with economic theory.

Using these functions, the aggregate and marginal benefits from commercial use could be determined across a defined range of commercial catch volumes, although, as discussed above, these were sometimes based on thin data sets.

As shown in the Flow Chart in Chapter 3, these values included the net benefits attributable to harvest and post harvest production (including inter-State and overseas export activities) and, where appropriate, the net benefits attributable to local retail consumption. The latter was applicable in the case of the Cockburn Sound Crab fishery and the West Coast 'wetline' fishery. The Perth abalone fishery was predominately export oriented and there was little (if any) material benefit attributable to local retail consumption to be taken into account in estimating the net benefits of commercial use in this fishery.

The aggregate net benefit functions were consistent with the theoretical framework outlined in Figure 7 in Chapter 4. The marginal net benefits were shown to decline as the catch volume increased. That is, the net benefits from production fell as local retail prices declined in response increased commercial catch or supply. This decline was not generally offset by the increased benefits attributable to local retail consumption in response to declining retail prices as the available catch volumes increased.

These marginal net benefits from commercial use are the values we compared with the marginal value for recreational use.

5.5.3 Optimizing the Net Benefits from Inter-Sectoral Allocations

The net benefits from the combined commercial and recreational use are optimized where the marginal net benefits from the competing uses are the same. In Chapter 4, the estimated marginal net benefits for both commercial and recreational activity are brought together to solve for the optimal resource in the case study fisheries.

In each case, the two net benefit functions intersected at a positive allocation to both sectors, indicating that, at the socially optimal allocation at this point in time, both sectors should receive catch allocations. The results also indicate the extent to which the actual current allocation appears to be non optimal and the direction and quantity of change required. However, this aspect of the results needs to be interpreted very carefully in the light of the known data issues and the assumptions underlying the models used to estimate the marginal net benefits from the respective uses.

Two assumptions proved to be particularly important, namely, the assumption that instantaneous reallocation is possible and the assumption that each of the competing user groups (recreational and commercial fishers) is optimized within its current allocation.

As noted above, the application of the model allowed the determination of the allocation that was socially optimal in the sense marginal net benefits from recreational and commercial use were the same. It also allowed determination of the magnitude and direction of any reallocation needed to from the current allocation to the socially optimal solution.

Any adjustment to achieve the socially optimal outcome must ultimately work through the stock abundance so that the speed of any reallocation will depend on how quickly reduced effort in one sector shows up as improved stock abundance and catch outcomes in the other. This issue proved to be especially relevant in the West Coast ‘wetline’ fishery. In this case, the underlying stock abundance issues are such that, for example, there is some uncertainty as to how any commercial effort reduction would show up as improved catch rates for recreational fishers. In this case for marginal allocation adjustments, the additional net benefits from changing share allocation may be problematic. This raises real practical issues around the concept of ‘fine-tuning’ inter-sectoral shares to achieve the socially optimal allocation outcome and the need is to think about coarser reallocations and the determination of an allocation “close enough”.

The second assumption relates to each sector currently optimizing its own allocation. In all three fisheries this turned out clearly to not be the case on the recreational side. For instance, there were clear indications that individual recreational fisher’s demand was not homogeneous or universally unsatisfied in each fishery studied. This means that, if individual recreational fishers were given greater choice within an existing fisheries management entitlement to better match daily catches and access times to individual preferences, there would likely be reallocation within the recreational allocation from those fishers not pushing on existing fishing limits and those that are.

Such intra-sectoral reallocation would increase overall benefits from recreational use without the need to address inter-sectoral allocation options. Once the intra-sectoral allocation issues are resolved, the marginal net benefits could be expected to fall and socially optimal inter-sectoral allocations would need to be re-assessed. All three case study fisheries therefore highlight the importance of resolving intra-sectoral allocation issues before inter-sectoral ones

The significance of product specification and prices to inter-sectoral resource allocation was also evident in all of the case study fisheries. This surfaced in two ways. First, product (specified in terms of the size of retained fish) for commercial and recreational use were not always the same. This meant that values were not being ascribed to identically similar fish.

Second, the prices received by commercial fishermen were based on kilogram of fish caught, whilst recreational fisher's willingness-to-pay is for a fish. This means that commercial and recreational use values may be different for various fish sizes. For example, in the Perth Abalone fishery, the larger sized abalone may have a higher value in commercial than recreational use. The recreational fisher may be indifferent to abalone size so long as the catch is enough for a decent feed. The opposite may be true of the 'wetline' fishery, where recreational fishers' may place a higher value on larger sized catch of dhufish and pink snapper for example than commercial fishers. The commercial fisher may be indifferent to fish size so long as the required catch volume is achieved given the market price received is on a dollar per kilogram basis.

5.6 Pilot Testing and Reality Checking

In all three case studies, the content of commercial and recreational surveys was subjected to 'pilot testing' before adoption and implementation. This process was designed with several objectives in mind. First, to ensure that the questions were eliciting relevant and useful information. Second, to ensure the questions were clear and unambiguous so that as far as possible there would be consistent interpretation by survey respondents. Third, particularly in the case of the recreational survey, to ensure the content, structure and length were compatible with Computer Assisted Telephone Survey techniques. Finally, the pilot testing was needed to ensure that the stated preferences and contingent valuation scenarios were realistic and believable and would provide relevant and analyzable information. This process resulted in significant 'fine-tuning' of the initial questionnaires before adoption for all three case studies.

The outcomes of the analytical models are dependent on the robustness of the assumptions that lay behind them. However, a series of 'reality checks' of the data sets and statistical outputs were undertaken in the course of the assessments to ensure the results appeared to be consistent with what was happening in the industry. This focused on whether the results appeared sensible and rational in economic terms, made sense in terms of the actual operation of the market, and were consistent with the overall circumstances in the fishery. In addition, the results in draft form were presented to seminars involving industry and fisheries department persons.

In hindsight, eventhough the analysis of the submitted data provided insightful results for the demonstration purposes of this project, there were certain aspects of the survey methods and content that could be improved. In particular, on the commercial side, we need to be able to more clearly specify the demand and supply conditions in each of these fisheries if this framework were to be used as input into an actual resource allocation decision making process.

5.7 Injection of a Dynamic Component

The analytical outputs from the application of the general theoretical framework provided a ‘snap shot’ at point in time. However, these analytical results may not provide a good guide to the socially optimal share allocations in the future. This depends on a number of conditions pertinent to the individual fishery.

Of particular importance are the preferences and values that are embedded in the marginal net benefits may change over time and in ways that are difficult to predict without detailed analysis.

The development of a dynamic or multi-period allocation framework would provide an analytical tool that could be used to assess expected changes in these values in the future and to determine what they mean for the future optimal inter-sectoral allocation. This information would then inform the allocation to be made in the present. This was beyond the scope of this project.

5.8 Summary

In summary, the case studies demonstrate that the general theoretical framework based on economic principles can be usefully applied. The results in all cases are broadly consistent with economic theory and can be a basis for considering and developing allocation policy.

6. GLOSSARY OF TERMS

Average total cost	Average total cost is the sum of all the production costs for a commercial fishing activity divided by the number of units produced.
Choke price	The lowest price at which the quantity demanded is zero. At every price higher than the choke price demand is zero.
Consumer surplus	The benefit consumers gain from being willing to pay more than the equilibrium market price. This is based on the notion that consumers (e.g. recreational fishes or retail consumers)m derive greater benefit from consuming a product or activity (e.g. recreational fishing or retail purchase of fish for consumption) than the cost to them of purchasing it.(e.g. time and money for recreational fishers).
Contingent valuation	The use of structured surveys to estimate the willingness of respondents to pay for public projects or programs. (e.g. access to fish stocks for recreational fishing).
Demand (curve or equation)	It shows the amount of a good that consumers are willing and able to buy at various prices.
Existence value	The benefit derived by an individual (s) from the knowledge that an environmental resource (e.g. fish stocks) exists.
Fixed cost	Costs that do not vary with the level of output. They are therefore constant in total as output changes..
Marginal cost	The amount spent on producing one extra unit. The marginal cost is the increase in total cost when one more unit is produced.

Opportunity cost	The decision to produce or consume a product or undertake an activity involves giving up another product. The real cost (opportunity cost) of an action is the next best alternative forgone in order to do it..
Option Value	The benefit derived by and individual(s) from retaining the option to use an environmental resource at some future date (e.g. to fish up to a bag limit in the future). Option value arises from the combination of the individual's uncertainty about future demand for the resource and uncertainty about its future availability.
Optimum allocation	Occurs when resources are allocated between competing uses (e.g. fish between recreational and commercial uses) such that it is not possible to redistribute resources to increase the welfare of any one consumer without reducing the welfare of some other consumer.
Price elasticity of demand	A measure of responsiveness of some other variable to a change in price
Producer surplus	The difference between the minimum price a producer would accept to supply a given quantity of a good and the price actually received. (e.g. the difference between the price received in the market place for commercially caught fish and the minimum price which reflects the marginal cost of catching).
Variable cost	Variable costs are costs that vary with the level of output/activity.(e.g. bait for commercial fishing)
Supply (curve or equation)	The relationship between the price of a good and the quantity of the good supplied by producers (firms).

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A Socio-Economic Valuation of Resource Allocation Options between Commercial and Recreational Use

FRDC Project No. 2001/065

PART TWO

THE WESTERN AUSTRALIAN COCKBURN SOUND CRAB FISHERY CASE STUDY

Dr P McLeod and J Nicholls

Economic Research Associates

Australian Government

Fisheries Research and Development Corporation

A Socio-Economic Valuation of Resource Allocation Options between Recreational and Commercial Sectors

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The Fisheries Research and Development Corporation plans, invests in and manages fisheries research and development throughout Australia. It is a federal statutory authority jointly funded by the Australian Government and the fishing industry.

Key Words: Fisheries Economics; resource allocation; evaluation framework; socially optimal allocations

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A Socio-Economic Valuation of Resource Allocation Options between Commercial and Recreational Use

The Report

The report relating to this research project will be presented in four parts. These parts are as follows:

Part One: The General Theoretical Framework;

Part Two: The Western Australian Cockburn Sound Crab Fishery Case Study;

Part Three: The Perth Abalone Fishery Case Study; and

Part Four: The West Coast Wetline Fishery Case Study.

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- The contribution from the many recreational fishers as well as commercial fishers and post harvest operators in our endeavors to discover the required socio-economic data;
- Our associates at Data Analysis Australia, Dr John Henstridge, Jodie Thompson and Rebecca Gordon for their practical guidance in survey design and the evaluation and choice of data collection methods, assistance with data collection and analysis, and their perseverance with our supplementary data demands and frequent modeling requirements as we applied the economic paradigm to the data analysis;; and
- Carole Lefort and Terri Burgess from Data Analysis Australia who provided typing and secretarial support to this project.

The achievements that have been made in this case study are in no small way attributable to the contribution and support they have provided. For this support and assistance we are most grateful.

FOREWORD

This case study is part of a wider project focused on 'socio-economic' valuation methodologies for evaluating resources allocation options between commercial and recreational use of fish resources. It is the first of three case studies to demonstrate the practical application of 'socio-economic' valuation methodologies within a general theoretical framework. The framework was developed as the first stage of the project.

The general theoretical framework was formulated in terms of use values associated with fishing activity. These values focus on extractive uses of the fish resource whether by commercial or recreational fishers. It identifies appropriate economic values for making sound, consistent and comparable comparisons between the various extractive uses and for considering the optimization of the net benefits to society from alternative allocations of fish resources between such uses.

The overall objective of the project, as explained above, is methodological. The case studies are designed to test aspects of the framework. Therefore, the empirical outcomes for this case study are primarily illustrative of the application of the framework. The application occurs at a point in time, and, therefore, provides only a snapshot of the circumstances in the fishery. This case study is not designed to be the basis for actual allocation decisions.

If ultimately there is a desire to adopt the proposed framework and associated valuation methods as input into any future resource allocation considerations in this fishery (either within existing or under any revised catch and effort controls for sustainability reasons), there will be a need for:

- Further research to obtain up-to-date and more exact information which might help to more exactly identify contemporary supply and demand curves; and
- A 'due diligence' process to independently validate the robustness of this or any further research and its outcomes relative to the net benefits to society from these extractive uses.

In addition, the approach to illustrate the framework is static. Therefore, there would also be a need to inject a dynamic component into these models to capture underlying changes, which can be expected to impact on social and economic values over time. How best to include a dynamic component was beyond the scope of this project

The scale of this case study fishery (in terms of both commercial and recreational use) is small. The size of the net benefits to society (under existing or alternative allocation options) is small when considered in the wider fisheries context in Western Australia. Nevertheless, the case study is important from two perspectives.

First, the outcomes of this study show the general framework is sound and the results are consistent with economic theory and the proposed framework.

Second, this fishery is typical of many fisheries where allocation issues are arising and will arise in future. Although relatively small, it contributes significantly to the well being of several commercial fishermen and many recreational fishers and their respective families.

Whilst the focus of this case study has been on extractive use values (and as it turned out these were the dominant values in this fishery), this is not to say other social values (for example, non-consumptive values, including conservation and preservation uses, experiential values such as catch and release values, as well as existence or option values, inter-generational values and the like) may not be important. Where there are '*a priori'* grounds to believe such values are likely to be statistically significant in a particular fishery, they can be handled within the general theoretical framework outlined in the first phase of this project.

Consistent with the objective for the overall project, this case study report is a 'warts and all' presentation as a learning experience in the application of socio-economic valuation methodologies within the general theoretical framework outlined in the earlier part of this project. This experience was called upon in undertaking the two subsequent case studies of this project. It is hoped that others may benefit from the experience outlined in this report.

TABLE OF CONTENTS

TABLE OF FIGURES

EXECUTIVE SUMMARY

This study is one of three case studies to demonstrate the application of socio-economic valuation methodologies for evaluating resource allocation options and of a general theoretical framework for considering the optimization of social and economic benefits from resource use. These were outlined earlier in the first phase of this project.

The general framework focuses on consumptive or extractive use values associated with commercial and recreational activities. As such it provides a basis for making sound, consistent, and 'like-with-like' comparisons between extractive commercial and recreational uses of fish resources.

Availability of Socio-Economic Data

Typical of many fisheries there is a dearth of relevant socio-economic data relating to the Cockburn Sound Crab Fishery. Hence, it is not possible to undertake benefit-cost analyses of resource allocation options in this fishery with the publicly available data. The official data sets, which were available for the fishery, were either incomplete or misleading.

The lack of relevant socio-economic data is, with hindsight, not surprising. The sort of evaluation framework proposed in this project is not currently applied, as a basis to support resource allocation decision-making processes and neither is broad benefit-cost analysis. Hence, managers and agencies have not had any particular need to produce this sort of data.

Discovery of Relevant Socio-Economic Data

The lack of data meant that original data collection was required for virtually all aspects of the case study. Relevant economic data was required for both harvest and post-harvest businesses as well as recreational fishers associated with the Cockburn Sound Crab Fishery. These data were collected through a series of surveys of businesses and recreational fishers. The survey implementation, including survey design, evaluation and selection of survey method (telephone, mail or face-to-face surveys) and associated original data collection, is discussed in the main body of the report.

During the design phase, considerable attention was given to the survey content and the choice of survey method. There are different benefits and costs associated with different methods as well as different statistical and sampling issues. The choice of the most cost-effective method involves trade-offs between data quality and collection costs.
Given the demonstration purposes of this project, we adopted methods, which kept overall collection costs to a minimum. As a general rule, it is often better to have a few, quality observations than many poor ones.

A number of unexpected gaps and inconsistencies were identified in the commercial data sets during the analysis of the commercial survey results. In these instances, a supplementary survey was developed for post harvest commercial activities. In addition, a number of face-to-face discussions were held with survey respondents and others with industry knowledge to resolve these gaps to the greatest extent possible. Ultimately, the commercial data set was adequate for the demonstration purposes of this project. However, if the methodologies and framework were to be used as input into a process considering future allocations in this fishery, further research to more exactly identify the supply and demand curves in the commercial markets for crabs would be worthwhile.

Valuing Recreational Use for Cockburn Sound Crab Fishery

The survey results indicate clearly that recreational fishers' trips to the Cockburn Sound crab fishery were primarily for the purpose of catching sufficient crabs to eat. This was consistent with our prior understanding of the nature of the fishery. In particular, the marginal values that the recreational survey respondents ascribed to additional catch from fishing in Cockburn Sound need to be interpreted in terms of this consumptive objective. Non-use values do not appear to play a significant role for recreational fishers, and, therefore, are not reflected in the values that the recreational fishers ascribe to crab fishing trips to Cockburn Sound.

The analysis of recreational values relied on the use of the stated preference approach and contingent valuation surveys. Reliance on revealed preference approaches using alternatives such as a recreational travel cost model was discounted in this case study. Such methods work best where there is a normal spatial distribution of the population in statistical terms with respect to distance from the fishing location of interest. In this case study, the surveyed recreational fishers were located in very close proximity to the Cockburn Sound Crab Fishery. This meant that there is not a statistically significant distribution of travel distances and costs to produce a meaningful result from the application of travel cost models.

The contingent valuation modelling indicates that Cockburn recreational crab fishers are currently optimizing at catches below the bag limits. This is not a surprising result; given quantity restrictions are non-binding on recreational fishing behaviour in this fishery. In economic terms, this means recreational fishers are optimising satisfaction (utility or well being) within their current preferences and existing budget (money and time) constraints. Consequently, recreational fishers are unlikely to value extra catches highly and this was confirmed by the survey data.

The data showed that at a 'zero' price (a 'nil' daily trip fee), an extra 163kg of crab are demanded. This represents around one extra crab for one out of every four Cockburn Sound recreational crab fishers in 2000/2001. The marginal net benefit (or the increased consumer surplus of recreational fishers) of this extra crab demand is around $2,000 or about $12 per kg.

Valuing Commercial Use

Estimates of producer surpluses for harvest and post-harvest activities and local crab consumer surpluses for annual commercial catches ranging from 210 to 280 tonnes were made. (This corresponds to commercial catch experience in the 2000/2001 financial year and the average of the reported catches over the past five years ending 2000/2001.) The sum total of the producer and retail consumer surpluses at each quantity level represents the annual net benefits attributable to commercial use, ranging from around $1.935 million to about $2.382 million over these catch levels.

Consumer surplus estimates excluded Eastern States consumer surpluses from export sales of Cockburn Sound crab. The fishery is located in State waters and the analysis considered the optimization of the net benefits from this resource use to the State. If a national perspective were taken, then the Eastern States consumer surpluses should be factored into the model.

Interestingly, industry (harvest and post harvest activities) cost and price data suggest that, at commercial catches around the five-year average of 280-300 tonnes, the industry is in negative (marginal loss) territory. At these levels, marginal costs outweigh marginal revenues. The industry appears to be at breakeven volumes with catches around 250 tonnes.

Optimising Net Benefits from Commercial and Recreational Use

The aggregate net benefits from commercial use were estimated to be around $1.935 million for the total commercial crab catch in this 2000/2001 year. The aggregate surplus in recreational fishing has not been calculated. However, as the framework paper makes clear, comparing two aggregate net values does not explain what should happen to resource allocation at the margin. For this we need to value the additional (marginal) catch for both commercial and recreational fishers on a comparable basis.

For the recreational crab fishers the extra kilos were valued at $2,000 in recreational use values based on the what is interpreted as the recreational fishers' consumer surplus from having the extra crab catch.

When expressed on a per kilogram basis, the value of net benefits at the margin for recreational use are higher than for commercial use for a range of resource sharing options. Indeed, for example, at commercial catch levels around the average for the last five years (that is, 280 to 300 tonne), the marginal net benefits per kilogram from commercial use are around $4.37 compared to about $5.53 from recreational use.

Whilst these values are worth highlighting to provide a perspective on particular measures, **the important values in a benefit-cost analysis of resource allocation options are not the aggregate but marginal net benefits for the respective uses. The optimum allocation occurs where the marginal 'net' benefits from each of the resource uses are the same**. Our modelling focused on the marginal benefits.

At existing catch levels of around 212,000 kgs, the marginal net benefits from commercial use ($8.33 per kg) exceed recreational ($5.19 per kg). If there were additional catches available to be allocated more would need to be allocated to commercial (about two thirds) rather than recreational (about one third) use to optimize overall net benefits from commercial and recreational use.

However, the proportional allocation should increasingly favour recreational use as additional availability of crabs progresses to 260 tonne.

At commercial catches around the five-year average (that is 280-300 tonnes), any extra crab available would need to be allocated entirely to recreational fishers if the overall net benefits are to be optimized. This is because, at these volumes of catch, the marginal recreational value ($5.33 per kg) exceeds the marginal commercial value ($4.37 per kg). In fact beyond a catch level of 250 tonnes, the combined harvest and post-harvest activities appear to be in negative (marginal loss) territory, and, beyond this, the increases in retail consumer surpluses at lower prices (due to the increasing availability to crab in the market place) do not outweigh the decline in producer surpluses.

Reality Checking of Model Outcomes

The results of the modelling are illustrative only and a ‘snapshot’ in time. The outcomes are dependent on the robustness of the assumptions behind the models. Nevertheless, we did undertake a series of “reality checks” of the data sets and statistical outputs in the course of the assessment to ensure the results appeared consistent with what was happening in the industry. This focused on whether the results appeared sensible and rational in economic terms, made sense in terms of the actual operation of the market and was consistent with the overall circumstances in the fishery.

Injection of a Dynamic Component

As already noted, the analysis applies at one point in time, yet the catch levels change substantially over time. For any actual implementation, the analysis would need to be updated (and recalibrated) as the underlying conditions behind economic and social values change over time.

One potentially important aspect of this is the growing and aging population and increase in residential development along the southern corridor of the Perth metropolitan area within close proximity of the crab fishery. This is likely to bring increasing recreational pressures in the Cockburn Sound crab fishery as the increased population seeks to participate in it. Leaving aside the sustainability questions, in the face of these developments under the existing management regime, any reduction in recreational catches below those which are now optimizing satisfaction amongst existing recreational fishers can be expected to place upward pressures on their social valuations of catches in Cockburn Sound crab fishery.

While the development of a dynamic element would be required to ensure that the analysis approximates more closely contemporary circumstances as they change over time, it is beyond the scope of the current study.

Overview

The case study demonstrates that the general theoretical framework has worked, and that the results were consistent with economic theory.

1. Background

This report applies the theoretical economic framework for evaluating the net benefit to society of resource allocation options developed in the first part of this project to the Cockburn Sound Crab Fishery. As such it is the first of three case studies, which will be used to demonstrate the application of this framework to resource sharing options in fisheries management.

Consistent with the objective of the overall project, this application to the Cockburn Sound Crab Fishery emphasizes methodological and practical issues in the application of the framework as much as the actual results.

Lessons for future application, including the subsequent applications that form part of this study, are considered. In particular, although the crab fishery is small in terms of the numbers of commercial fishermen, the value of the commercial catches and the size of the recreational catch, the principals incorporated in data collection for recreational and commercial activities along with survey designs, analytical models, statistical analyses, together with survey and analytical lessons learned, will form the basis for the subsequent case studies in the overall project.

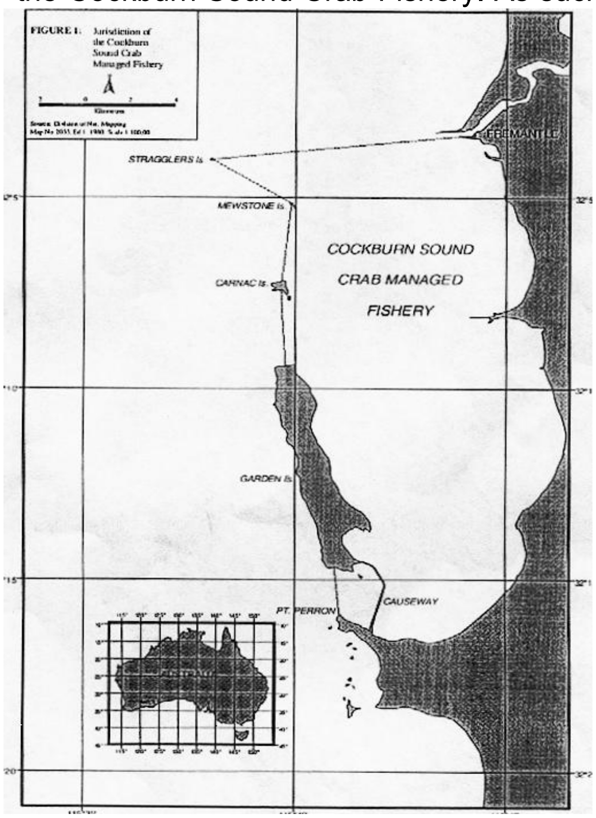

Figure 1 Location Map, Cockburn Sound Crab Fishery

1.1 Management Framework

The Cockburn Sound crab fishery is located in a small embayment off the coast from the port city of Fremantle and the nearby industrial area of Cockburn (see Figure One).

The fishery is managed under the Cockburn Sound (Crab) Management Plan established during 1995. This Plan was subsequently amended to incorporate the outcome of an 'Agreed Arrangement Proposal' (AAP) negotiated between representatives of the commercial and recreational sectors and the Fisheries Management Agency in Western Australia.

The AAP emerged under determined Guidelines for a Voluntary Resource Sharing (VRS) process. The Cockburn Sound Crab Fishery Proposal was the first outcome from the mediated VRS process and represents a successful cross-sectional negotiated agreement in a fishery plagued by resource sharing difficulties.

The reported objectives of the 'AAP' were:

> "*To achieve either an 800 pot commercial fishery or an explicit proportional catch share of 3/8^ths^ recreational and 5/8^ths^ commercial take of blue manna crab in the Cockburn Sound Crab Fishery within 3 years from the date of the gazetted of the 20 per cent commercial pot reduction.*
> *If the proportional catch share arrangements, including the progressive reduction of commercial pot numbers are not achieved, then further management mechanisms will be introduced*."[3]

There is no explicit total allowable catch (TAC) for commercial and /or recreational crab catch in Cockburn Sound. According to the Fisheries Department of Western Australia, an implicit overall TAC is currently around 300 tonnes, assuming a recreational catch of around 20 tonnes. This is open-ended because of the potential for increasing recreational participation with population growth.

1.1.1 Commercial Fishing

Limited Entry

This is a limited entry fishery with twelve (12) commercial licenses issued; although there are effectively eight (8) commercial operators after allowing for multiple licenses holding in the fishery and lease arrangements. All but two (2) commercial licensees hold licenses in one or two other fisheries in Western Australia.

Licenses are transferable, except for one remaining Class B license.

Input Controlled

840 pots were on issue in year 2000 with holdings per licensee ranging from 1 to 80 pots. Pots are transferable with a minimum holding of 40 pots required to operate in the fishery. No restrictions apply to the maximum pot holding per licensee.

Size Restrictions

A legal minimum size of 130mm carapace width applies.

Seasonal Closures

Seasonal closures to commercial fishing apply during October and November each year.

[3] Fisheries Western Australia, 'State of the Fisheries 1999-2000', page 22.

Management Fees

Commercial licensees pay a managed fishery license fee based on a percentage of the gross value of production. This fee has two components: a contribution towards the cost of managing the commercial fishery plus a Development and Better Interest Fee which was introduced as a return to the community[4].

Annual Catch

According to data provided to the Fisheries Department's Research Division by licensed commercial fishermen operating in Cockburn Sound, annual catches fluctuate and the 2000-2001 year catch was around 212 tonnes with an estimated 'beach' value of about $0.96 million.

1.1.2 Recreational Fishing

Unlike commercial fishing, there is no restriction on recreational fishers entry to the crab fishery nor on seasonal closures to recreational crab fishing in Cockburn Sound.

Recreational fishers can only catch crabs by hand, using non-piercing wire hooks, wire scoop nets or drop nets. A boat limit of 10-drop nets applies, or 10 nets per person if fishing from shore. A daily bag limit of 24 crabs per fisher or 48 per boat (two or more fishers) applies, although Fisheries' Department survey data suggest recreational fishers' daily catches are generally less than the bag limits. Also, a minimum legal size of 127mm carapace width applies to recreational fishers. All spawning females must be returned to the ocean.

The Fisheries Department's survey data suggest most recreational crab fishing in Cockburn Sound is from boats using drop nets, although shore fishing and diving also account for a portion of the recreational catch. The boats used are typically runabouts or open type vessels constructed of either aluminum or fiberglass, ranging from three (3) metres to six (6) metres in length.

The Fisheries Department estimates the recreational catch to be around 20 tonnes in 1996-1997. This is the most recent year for which survey data are available at the time of the case study. A survey is currently underway for the 2001-2002 year.

1.2 Resource Sharing Setting

This fishery has a history of resource sharing conflict. In the context of the recent AAP, there is a recreational community expectation that, if the stated proportional catch shares are not achieved, then further management changes would be introduced, presumably to reallocate crab resources away from commercial to

[4] Hon. M House, MLA, then Minister for Fisheries[1] presentation on the "Future Directions for Fisheries Management in Western Australia" (22 September 1995), page 24.

recreational use. The low catch events in the current and the previous year compared to catch experience of the recent past will be adding to these pressures.

In this context, and, assuming the existing commercial and recreational crab fishing effort in Cockburn Sound is sustainable, this study considers the marginal net benefits of commercial and recreational uses. The study focuses only on **extractive use values** of commercial and recreational fishing. In addition, consistent with what we understand to be the resource sharing issue, the study focuses on the relative marginal net benefits of an extra consumptive crab catch rather than the value of retaining existing catches.

There was no 'a priori' reason to believe that option or existence values were likely to be significant in relation to Cockburn Sound recreational crab fishing experience.[5] Cockburn Sound crab fishing does not appear to offer a unique experience that would be different to that which the population can achieve at the nearby Swan River, the Peel-Harvey inlet or Geographe Bay. If such values were thought to exist, then they would need to be tested for separately. [6]

1.3 Underlying Settings

The study was carried out within the fisheries management arrangements and the social and economic climate prevailing at the time of the study, and, not in the context of past decisions, which may have included values on a resource re-allocation in this fishery. We also did so against the choices implicit in the commercial and recreational fishers' decisions to fish for crab in Cockburn Sound and those of Western Australian consumers who decided to buy Cockburn Sound crabs through retailing establishments, including restaurants.

Of particular significance, there was no single, discreet and realized total allowable catch within which to analyze the net benefits of changes in share allocations between commercial and recreational use. Indeed, the aggregate total catch is uncertain. There was official data from the Fisheries Department of Western Australia on the level of, and variation in, commercial crab catches in Cockburn Sound. However, there was much less certainty around the magnitude of current recreational crab catches in Cockburn Sound.

As noted previously, a Department estimate put the recreational crab catch at around 20 tonne in 1996-1997. However, this estimate is not universally accepted. This means that it is difficult to apply the resource sharing model as outlined in the general theoretical framework phase of this project because the overall total allowable catch to be shared is unknown. The approach taken in this case study was to consider

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[5] This relates to those natural resources experiences so unique (eg. Great Barrier Reef or Ningaloo Reef) that the population generally aspires to the experience at least once in a lifetime such that they would wish to see the resource sustainably managed so that they may be able to exercise an option to enjoy the experience if they were to visit the site at some time in the future.

[6] As mentioned in the general theoretical framework chapters to this project, other categories of social values related to non-consumptive uses, preservation or conservation values or inter-generation values are not addressed, in this case study.

values and allocation at the margin over a range of commercial catch levels indicative of the recent past. In this context, the size of the overall recreational catch (whether it is 20, 50 or 60 tonne) became less significant. The important values were the marginal net benefits of commercial and recreational use and the way they vary at different potential catch levels.

2. Valuing Recreational Use

As with many recreational fishing activities, there is no well-established market where values that recreational fishers place on crab catches in Cockburn Sound may be observed. Whilst past surveys have collected data on recreational effort and catches in the Cockburn Sound fisheries, there is no appropriate socio-economic data set available which would enable an estimation of the values placed on Cockburn Sound recreational crab catches. Hence, to develop estimates of recreational fishing values for the Cockburn Sound crab catches required original data collection.

2.1 Data Collection

Valuing such non-market goods (namely, recreational crab catches) required the collection of appropriate socio-economic data. This meant careful consideration of what data needed to be collected and how to cost effectively discover the required data

The required data needed to meet the objectives of the project which were to demonstrate the application of valuation methodologies based on revealed and stated preferences using surrogate and simulated market approaches.

The survey questionnaire was developed with the assistance of an Interested Parties Consultative Group that comprised people with a sound knowledge of fisheries. A ‘test run’, using a recreational fisher who had fished for crabs in Cockburn Sound, provided valuable feedback. This helped to ensure that, as far as possible, the proposed questions were clear and unambiguous, and, in particular, the contingent valuation question posed a believable and realistic scenario. In part, this study is pilot for two subsequent studies; the lessons learnt from this study will be fed into the subsequent studies. The questionnaire is presented in Appendix 1. The appendix also gives a rationale for each of the questions used.

In the absence of recreational licenses applying in a fishery, surveys would normally sample a cross section of the general population in regions judged to be the likely ‘draw areas’ of recreational fishers or perform a ‘face-to-face’ survey at boat ramps on most frequented fishing spots. In this case study, we were able to draw from a pool of identified Cockburn Sound recreational fishers from two different survey populations. The Fisheries Department of Western Australia carried out these surveys previously.

Our survey was conducted in two waves using these two different survey populations. The first wave used 86 respondents from the 1996/1997 Boat ramp survey of recreational fishers by the Fisheries Department of Western Australia.

These respondents were contacted by the Agency and asked if they would be willing to participate in a further survey.

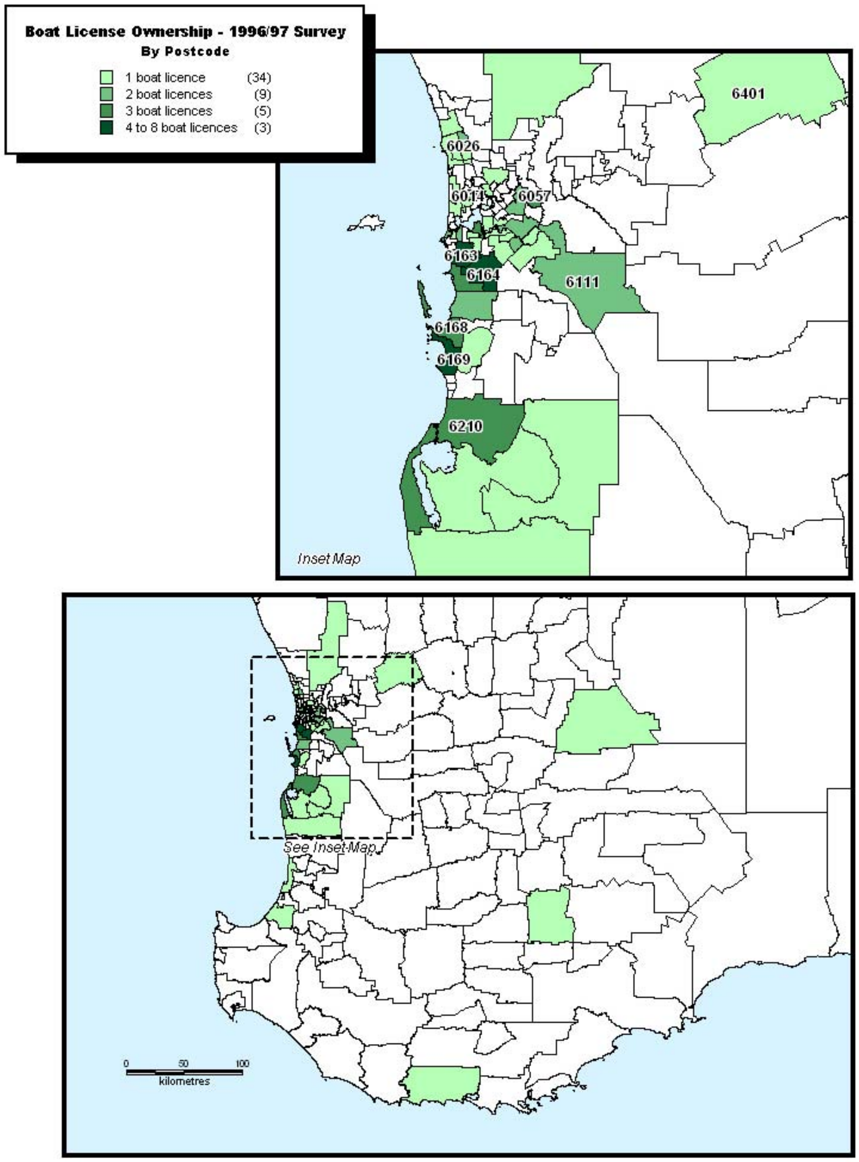


Figure 2: Locational Pattern of Boat License Owners known to be Cockburn Sound Recreational Crab Fishers

A further 16 contacts were provided by the Agency from the 2000/2001 National Recreational Fishing Survey giving a first survey sample of 102 contacts. Introductory letters were sent to the Wave One sample contacts on 19 November 2001. Two respondents requested their removal, as they no longer fished for crab in Cockburn Sound. The remainder was approached by telephone for interviews between 29 November to 10 December 2001.

The majority (almost 60 per cent) of these boat-owning contacts was located in the southern residential corridor of the Perth metropolitan area, which is in close proximity to the Cockburn Sound crab fishery (See Figure 2).

A second wave survey of 69 contacts was conducted in April 2002. These contacts were drawn from a current 2001-2002 catch and effort survey of Cockburn Sound recreational fishers by the Western Australian Fisheries Department. They were recreational fishers who had fished for crabs and who had agreed to participate in further surveys. Like the first wave, the survey population was mostly boat owners, although those who dived or shore fished for crabs were also included.[7]

The survey data were collected by telephone interviews using Computer Assisted Telephone Interviewing techniques This was judged to be the most cost effective data collection method for this demonstration project and expected to achieve a reasonable number of observations. With a small initial survey (102 contacts), a mail out survey was expected to achieve too few observations. Mail out survey methods typically achieve a 30 per cent response rate.) ‘ Face-to-face’ interview methods were clearly too costly for the purposes of this project. These other survey methods may be cost effective data collection methods in other circumstances. The choice of the survey method will be a case-by-case decision depending on the circumstances at the time.

The two-wave survey was statistically significant from two perspectives. First, it provided a basis to gauge whether there had been any significant change in Cockburn Sound recreational crab fishing behaviour in the intervening five years between the two survey populations. Second, we could check whether there was any statistically significant difference between the two survey populations. This added a dynamic dimension to the analysis and replicated the kind of practical real world considerations of changes in social valuations over time.

2.2 Data Analysis

The results of the two waves of telephone surveys are presented in Appendix 2. The key outcomes are outlined below:

General Population and the Sample Group

- The total population of recreational crab fishers appears to have been around 550 to 600 during the 2000-2001 year. This estimate is derived from the Fisheries Department estimates of the total recreational crab catch using the

[7] The fact that a question has been included in surveys about the willingness to participate in further studies related to the fishery was a significant benefit to our current study as it allowed for a ready approach to defining a survey sample. It would be desirable if including such a question became standard practice in fishing surveys. This would allow for future sample selection and helps avoid further surveying of people who do not want to be contacted.

assumption that the survey groups catch experience was representative of the rest.

- Out of the contact list of 171 households (102 for the first wave and 69 in the second), 162 contacts were attempted with 145 ultimately achieved; a 15 per cent leakage before interviews commenced. This was due to difficulties in aligning contact names and addresses to telephone numbers, disconnected telephones, prior withdrawals before the survey commenced for the first wave, and those who could not be contacted by telephone after six attempts.

- Of the 145 contacted, only 82 (or 57 per cent) completed the telephone survey. This was less than the number expected and somewhat less than the preferred sample size for statistical purposes, that is, we would have preferred at least 100 respondents.

- The leakage of 63 (43 per cent) of those contacted was due to various reasons and mainly attributable to first wave of survey contacts. This represented an overall leakage of 52 per cent from the initial contact list.

- Two-thirds of this leakage were first wave respondents who had fished for crab in Cockburn Sound five years ago but not in the last twelve months. Also, interview declines accounted for another 20 per cent.

- The annual crab catch of the survey group totaled about 3 tonnes. This suggests that those who completed the interview represented around 15 per cent of the population of recreational crab fishers in that year in terms of both numbers and catch.

- The two sample groups were not significantly different statistically (see Appendix 3) and could be combined for analytical purposes.

Respondents Fishing Background

- In the main those who completed the questionnaire fished recreationally for other species and in other locations. Only 13 per cent of the survey group focused their entire fishing effort on targeting Cockburn Sound crab. For two-thirds of the respondents, Cockburn Sound crab fishing accounted for less than 50 per cent of their recreational fishing trips.

- The sample group was dedicated Cockburn Sound crab fishers. Some 90 per cent of the respondents crab fished more than twice in the 2000-2001 period. Half of the group fished for crab more than five times.

- During 2000-2001, 40 per cent had also fished or crabbed in other locations, particularly in the near by Swan River and the Peel-Harvey inlet.

- Recreational crab fishing appears to be a male domain with few females included in the survey group. Retirees and pensioners, that is the over 60's, represented 30 per cent. Those in their 30's, 40's, and 50's each accounted for about 20 per cent of the group. Annual incomes of between $26,000 and $36,399 had the most number of respondents.

- Crab catches were either eaten by the household or shared with friends.

Crabbing Experience in Cockburn Sound

- Crab fishing tended to be group orientated rather than an individual experience. Generally, the group size was 2 to 3 people but 4 to 5 people were not unusual. The group included both family and friends.

- Crab fishing trips were on average between 3 to 4 hours duration on the water with the period away from home mostly between 3 to 5 hours. This reaffirmed the draw areas for recreational fishers tended to be in close proximity to Cockburn Sound and the trips were 'purposeful' visits rather than associated with other activities. This meant values besides crab fishing were unlikely to be included in any cost or values which respondents attributed to crab fishing trips to Cockburn Sound.

- The reported catch per trip over the 2000-2001 period was well below the bag limits. Most said they stopped crab fishing because catch was all that they could eat or use (40 per cent), or all they could catch in a set time (27 percent), or represented as many as they could catch (27 per cent). An economic interpretation of this is that recreational fishers have optimized their utility (which is also referred to as satisfaction or well being) at catch levels below allowed catch. The economic implications of this for marginal willingness to pay and resource sharing are considered below.

- In terms of both importance and satisfaction, factors such as having a 'good time' regardless of how many crabs were caught, social interaction with family and friends, and the size of the crabs caught were rated highly. Other factors like the numbers of crab caught, the actual number of crab caught compared to expected numbers, and the time taken to catch the desired number of crab were not rated highly.

Cockburn Sound Crab Trip

- Recreational crab fishing of the survey group concentrated mostly in the January-March period.

- Most chose to crab in Cockburn Sound either because it was local and convenient, or, because of habit. For three-quarters of the survey group the 'round trip' to crab fish Cockburn Sound was 40 kilometres or less. This suggests these recreational fishers were within 20 kilometres of Cockburn Sound, that is, around 30 minutes each way trip in the Perth metropolitan environs.

- The majority (68 per cent) of the respondents were satisfied with the number of crab they kept on their last crab fishing trip to Cockburn Sound, whilst only

32 per cent were dissatisfied. This satisfaction result is consistent with a management regime where recreational fishing restrictions are non-binding on fishing behaviour, and, utility (satisfaction or well being) is being optimized at catches below the allowable bag limits.

- In terms of the most recent trip, most fishers stopped fishing for crab before reaching their bag limits. They said this was because they had run out of time, or because they had caught enough for a feed, or because they were not having much success. This was consistent with the ‘on-average’ response to crab fishing in Cockburn Sound over the last twelve months.

2.3 Revealed Travel Costs and Demand

Travel cost data revealed by surveyed Cockburn Sound recreational crab fishers are presented in Appendix 2. This shows, among other things, distances traveled, costs on average per trip to fish crab in Cockburn Sound, and the number of crab fishing trips to Cockburn Sound in the last twelve months.

Basic statistical analysis (correlation and regression) was applied to appropriate variables in the data set to determine whether there was any statistically significant relationship between the number of crab fishing trips and the distance traveled per trip, the cost per trip, the number of trips and socio-economic variables like income. These latter variables are the ones expected to be significant in a travel cost model.

The underlying premise of travel cost models (TCM) applied to natural resource use is the cost of accessing the site of the recreational activity (a combination of out-of-pocket and time costs) can be used as a proxy for the “price” paid to access the site and the associated recreational activity.

The implementation of the model is based on the assumption of a normally distributed population of potential recreational users to a site in terms of distance to the specific site of interest. This being the case, those people living closest to the site will have the lower per trip access prices and will therefore tend to visit the site more frequently than those who live further away. That is because the access price as measured by the travel (out-of-pocket and time costs) of a return trip to the site is higher for those living further away and they will “demand” fewer trips. This type of modeling has been successfully in a variety of applications, especially for well-defined sites such as wildlife parks and reserves and lakes in the United States.

Our correlation and regression analysis did not indicate any statistically significant relationship between the number of crab fishing trips and the key potential explanatory variables in the travel cost data set (See Appendix 4). The R-square for the estimated of the basic travel model was around 0.10 and 0.15 with no statistically significant variables. There were some clear outliers, but, even with these outlying observations excluded, the R-square values were only around 0.20 and the resultant relationship was not statistically significant.

In the light of these results it was concluded that a travel cost model was not appropriate for the Cockburn Sound crab fishery. The subsequent analysis discussed below therefore relies on the results from the contingent valuation survey to estimate the social valuation placed by recreational fishers on additional Cockburn Sound crab catches.

A comment on the conclusion regarding the inapplicability of the travel cost model is appropriate. On reflection, it is not a surprising result. Travel Cost Models are most appropriate in circumstances where the population of actual and potential fishers is spatially distributed over a significant distance from the recreation site. This ensures the required variability in distance in access times. In this fishery, the survey population was concentrated in close proximity of location to the Cockburn Sound site. Consequently, there was not a great variation in travel distances and hence in expected cost per trip. Most respondents lived within 15 to 30 minutes of the site.

Where travel cost modelling has been used, the presence of alternative sites has been important in influencing consumers' behaviour. Such sites have to be modeled explicitly as substitutes for the specific site of interest and their availability may affect demand by people at varying distances from the site of interest. Alternative sites to the case study fishery exist at the Swan River, the Peel-Harvey Inlet or Geographe Bay. However, inclusion of these sites would not be expected to have any profound impact on the travel cost model results because the potential recreational users to these sites, especially the Swan River and Peel Harvey are still likely to come from Perth and are concentrated within a very narrow distance and travel cost range. This may well be true for many Western Australian fisheries given the State's population demographics and the concentration of population of people in Perth.

2.4 Stated Preferences and Contingency Valuation Modelling

Assuming sustainability is not an issue under the existing combined commercial and recreational fishing effort, the option considered in this study is a reallocation at the margin to recreational use. Hence, the focus is on the value which recreational fishers place on extra crab catch and the comparison between marginal values of extra catch for recreational and commercial fishers.

The marginal value of extra crab catch rather than the marginal value of retaining the existing crab catches is the key question for this analysis. In particular, the extent of any increased 'consumer surpluses' from greater catch is the key variable to be considered. The basic theoretical model for approaching this issue is set out in Figure 3 below.

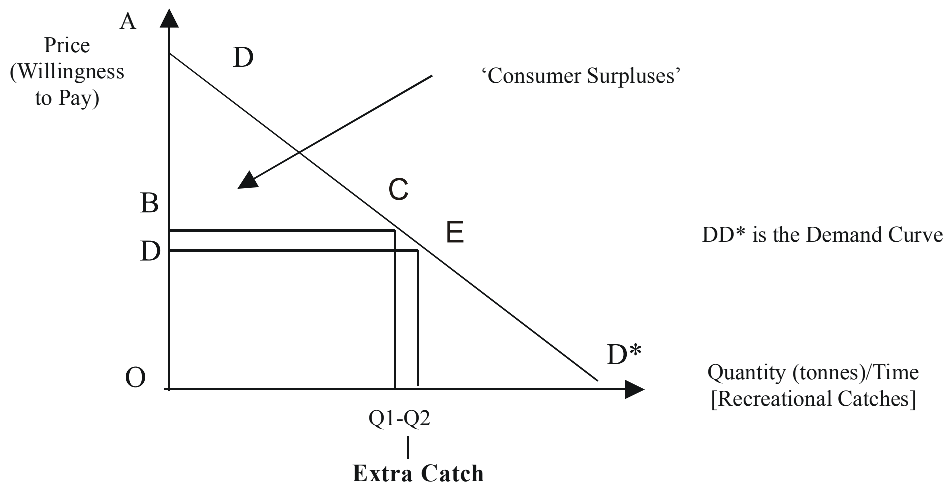


Figure 3: Theoretical Demand Curve for Recreational Catches

Existing Recreational Catches

- **OBCQ1** is what recreational fishers are willing to pay for catches at level Q1
- **OACQI** is the total benefits recreational fishers derived from existing recreational catches.
- △**ABC** is the 'consumer surpluses' or the net benefit related to the existing recreational catches.

Increased Recreational Catches

- **Q1 Q2** represents extra catches by recreational fishers arising from a fisheries management policy decision to reallocate resources in a fishery. **ODEQ2** is what recreational fishers pay for catches at level Q2.
- **OAEQ2** is the total benefit derived by recreational fishers from increased Q2 catches.
- △**ADE** is the 'consumers surpluses' or the net benefit related to the increased Q2 recreational catches.
- **DBCE** is the gain in 'consumer surpluses' or the net benefit related to the extra recreational catches from Q1 to Q2.

The aggregate values of the willingness to pay (OBCQ1and ODEQ2), of the total benefits derived from recreational catches at Q1 and Q2 (OACQ1 and OAEQ2), and the 'consumer surpluses' at their respective Q1and Q2 catches (△ABC and △ADE) are important economic values. However, in a resource allocation consideration context, the most important values are the marginal changes in these values as resources are reallocated from Q1 to Q2 (or vice versa), in particular the changes in the 'consumer surpluses' of recreational fishers associated with an allocation change.

For example, in Figure 1 above, the difference between ∆ADE and ∆ABC represents the increase (or decrease) in recreational fishers 'consumer surpluses' from resources reallocation to (or from) recreational fishers from Q1 to Q2 (or vice versa).

It is this marginal value that we seek to quantify using contingent valuation methods. Each contingent valuation survey values a particular scenario. The scenario we advanced to survey respondents regarding the Cockburn Sound crab fishery was based on a proposed fisheries management change that, if implemented, would increase the probability of extra crab catches for the recreational fishers. The respondents were asked to respond to the scenario presented in terms of their willingness to pay a daily trip fee to fund the management change and the associated expected extra crab catches. The number of extra crab and the amount of the daily trip fee was varied and randomly assigned to respondents. Each respondent was asked to give a 'yes' or 'no' answer (See Appendix 1, Q39 to Q41). This is a common approach in contingent valuation and is premised on enabling a simulation that approximates the 'take it' or 'leave it' aspects of competitive market pricing.

In the second wave, where respondents indicated an unwillingness to pay the nominated daily trip fee above one dollar, the interviewer probed the reasons and their willingness to pay a lower fee. This was designed to gauge the extent to which their initial response was simply a protest vote as opposed to a genuine 'Nil' valuation.

A logistic regression model was applied to analyze the variables that might best explain the recreational fishers willingness to pay for extra crab. The factors that might best predict the probability of a 'yes' response (that is, P (Y)) may be mathematically represented by the following equation:

P (Yes=1)= f{the daily trip fee, income, gender, age, distance traveled, number of trips, number and size of crabs, time taken to achieve the desired catch, etc}.

This statistical analysis of this equation is shown in Appendix 3.

The statistical analysis of the logistic regression indicates that:

- The daily trip fee is statistically significant and can be adopted as a good measure of the willingness to pay. The 'goodness of fit' was on the high side of the acceptable range (that is, Z=1.62, where a Z value above 2 is usually regarded statistically as not being a particularly good fit).

- The results show that, for every dollar increase in the daily trip fee, the probability of the respondent being willing to pay the fee decreases. This is what economic theory would predict and implies a downward sloping demand curve for extra crab catch.

- the number of crab fishing trips undertaken, the fishing time required to achieve the derived catch, distance traveled, age, income, employment status, were non-significant statistically as explanatory variables in the willingness to pay equation.

- The number of extra crabs obtained for the nominated (daily trip fee) price also turned out to be statistically insignificant. This indicates that the number of crabs associated with that price did not influence the probability of a respondent saying, “yes” to a nominated price. Therefore, in our analysis, the “yes” response has been interpreted as “yes” for a minimum one extra crab. The resultant probabilities and associated prices are treated as per crab probabilities and prices.

- Apart from the daily trip fee, the only other factor of statistical significance in explaining the willingness to pay was ‘having a good time in trying to catch crab’, indicating that an experiential element is involved in the utility from crabbing in Cockburn Sound and in the associated willingness to pay.

From the probability density function, we could derive a demand function for the survey group. This shows the willingness to pay for extra crab. The results were ‘scaled-up’ to estimate the demand function for the population of Cockburn Sound recreational crab fishers. The ‘scaling-up’ factor was based on the survey groups’ catches in the last year as a proportion by volume of the Fisheries Department estimate of the total recreational catch and assuming that, on average, there are three crabs to the kilogram. The ‘scaled-up’ estimates are shown in Figure 4 below.

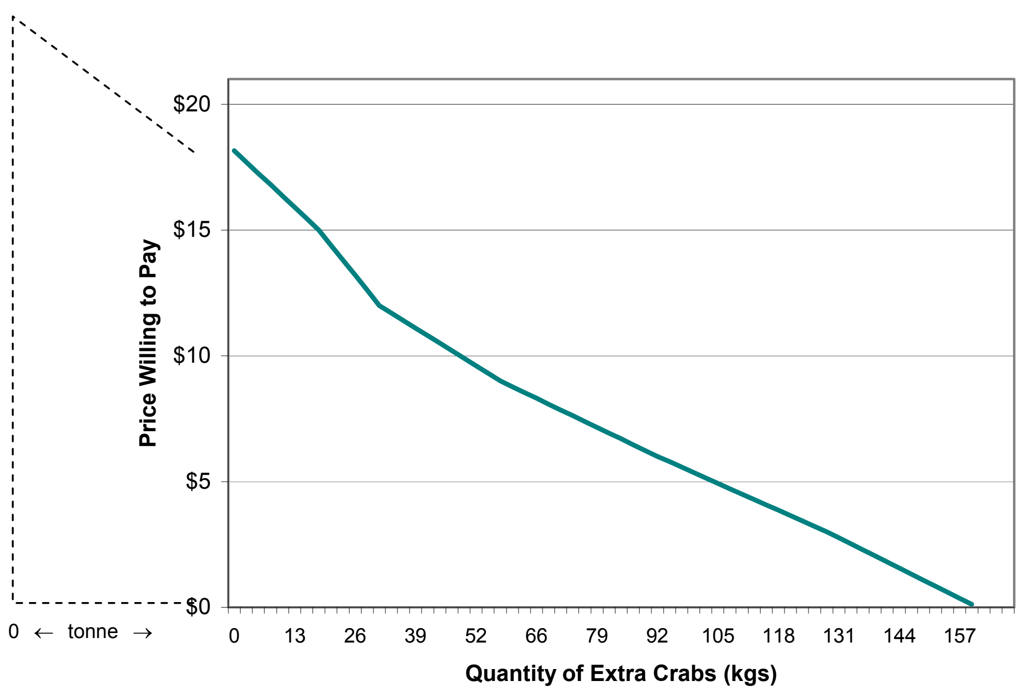


Figure 4: Recreational Demand for Cockburn Sound Crab

As we were interested in the marginal willingness to pay for extra crab, the 'nil' quantity in the above figure corresponds to the existing recreational catch. This was based on the Fisheries Department estimate of 20 tonnes.

These estimates reflect stated preferences and not revealed preferences observed in the market. Such demand estimates are at best indicative only.

The marginal valuations indicate that the number of extra crabs required at the various prices is relatively small in the context of the currently estimated 20 tonne recreational catch. At a price of $6 only an extra 92 kgs are demanded. At a zero price only an extra 163 kgs are demanded, or, on average, about one extra crab for approximately one out of every four Cockburn Sound recreational crab fishers.

While this may appear a surprising result, economic theory indicates that it is not. The empirical survey results showed that many fishers are not choosing to catch the bag limit either because they are satisfied with number of crabs caught, or because they have reached the time limit they have allocated to this fishing activity. Therefore, although there are restrictions on recreational activity in this fishery in the form of bag limits, these quantity constraints appear to be non-binding on fishing behaviour.

In this context, and premised on the assumption that the aggregate catch in the fishery is sustainable, the appropriate economic interpretation based on consumer theory is that, without any binding quantity rationing, the crab fishers have been able to maximize utility (consumer welfare) by allocating the appropriate amount of their resources (including time and dollars) to crab fishing. This is illustrated in Figure 5 below.

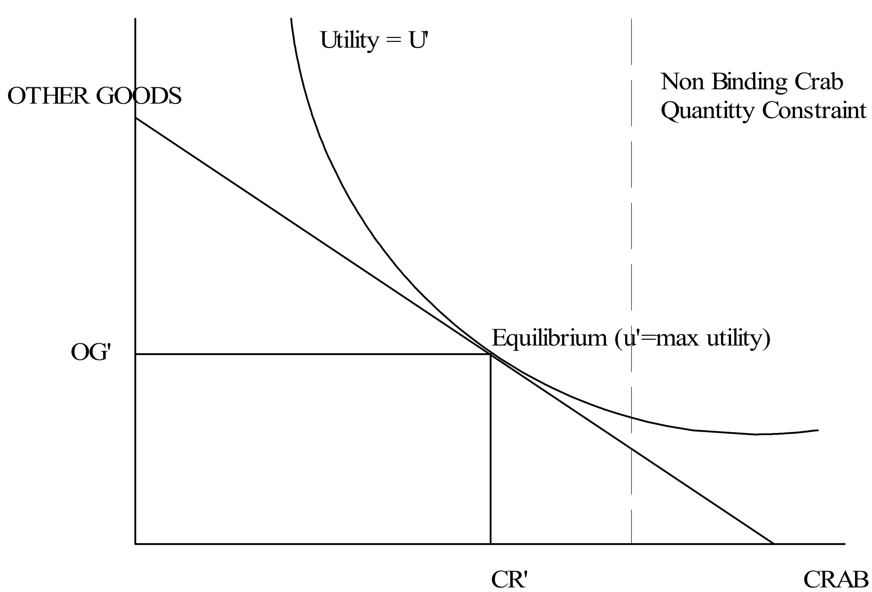


Figure 5: Utility Function

Consumer equilibrium is achieved at U' for a given budget constraint. This maximum utility is achieved at OG' other goods and CR' crab catch. The equilibrium CR' from crabs falls inside the quantity constraint as shown so that the latter (quantity constraint) has not prevented achievement of the optimum.

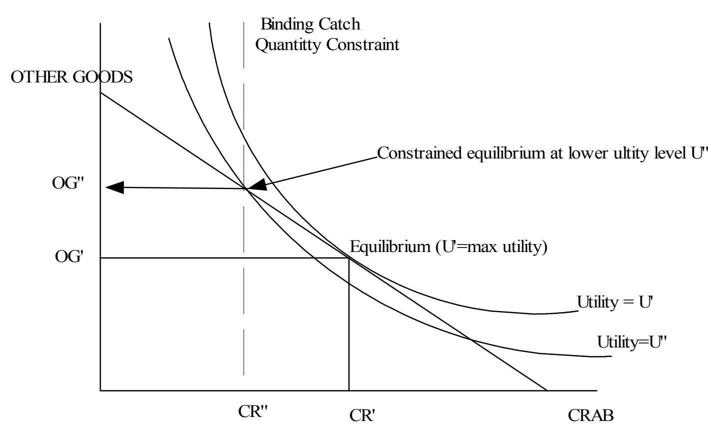
A recreational fisher in this position is generally happy with catch. They will not be catching the bag limit because, given the nature of their preferences and their resource budget (money and time), it is not optimal for them to do so. [8]

The derived demand curve suggests a 'choke price' (daily trip fee) is around $18 per kilogram[9]. At this price no extra crab is likely to be wanted. On the other hand, a 'nil' price encourages an unfettered and unrationed demand for extra crab in circumstance where bag limits appear to be non-binding. This is typical characteristic of any free good.

The dotted profile in Figure 4 above sets our analysis in the context of the existing recreational catch. In this context the following observations can be made:

- The backward projection of the derived demand curve cannot be used to confidentially predict the demand curve within the existing catch range (that is, below 20 tonnes), but can provide reasonably reliable 'ball park' estimates of the marginal values of any reduced recreational catch with an immediate range, that is, if recreational catch were reduced by say one tonne and perhaps as low as two tonne.

[8] This case can be contrasted with the case of a binding quantity constraint as shown below. In the case of a binding quantity constraint, recreational fishers are prevented from achieving the optimum catch, and utility is lower than would be the case otherwise. The consumer is prepared to commit more resources (money and time) to catch more fish than the binding constraint allows them to. Consequently, in theory, the recreational fisher would be willing to pay to alleviate the constraint and catch more fish. The willingness to pay is directly linked to the utility loss being suffered.



[9] This estimate is based on a backward extrapolation of the estimated demand curve.

- The intercept of the derived demand curve with the vertical axis defines the 'choke price' for demand. Based on a fitted demand curve and economic theory it is estimated that it could be like the 'dotted backward' projection of the demand curve as shown in Figure 4.

From the derived demand curve we were able to estimate the Cockburn Sound recreational crab fishers cumulative 'consumer surpluses' for extra crab catches. This is shown in Figure 6 below.

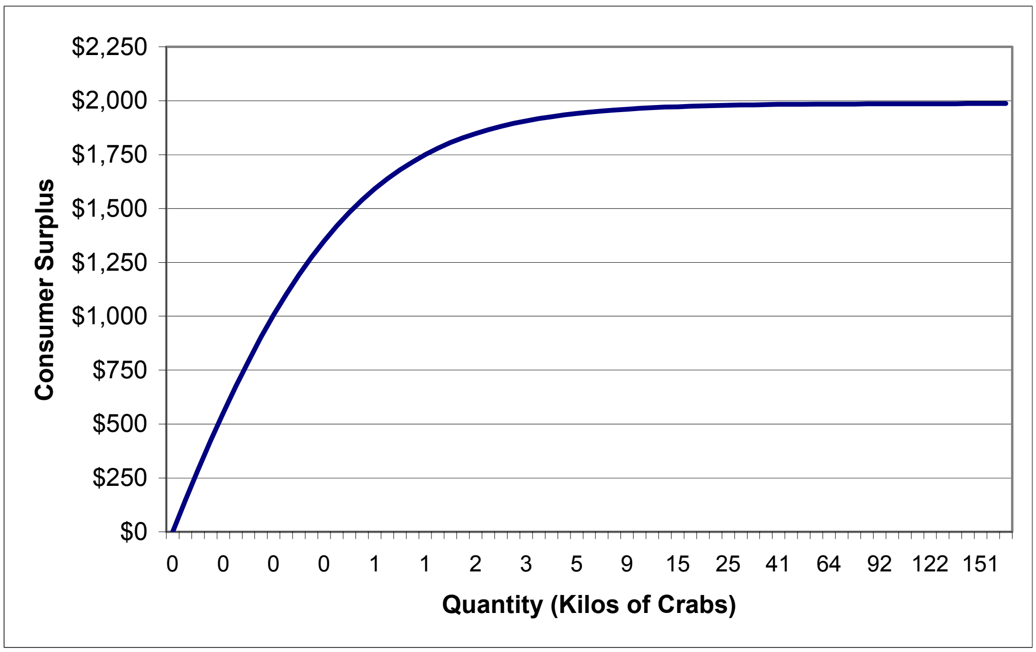


Figure 6: Cumulative Recreational Fishers Consumer Surpluses

At a zero price (or 'nil' daily trip fee), the aggregate consumer surpluses for extra crabs is around $2000 or about $12 per kilogram.

3. Valuing 'Producer Surpluses' From Commercial Use

Whilst the paucity of information on recreational fishing values is generally recognized in fisheries management, there is often little recognition given to the data issues in respect of commercial activities. The resource-sharing framework requires that marginal values for recreational and commercial activities be compared on a 'like-with-like' basis. As the framework paper makes clear, this requires a producer surplus calculation for commercial activities.

Contrary to generally held perceptions that the data needed to estimate 'producer surpluses' would be readily available from official databases we discovered that the required socio-economic information is not generally available.

In respect of the Cockburn Sound Crab Fishery, there was no database that could be accessed that had any "official" status. Hence, the required estimation of the relevant 'producer surpluses' for both the commercial crab catching sector and the associated post-harvest processing, distribution, and retailing activities had to be based on data collected specifically for this study.

The required price and cost data (including the sensitivity of prices and costs to changes in volume) as well as certain social information (such as business structures and employment) had to be collected directly from the seafood industry including a survey of commercial operators.

3.1 Data Collection

A survey questionnaire was developed with input from the Interested Parties Consultative Group. A 'test run', using an accountant known to the fishing industry, provided valuable feedback on the design and content of the questionnaire. This process helped to ensure the questionnaire was unambiguous and the proposed questions were couched in a way that would be easily understood and consistently interpreted by commercial fishermen (and others).

The survey questionnaire used is shown in Appendix 5.

Where surveys seek disclosure of private and commercially confidential business information, there in a natural and understandable predisposition towards non-disclosure. In such circumstances, voluntary disclosure should not be readily expected nor easily secured.

Such circumstances usually necessitate a process that attempts to build a rapport with, and gain the confidence of, the potential respondents. For our case study, this process occurred at two separate levels.

Pre-survey meetings were held with Cockburn Sound crab fishermen in the presence of a representative of the peak industry body. The meetings were designed:

- to explain the objectives of the research project;

- to outline the particular data which we needed to complete the study and how the data would be used for aggregate statistical analysis purposes only;
- to provide assurances that individual enterprise data would be used for the purposes of this project only and treated in the strictest of confidence; and
- to seek their cooperation in the provision of survey information and to gauge the extent of the likely willingness to participate (which may be used to judge what might be the most cost effective survey method to be adopted).

Independently, the peak industry body, under separate correspondence to industry, indicated its support for this research, encouraged the potential industry respondents to complete the questionnaire, and extended a testimonial as to our credentials and the integrity of our ‘confidentiality assurances’.

The survey questions did not easily lend themselves to telephone collection methods. Mail survey and subsequent telephone contact was seen as the least cost method, despite the low expected response rates typically associated with such data collection methods. Following our meetings with industry we expected adequate quality data to be forthcoming for the purposes of demonstrating the relevant economic values. Indeed, as ‘a rule of thumb’, a few, quality responses may be better than many low quality ones.

With the catching sector effectively concentrated in the hands of only eight operators that were geographically clustered, ‘face-to-face’ survey methods (with or without the presence of their accountants) might otherwise prove to be a cost effective data collection method in other circumstances.

Our correspondence that accompanied the mail survey formally reaffirmed our ‘confidentiality assurances’ to provide the requisite comfort to industry and to ‘shore up’ industry confidence with the view to achieving a reasonable response.

3.2 Data Analysis

Survey returns combined with supplementary information provided us with adequate quality data for the catching and processing activities to meet the demonstration objectives of this project. These data covered prices and costs for harvest and post-harvest activities associated with Cockburn Sound crabs. For reasons of commercial confidentiality, individual and aggregated returns could not be published.

The surveys produced data across a range of producers from those highly dependent on Cockburn Sound crab to those with much lower dependency. In the latter case, cost apportionment between various fishing activities was necessary. This was the case across both the harvest and post-harvest activities.

3.2.1 Markets for Cockburn Sound Commercial Catches

The data initially obtained from respondents on the operation of the markets for Cockburn Sound commercial crab catches were incomplete. The important gaps were subsequently ‘plugged’ as best we could through information obtained from industry contacts, including a supplementary questionnaire for seafood wholesales/distributors and retailers. (See Appendix 6). This was not as difficult as it might have been otherwise given the small number of businesses involved. However, this is a situation that is likely to occur in most other fisheries and obtaining similar kinds of supplementary information which is objective and reliable may be much more difficult (and costly) where there are many buyers and sellers.

With this supplementary information, we pieced together our best estimates of where the Cockburn Sound commercial catch went and of the significance of each of these outlets relative to the recent low catch years. These estimates suggest:

- 55% sold on local 'seafood' markets[10];
- 30% sold on interstate markets (Sydney and Melbourne)[11]; and
- 15% sold for processing

These proportions vary both between and within years. For example, in high catch years in the recent past, increased quantities were sent to Eastern States markets. Interstate markets, in particular the Sydney Fish Market, has apparently been the 'benchmark' prices paid to fisherman by local seafood wholesalers/distributors, processors and retailers. This is shown in Figure 7 below.

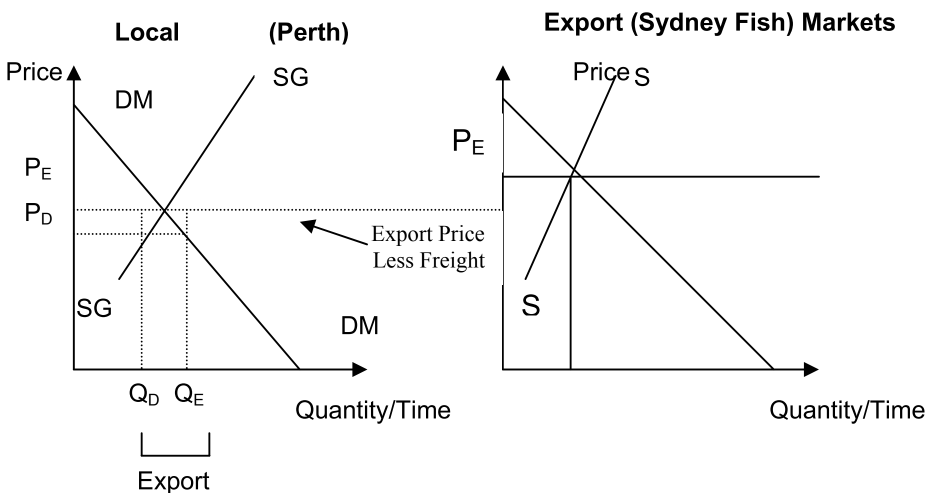


Figure 7: Local and Export Market Relationship for Cockburn Sound Crab Commercial Catches

If all the local commercial catch were placed on the local (Perth) markets, it would drive the local price (P_D) below the interstate market price (P_E) net of freight. Tactically, it appears that local fisherman have established an expected local price based on past market outcomes. They appear to secure this local price by sending

[10] Includes sales made directly to retail outlets (seafood retailers, restaurants, etc) and sales interstate by fisherman and by seafood wholesaler/distributors and processors.
[11] Exported crab products included chilled or frozen green and cooked crabs, crab meat and crab legs.

any local catch in excess of local demand at this price to the Sydney fish market. The supplies from Western Australia are not expected to significantly affect the overall quantities on offer and realized prices on the day at the Sydney Fish Market.

In recent times, the development of alternative market opportunities locally based on new crab processing capacity have provided commercial fisherman with increased flexibility in the disposal of their catches. This has the potential to underpin a 'floor price' for local crab catches.

3.2.2 Cost Data and Resource Costs

In economic terms, the costs of particular interest in a resource sharing context is the resource (or opportunity) cost of inputs used (that is, the value in alternative uses) in commercial catch and its subsequent processing, distribution and retailing to consumers. As is standard in economic studies, this often requires some adjustments to collected data so that they better approximate the underlying resource costs from society's viewpoint.

To achieve this, adjustments were made to the returned cost data in order:

- To remove transfer payments such as interest and pot lease payments, taxes (like diesel fuel excise) and other Government levies (except for the component of the managed fisheries fee that was directly attributable to the cost of services to manage the fishery), as well as those included in insurance premiums (where the real service cost included in paid premiums is typically around 8 per cent);
- To ensure consistency in the treatment of capital items in terms of replacement values, expected life, and depreciation method;
- To reflect the opportunity (or resource) cost of inputs used, particularly labour where average weekly earnings were taken arguably as indicative of the cost of labour in alternative uses (that is the opportunity cost) from society's viewpoint. There was no apparent indication that other expenditures were not reasonable measures of resource or opportunity costs; and
- To adequately scope packaging and freight costs for significant volumes exported to interstate markets.

The adjusted cost data enabled an estimate of the total (resource) cost for commercial activity based on the submitted returns. These estimates were 'scaled-up' to derive 'ball park' estimates of the total resource costs for the harvest and post-harvest activities based on the 2000-2001 Cockburn Sound crab catch and costs. The 'scaling-up' factors were based on the proportion by volume that the aggregate returns represented of the harvest. These 'scaled-up' estimates are shown in Table 1.

Table 1 'Scaled up' Industry Revenue, Resource Costs and Producer Surpluses Estimates: 2000/2001 Cockburn Sound Crab Catch

HARVEST		
Revenue		
212,000kg @ $4.90 per kg (ex wharf prices) [a]		
Total Revenue Catching		***$1,035,000***
Costs		
Boat Fuel (Diesel Fuel) [b]	$26,396	
Vehicle Fuel Catching [b]	$5,000	
Wage and Salary Payments Catching [c]	$301,963	
Bait	$54,844	
Repairs and Maintenance	$22,583	
Depreciation	$76,749	
License Fees (inc. Transport and Fisheries) [d]	$31,536	
Electricity, Gas and Water	$6,775	
Payroll tax, Banking, Accountant fees	$6,130	
Telephone, Facsimile, Internet access	$3,549	
Other [e]	$1,258	
Total Catching Resource Costs		***$536,782***
Aggregate Surplus		**$498,218**
Aggregate Surplus per kg		$2.35
LOCAL PROCESSING, DISTRIBUTION AND RETAILING		
Revenue		
212,000 @ $8.30/kg		
Total Revenue Processing & Retailing		***$1,759,600***
Costs		
Crab Costs		$1,035,000
Diesel Fuel [b]	$3,793	
Electricity, Gas and Water	$8,811	
Telephone, Fax, Internet Access	$3,246	
Wage and Salary Payments [c]	$122,895	
Depreciation	$6,493	
Distribution Cost	$83,200	
Repairs & Maintenance	$5,000	
Total Processing and Retailing Resource Costs		***$233,438***
Aggregate Surplus		**$491,162**
Aggregate Surplus per kg		$2.32
AGGREGATE HARVEST AND POST HARVEST SURVEY		
Revenue		$1,759,600
Less Harvest and Post Harvest Resource Costs		$770,220
Aggregate Surplus		**$989,380**
Producer Surplus (f)		1,532,760
Producer Surplus per kg		$7.23

(a) Total crab catch in 2000/2001 estimated by the Fisheries Department to be 212,000 tonnes
(b) Excludes Fuel Excise and GST
(c) Adjusted to reflect a male's average weekly earnings in 2000/2001 (as a measure of the opportunity cost of labour) and for the duration of the operator's Cockburn Sound fishing activities and apportioned to reflect the income derived from fishing.
(d) Excludes all taxes and levies except the contribution for fisheries management costs.
(e) Assumed insurance service commission of 8%.
(f) Producer Surplus (PS) is calculated by using the following equation, PS = (Price – Marginal Cost) +Quantity

The results indicate that, on average, for the year 2000-2001, in the catching sector, average cost was about $2.55 per kg and average wharf price were around $4.90

giving an estimated average surplus of the order of $2.35 per kg. In the processing, distribution and retailing activity, average price was $8.30 per kg; average cost was $5.98 per kg, giving an estimated aggregate surplus of $2.32.

The overall harvest and post harvest 'producer' surpluses (which is not the same as aggregate commercial profit) were estimated to be about $1.533 million or $7.23 per kilogram for the 2000 – 2001 commercial catch. (The producer surpluses' represent the retail price that is $8.30 per kg, less the marginal costs estimated to be $1.07 per kg multiplied by the 212,000 tonne catch.) The harvest sector accounted for almost $4.90 per kg of this surplus (as this sectors' cost structure is largely fixed), whilst the post- harvest activities accounted for the remaining $2.33.

Information on the way total costs vary with volume of catch (or throughput) was obtained in discussions with industry contacts. This allowed an analysis of those cost items that remain fixed over a volume range and those that are variable over that range. It shows that total harvest cost varies little with changes in catch volumes, whilst post-harvest costs were more sensitive to volume changes, as the major attributable costs (which were energy and labour) varied with volume.

On the assumption that there are no significant scale economies associated with harvesting due to changes in vessel sizes across ranges of catch volumes, we estimated the cost structures of the combined harvest and post-harvest activities related to the 2000-2001 Cockburn Sound crab catch and cost data. These estimates are shown in Appendix 7 and diagrammatically in Figure 8 and 9 below.

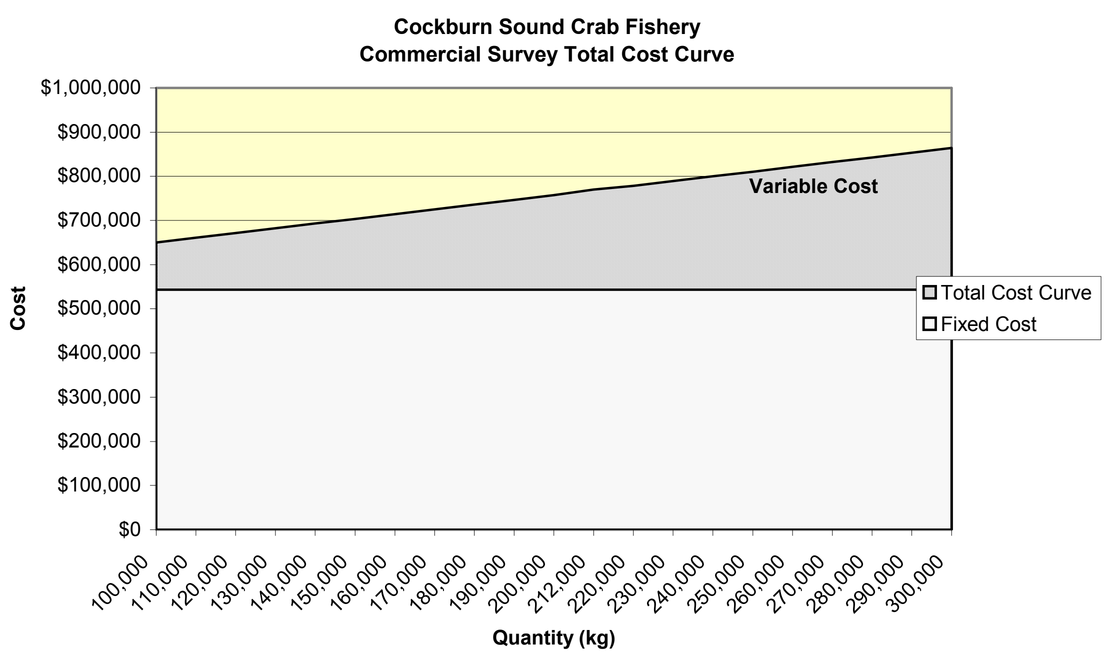


Figure 8: Industry's Total Cost Curve

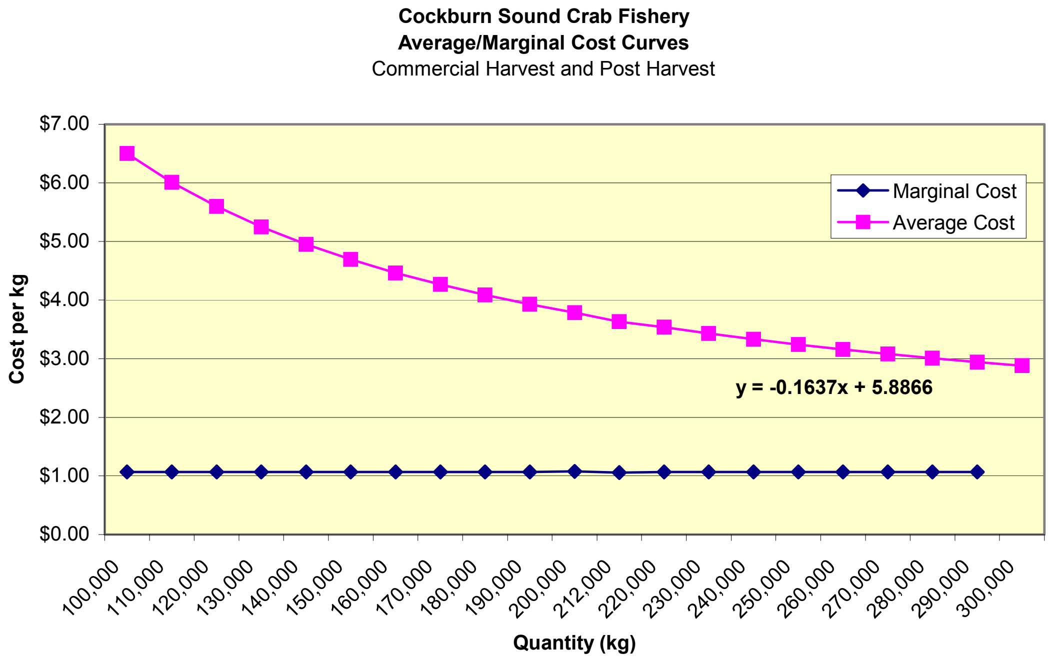


Figure 9: Industry's Average and Marginal Cost Curves

3.2.3 Prices and Revenue Data

Price data were also available for harvest and post-harvest sector for the 2000-2001 commercial crab catches. These data enabled us to estimate the aggregate revenue for the harvest and post-harvest returns. These estimates were then 'scaled-up' (in a similar manner to that used on the cost side of the equation) to estimate the aggregate 'industry' revenue for the harvest and post-harvest activities associated with the 2000-2001 Cockburn Sound crab harvest. These estimates are also shown in Table 1 above.

Average price and revenue estimates for commercial catches ranging from 210 to 280 tonnes were based on observed marketing behaviour relating to the disposal of variable local catches. This allows for the possibility of increased flexibility associated with recent developments in local crab processing capability and other Eastern State (Melbourne and Adelaide) market opportunities at times of increasing commercial catches. This was outlined in Section 3.2.1 above.

Sydney Fish Market data set available for blue swimmer crabs from Western Australia dated back to 1992. On the assumption that the pattern and level of crab supply's to Sydney Market other than 'blue swimmer' crabs from Western Australia mirrored the recent past, 'best estimates' of possible price responses to any increased offerings of 'blue swimmer' crabs from Western Australia were made. These estimates were not as robust as we would have preferred.

3.2.4 Value Added and Producer Surpluses

The estimates in Table 10 suggest:

- The combined harvest and post-harvest 'producer surpluses', which is not profit in the accounting sense as certain costs are excluded or adjusted but what in economic terms is the value added by industry, was of the order of \$7.23 per kilogram for the 2000-2001 Cockburn Sound crab catch; where
- The catching sectors 'producer surpluses' were in the vicinity of almost \$4.90 per kilogram; with
- The post harvest sectors accounting for the \$2.33 per kilogram balance.

These estimates for a range of commercial catches indicative of the recent past are presented in Figure 10 below and Appendix 8.

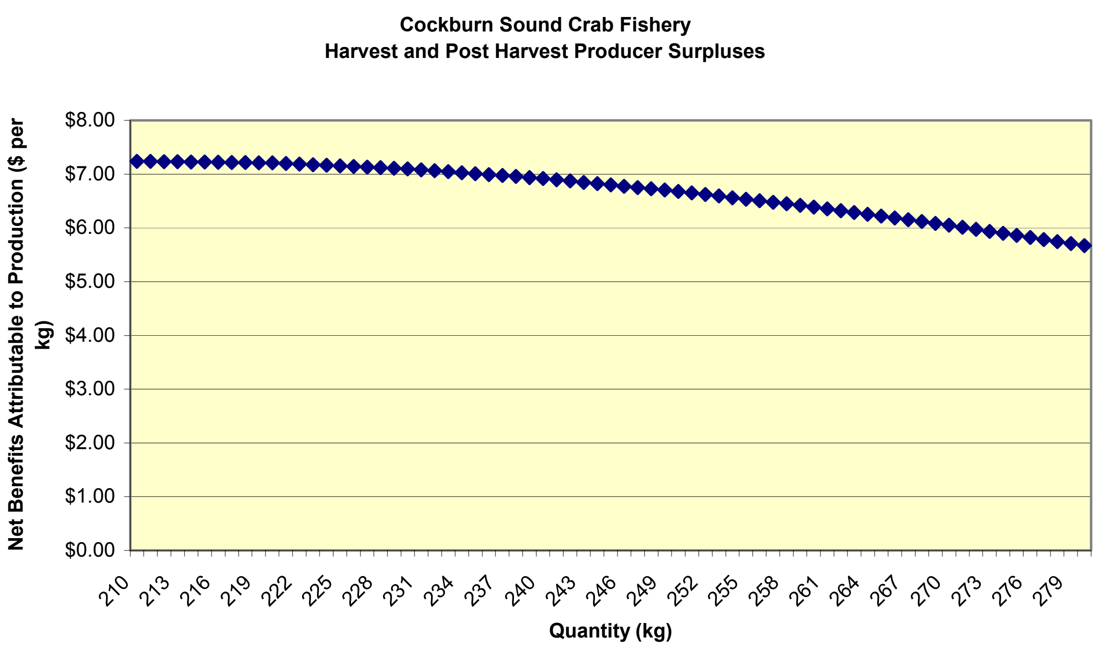


Figure 10: Combined Harvest & Post Harvest Aggregate Producer Surpluses

Interestingly, the decline in 'producer surpluses' reflects the industry's (that is combined harvest and post harvest activities) marginal costs exceeding its marginal revenue. Indeed, the data indicates that the industry enters negative (marginal loss) territory at catches around 250 tonne and above. These estimates are presented in Figure 11 below.

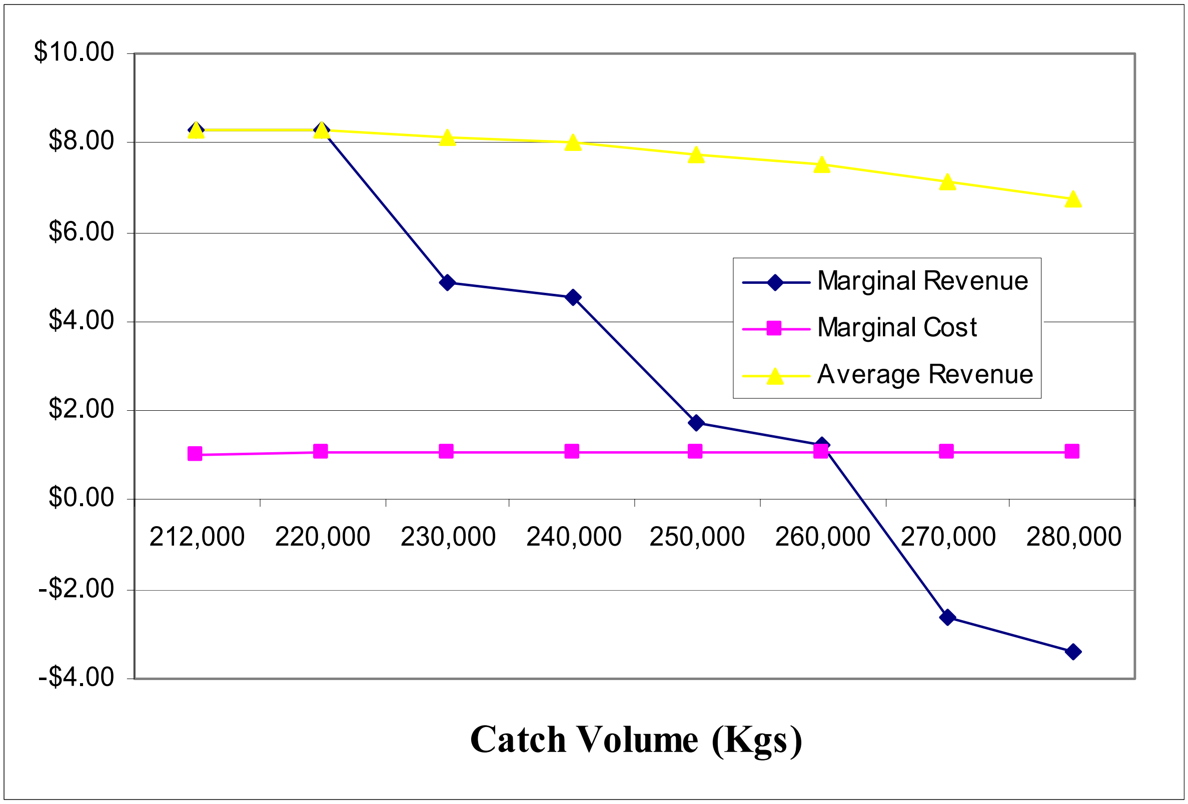


Figure 11: Marginal Cost and Revenue Estimates from Commercial Use

4. Consumer Demand and Surpluses

Initial data on retail volumes and prices for Cockburn Sound crab sold through the local seafood outlets were incomplete and misleading. We attempted to plug these information gaps through a supplementary survey of seafood wholesalers/distributors and retailers. Whilst this additional data helped to give us more exact information, further research would be required to more exactly identify supply and demand curves. This is discussed further below.

The available data suggests the local 'seafood' market typically absorbs around 110 tonnes annually depending on product availability and retail prices, over recent years. Retail prices fluctuate throughout the year with seafood demand and supply patterns. Christmas/New Year is typically a period of high seasonal demand with traditional low commercial catches corresponding to the commencement of the commercial crab season and consequently, higher retail prices. Easter period is also a period of relatively high seafood demand and retail price, whilst post Easter demand is apparently bearish and retail prices weaken.

From the limited retail price and quantity data for local 'seafood' outlets, we derived demand function for Cockburn Sound crab. This was based on estimated annual average prices and quantities and is shown graphically in Figure 12.

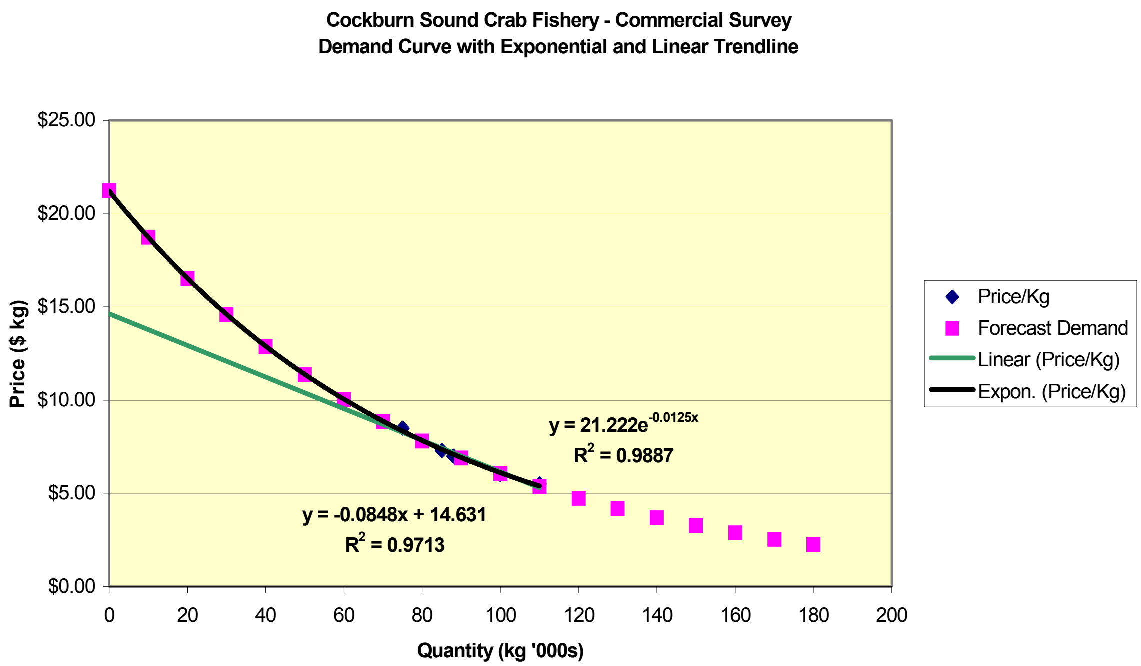


Figure 12: Cockburn Sound Crab Fishery – Local Consumer Demand Curve (Exponential and Linear Trendline)

The price elasticity varies over the observed range of prices and quantities, from -0.46 at a price of $2.24 per kg to -5.34 at a price of $18.73 per kg. This is consistent with standard demand theory. At a price of $5.37 and local quantity of 110,000 kgs, the estimated price elasticity is estimated to be -0.786 which implies that if retail crab prices fell by 10 per cent, the quantity demanded will increase by around 7.8 per cent reflecting a strong consumer preference for crab. As already noted, the above estimates were based on limited data. To develop a more definitive estimate of the price elasticity would require simultaneous estimation of both the demand and supply curves based on more extensive data collection and analysis. However, we should note that the price elasticity estimate is consistent with estimated elasticities for other foodstuffs. The medium to long-term elasticity estimates for beef is estimated to be in the range -0.54 to -0.56 and poultry is in the range -0.55 to -0.74.

Other data sets, such as the Sydney Fish Market monthly prices and quantity series for West Australian blue swimmer crabs since 1992, were investigated but no statistically significant demand function could be identified from these data. Our derived demand, despite the 'thin' database, was used for the illustration purposes of the project in the absence of any other objective and reliable data set for demand and supply. However, in any actual resources allocation context, further research may be worthwhile. The available data suggests there may well be simultaneous shifting of both demand and supply. If this is the case, a more exact identification of the demand and supply curves would require simultaneous solutions based on more extensive data collection to properly identify both curves. [11]

4.1 Estimating the 'Choke Price'

The 'best fit' demand equation can be used to derive estimates of the 'choke price', that is the price at which there is unlikely to be any demand for crab. The 'choke price' estimates are the basis for estimating the 'consumer surpluses'. This is the satisfaction derived by the consumer beyond their expenditure on consumed crab.

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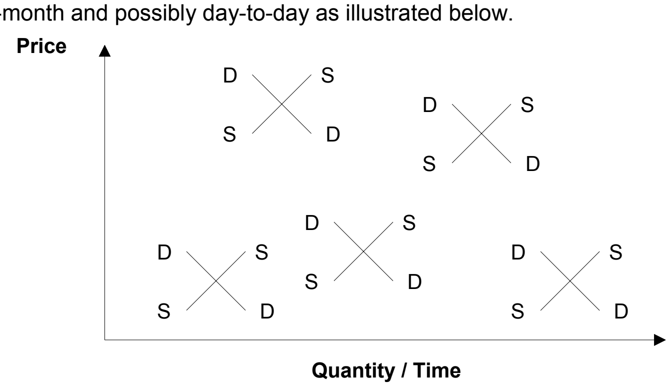
[11] 'Eyeballing' the Sydney Fish Market data set, the observed prices may reflect shifting demand and supply curves from month-to-month and possibly day-to-day as illustrated below.



Where demand equations are derived from a 'thin' data set, which was the case in this study, there is less confidence in the 'choke price' estimates. In the absence of any other objective and reliable data set, we have used the 'choke price' estimates derived from our limited data set for the demonstration purposes of this study.

From the demand curve depicted in Figure 12 above, it can be seen that a 'choke price' may be as low as $15 per kilogram (based on the linear demand curve) or as high as $21 per kilogram (using the exponential demand curve). A rough reality check suggests that a 'choke price' at the higher end may not be unreasonable 'ballpark' estimates. We have observed local retail prices of as high as $13 to $14 per kilogram for Cockburn Sound crab in the last twelve months and retail prices for other fresh seafood products for which it may be a substitute well above these values. For the demonstration purposes of this study, we used a 'choke price' estimate of around $21 per kilogram derived from the exponential demand curve, as this equation was a marginally better fit to our limited data set. The resulting 'consumer surpluses' estimates from using such a 'choke price' must be interpreted with the reservations we outlined above.

4.2 Estimating Retail Consumer Surpluses

We used the exponential demand curve to generate the price-quantity relationships, which were then used to estimate the retail 'consumer surpluses' from local consumption of Cockburn Sound crabs. This is shown in Figure 13.

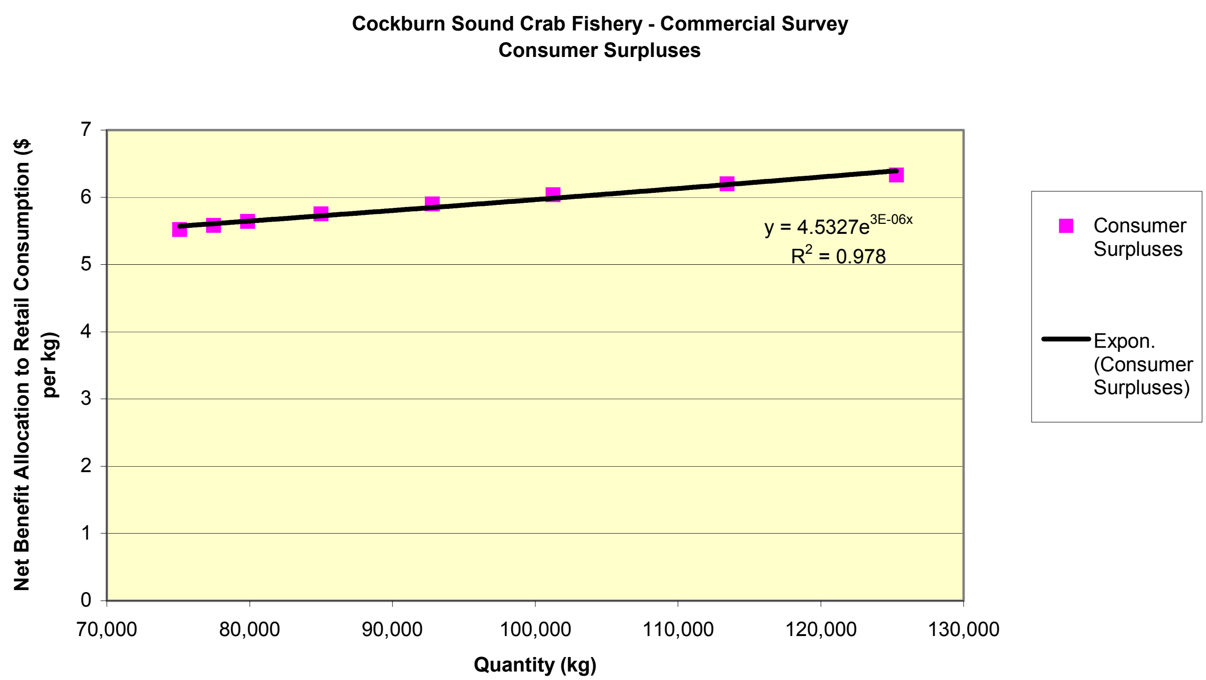


Figure 13: Cockburn Sound Crab Fishery – Retail Consumer Surpluses

This suggests that, for the quantum of the 2000-2001 commercial catch consumed locally, the ‘consumer surpluses’ were estimated to be around $414,276 or about $5.52 per kilogram.

For the purposes of this analysis the focus is on the State and the associated net benefits from allocation to consumers in Western Australia. We have ignored any ‘consumer surpluses’ accruing to Eastern States consumers of Cockburn Sound crab. If a national perspective were to be taken in considering resource allocation options in this fishery, the surpluses obtained by these Eastern States consumers would need to be factored into this model.

5. Estimating the Net Benefit for Commercial Use

The net benefit from commercial use is the aggregate of the consumer surplus associated with consumption and the producer surplus associated with harvesting and processing and distribution. Producer and consumer surplus will vary according to price and catch. The estimated producer and consumer surpluses for commercial catches ranging from 210 tonnes to 280 tonnes are shown in Figure 12 based on the analysis and results from sections 4 and 5 of this report. The corresponding data is given in Appendix 10.

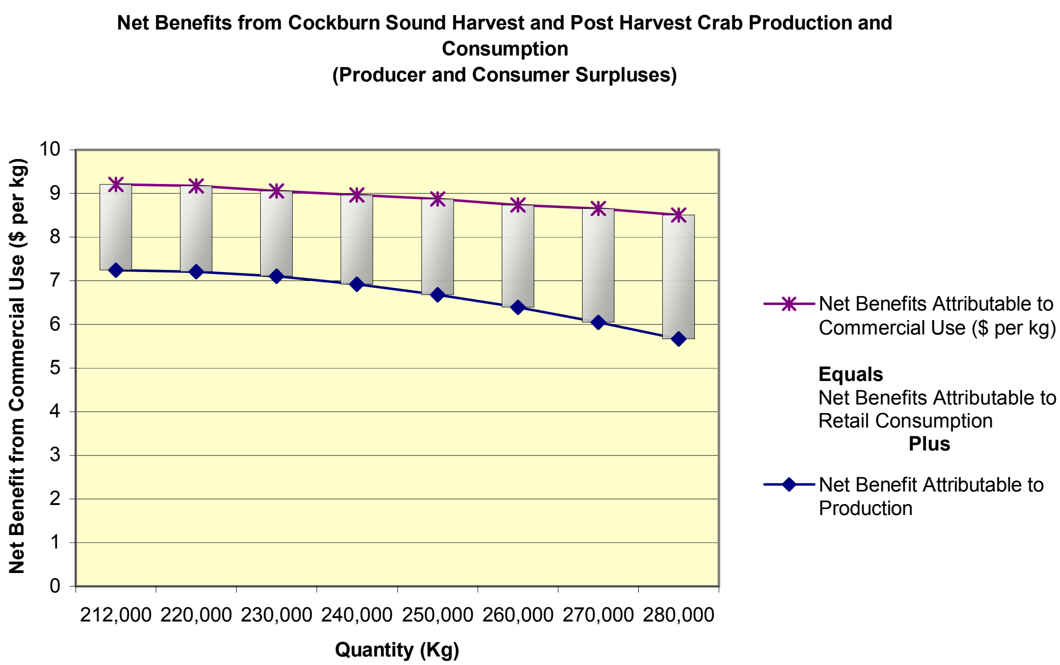


Figure 14: Net Benefits from Commercial Use of Cockburn Sound Crab

The overall aggregate net benefit from commercial use for the 2000-2001 commercial catch is estimated to be $1.935 million or about $9.21 per kilogram, and around $2.382 million or about $8.51 per kilogram for commercial catches at the five year average (280 to 300 tonnes).

6. Optimizing the Net Benefits of Resource Allocation

In the first report from this study we developed the theoretical framework for considering the optimization of the net benefits of resource sharing between the extractive recreational and commercial uses. This theoretical framework, which focused on resource allocation within a sustainable catch and effort, is depicted in Figure 15 below.

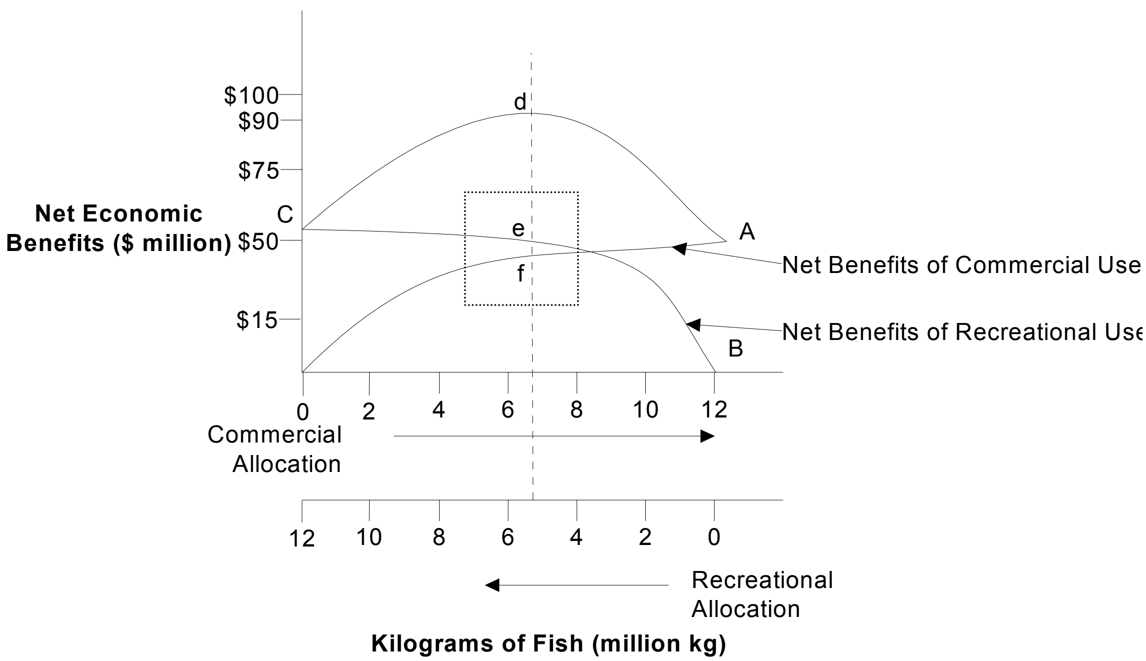


Figure 15: Net Benefits of Resource Allocation: A Theoretical Framework

In the diagram, curve BC is the net benefits attributable to recreational use, OA is the net benefits attributable to commercial production and local Consumption or commercial use, and AC is the total net benefit attributable to the combined commercial and recreational use.

Point 'd', which represents the apex of curve AC, is the point at which the overall net benefits are optimized from the combined commercial (point f) and recreational (point e) uses. This is the highest point on the aggregate surplus curve AC and at this point the marginal benefit is the same in both competing uses. At no other allocation is the overall net benefit as large. Moving away from this point to an alternative allocation could increase the benefits of one user group but would reduce the benefits to the other user group and would reduce overall benefits because the marginal benefit to the gaining group as we move away from point 'd' would be less than the loss to the losing group.

In economic terms, the overall net benefits from combined commercial and recreational use are not optimized by allocation based on the greatest aggregate net benefits. As previously mentioned, they are optimized where the marginal benefits to commercial and recreational use are the same. This is the point where the slope of the net benefit curve for recreational use is the same as the slope of the net benefit curve for commercial use.

Therefore, in implementing this framework, our analysis focuses on the marginal net benefits of the respective uses for the demonstration purposes of this project, and across a range of commercial catches indicative of the recent past as shown by dotted insert box in Figure 15 above. That is, we set out to find the point at which the marginal net benefits of commercial and recreational use of Cockburn Sound crabs are the same.

The results of our analysis are shown in Appendix 9 and reflected in Figure 16 below.

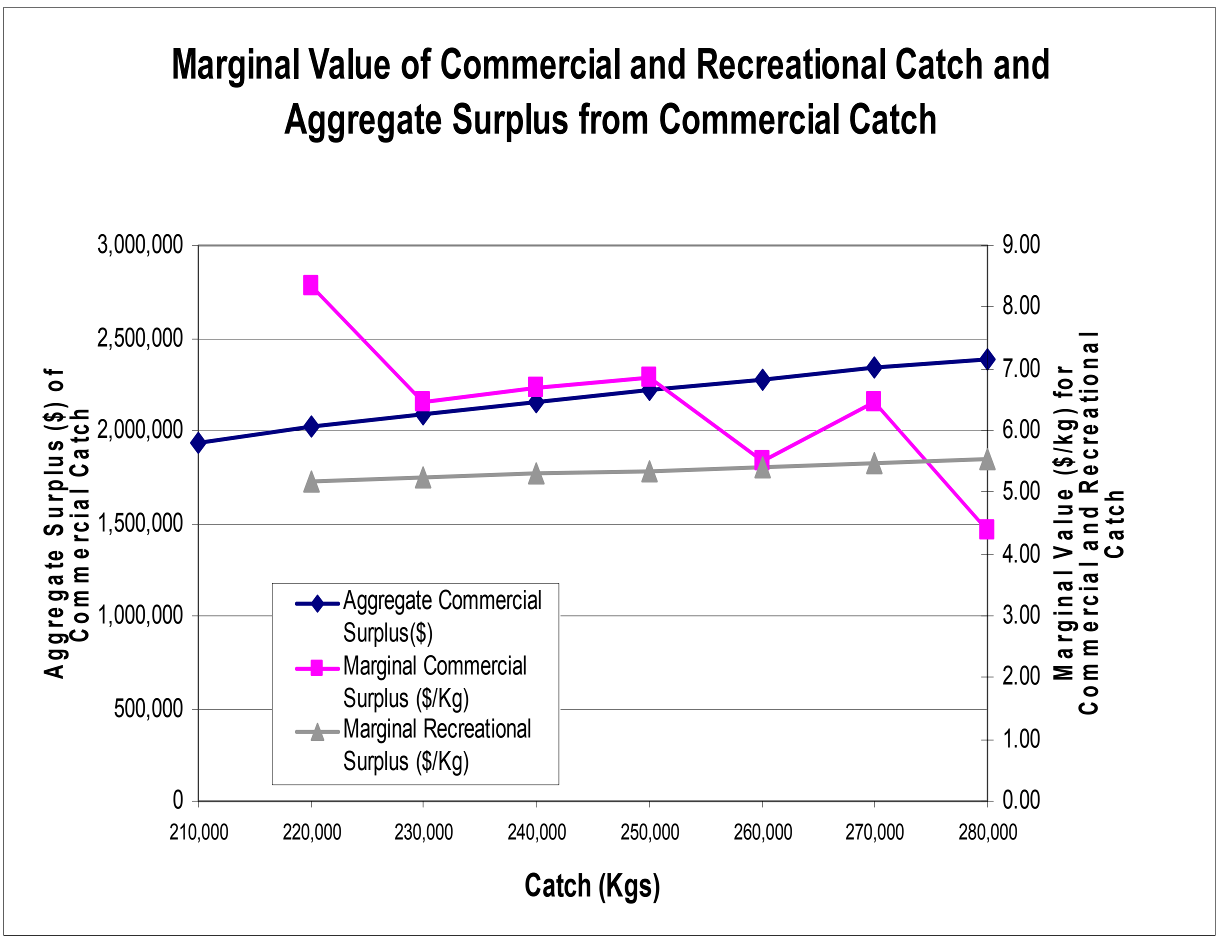


Figure 16: Marginal Value of Commercial and Recreational Use and Aggregate Surpluses from Commercial Catch

The relationship between the marginal benefit from commercial and recreational use varies with catch level. This reflects the underlying demand and supply conditions on the commercial side and the underlying preferences on the recreation side.

At low catch level, such as those that have been achieved recently, the marginal net benefits from commercial use are estimated to be higher than the marginal net benefits from recreational use. If additional crabs were to become available for allocation, proportionally more would need to be allocated to commercial use (about two thirds) than to recreational use (about one third) in order to optimize overall net benefits from the combined commercial and recreational uses.

However, proportionally more of any increased availability of crab would need to be allocated to recreational use as catches approach 260 tonne, the point at which marginal benefits of commercial and recreational use are estimated to be the same.

Any additional crab available for allocation beyond around 250-260 tonne would need to be allocated entirely for recreational use. This is because industry (combined harvest and post harvest activities) are estimated to be in a situation of marginal loss when commercial catches exceed 250 tonne. That is, industry's estimated marginal costs exceed its marginal revenue. This decline in 'producer surpluses' is not off set by the increase in retail consumer surpluses at lower prices due to the increased supply of Cockburn Sound crabs with increase catch entering the local markets.

This illustrates that, whilst the gross value of production may increase at higher catch levels, the overall industry net benefit or well being declines, highlighting the danger of using gross value of production estimates to measure the benefits from commercial use.

It was noted previously that one of the issues in applying the framework was the absence of a definitive aggregate catch figure. Applying the above logic allows an indication of the appropriate allocations without this. For example, if the total sustainable catch was estimated to be 400 tonnes, the split would be approximately 250 tonnes commercial and 150 tonnes recreational. As an approximation if the estimated marginal value from our surveys of around $5.50 were applied to the whole recreational allocation, it would be valued at $825,000.

Of course, these results are illustrative only and a 'snapshot' in time. The outcomes are dependent on the robustness of the assumptions behind the modeling.

In addition where results relating to optimal allocation and marginal values are derived in a static framework, they need to be reviewed and updated over time as the underlying conditions behind economic and social values change. The injection of a formal dynamic element into the analysis would ensure that the analysis and results approximate more closely contemporary values over time but incorporating this into the models is beyond the scope of this project.

The growing and aging population and residential development along the southern corridor of the Perth metropolitan area will bring increasing recreational pressures in the Cockburn Sound crab fishery. Leaving aside the sustainability questions in the face of these developments under the existing management regime, any reduction in recreational catches below those which are optimizing satisfaction amongst existing recreational fishers can be expected to place upward pressures on their social valuations of catches in Cockburn Sound crab fishery.

This case study outcome demonstrates that the general theoretical framework has worked and the results are consistent with economic theory.

7. Glossary of Terms

Average total cost	Average total cost is the sum of all the production costs for a commercial fishing activity divided by the number of units produced.
Choke price	The lowest price at which the quantity demanded is zero. At every price higher than the choke price demand is zero.
Consumer surplus	The benefit consumers gain from being willing to pay more than the equilibrium market price. This is based on the notion that consumers (e.g. recreational fishes or retail consumers)m derive greater benefit from consuming a product or activity (e.g. recreational fishing or retail purchase of fish for consumption) than the cost to them of purchasing it.(e.g. time and money for recreational fishers).
Contingent valuation	The use of structured surveys to estimate the willingness of respondents to pay for public projects or programs. (e.g. access to fish stocks for recreational fishing).
Demand (curve or equation)	It shows the amount of a good that consumers are willing and able to buy at various prices.
Existence value	The benefit derived by an individual (s) from the knowledge that an environmental resource (e.g. fish stocks) exists.
Fixed cost	Costs that do not vary with the level of output. They are therefore constant in total as output changes..
Marginal cost	The amount spent on producing one extra unit. The marginal cost is the increase in total cost when one more unit is produced.

Opportunity cost	The decision to produce or consume a product or undertake an activity involves giving up another product. The real cost (opportunity cost) of an action is the next best alternative forgone in order to do it..
Option Value	The benefit derived by and individual(s) from retaining the option to use an environmental resource at some future date (e.g. to fish up to a bag limit in the future). Option value arises from the combination of the individual's uncertainty about future demand for the resource and uncertainty about its future availability.
Optimum allocation	Occurs when resources are allocated between competing uses (e.g. fish between recreational and commercial uses) such that it is not possible to redistribute resources to increase the welfare of any one consumer without reducing the welfare of some other consumer.
Price elasticity of demand	A measure of responsiveness of some other variable to a change in price
Producer surplus	The difference between the minimum price a producer would accept to supply a given quantity of a good and the price actually received. (e.g. the difference between the price received in the market place for commercially caught fish and the minimum price which reflects the marginal cost of catching).
Variable cost	Variable costs are costs that vary with the level of output/activity.(e.g. bait for commercial fishing)
Supply (curve or equation)	The relationship between the price of a good and the quantity of the good supplied by producers (firms).

8. Appendices

Appendix 1: Cockburn Sound Recreational Crab Fishers Socio-Economic Survey Questionnaire

This appendix works through the survey and the development of the survey instrument used to survey recreational crab fishers.

Survey Instrument Design

The survey questionnaire (see Attachment A) was constructed by the research team after consideration of the data needs, availability of information and designs of other economic surveys of recreational fishing. Every item in the questionnaire was used to develop a descriptive understanding of the recreational crab fisher and crab fishing trips in Cockburn Sound. A subset of these items was also used in the development of economic models to estimate the value of recreational crab fishing in Cockburn Sound.

The questionnaire was tested on a recreational crab fisher to ensure that the language and flow of the interview was appropriate. Minor modifications were made as a result of the feedback from the respondent and further improvements were made after the first survey wave.

In order to facilitate understanding of the survey, the following sections provide a justification for each question included in the questionnaire.

All respondents were asked each question unless otherwise noted...The questionnaire includes instructions for use by the telephone interviewer.

General Fishing Background

This section provided information about the type of fisher the respondent is, for example a regular or infrequent crab fisher, predominant use of Cockburn Sound or another fishery, predominantly crab fisher or general fisher, and social or serious crab fisher. The characteristic of the fisher will be used to interrogate the types of responses given to the Contingent Valuation question.

Background information is restricted to the last twelve months. If a respondent hadn't fished for crabs in Cockburn Sound in the last twelve months, the interview was terminated (Q4).

The following table shows the fishing background questions with their justification.

Item	Question	Reasoning
Q 1	To start with, where have you gone fishing, crabbing or pawning in the last twelve months?	A warm-up question to introduce the survey topic to the respondent. Gives an idea of the respondent's involvement in fisheries including Cockburn Sound.
Q 2	Which of the following species have you tried to catch in the last twelve months?	Gives an idea of whether the respondent specifically fishes for crab or is involved in other fisheries.
Q 3	In the last twelve months, where have you fished for crabs?	More focused than Q1 - now introduces crab fishing.
Q 4	Over the last twelve months, how many times have you fished for crabs in Cockburn Sound?	A measure of the extent to which the respondent fishes for crab in Cockburn Sound. If none, terminate interview.
Q 5	Over the last twelve months, what percentage of your fishing trips were to fish for crabs in Cockburn Sound?	To measure the degree to which the respondent is primarily a crab fisher in Cockburn Sound.

About Crabbing in Cockburn Sound

One section of the survey specifically targeted information on recreational crab fishing by the respondent in Cockburn Sound over the past twelve months. The questions included in this section and their justification is shown below.

Item	Question	Reasoning
Q 6	How do you find out when the crabs are running in Cockburn Sound?	The extent of experience and knowledge of Cockburn Sound crab fishery.
Q 7	Do you generally fish for crabs by yourself or with a group of others who are also fishing for crabs?	Dynamics of the crab fisher - whether it is a group activity or not.
Q 8	(If a group - Q7) Including yourself, how many people are usually in the group?	Dynamics of the group.
Q 9	(If a group - Q7) What is the relationship of the other people to you?	Dynamics of the group.
Q10	How long on average do you spend on the water actually trying to catch the crabs? (hours)	Measure of effort and investment of time.
Q 11	On average, how long are you away from home when you go fishing for crabs at Cockburn Sound?	Measure of extended effort and investment of time - time away from home less time spent on boat gives an idea of time a

Item	Question	Reasoning
		respondents spends getting to and from the fishery.
Q 12	On average over the last twelve months, how many crabs did you / your group catch and keep at Cockburn Sound?	Measure of catch, with detail of apportionment between boat owner and the rest of the group (if there is more than one crabber). Result is used to personalise the Contingent Valuation question.
Q 13	(If a group) How is the catch usually shared amongst you and the rest of the group?	Apportionment calculation of share of catch.
Q 14	On average in the last twelve months, why do you stop at the number of crabs you catch?	Barriers to increased catch may be explanatory variables to the respondent's response to a daily trip fee.
Q 15	In the last twelve months, when do you usually fish for crab?	Adds to crab fisher profile and experience of Cockburn Sound (eg whether in busy or quiet conditions)
Q 16	What have you usually done in the last twelve months with the crabs you kept?	Measure of worth of crabs to the fisher. Unprompted.
Q 17	Of the crabs caught and kept on average in the last twelve months, what proportion would you say was: a) given to another household? b) eaten by your household? c) used as bait? d) or for some other purpose?	Measure of worth of crabs to the fisher. Prompted response for each specific category.
Q 18	I am going to read out factors about crabbing in Cockburn Sound. As I read out each one, please tell me how important a role it plays in a successful crabbing trip, and how satisfied you are with each factor: a) Being out in Cockburn Sound b) No congestion at the boat ramp c) You catch as many crabs as you expect to d) The number of crabs you catch e) The size of the crabs you catch f) The time it takes to catch the number of crabs you want g) You catch enough crabs for a decent feed h) Having a good time trying to catch the crabs regardless of how many you end up with i) The social aspect of crabbing with friends or family	A composite score or scores will be extracted from the 8 statements to measure attitudes to crabbing (social or serious) and importance of crabbing. This will be used with the Contingent Valuation results to understand the respondent's response.

Most Recent Crab Fishing Trip at Cockburn Sound

Recent experience with the crab fishing activity in Cockburn Sound was expected to influence the valuation placed on the recreational activity by respondents. Moreover recent experience is much more likely to be accurately remembered than on average experience. Therefore, in addition to general crab fishing background, a separate section was included to obtain more quantitatively accurate information on crab fishing activities than the "on average" type questions in the previous section. The questions used in this section and their rational is presented below.

Item	Question	Reasoning
Q 19	When was the last time you went fishing for crabs at Cockburn Sound?	Focuses the respondent on a recent fishing trip by them recalling when it was. For the first survey wave, the last trip could be up to four years ago.
Q20	Was fishing for crabs the main reason for visiting Cockburn Sound that day?	These two questions give an impression of purpose of fishing trip, and add to information given in the first five questions on the characteristic of the fisher.
Q 21	If not, what was your main reason for visiting Cockburn Sound that day?	Again, to determine whether the respondent is a serious or social crab fisher.
Q 22	Why did you choose Cockburn Sound rather than some place else?	A measure of dedication to the Cockburn Sound fishery.
Q 23	How did you fish for crabs that day?	Last trip behaviour may be different to 'on average'.
Q 24	Did you fish for crab by yourself or with others also fishing for crabs?	Puts the last crabbing trip in context and to cross-validate with 'on average' question.
Q 25	Including yourself, how many people were in the group that day?	
Q 26	What was the relationship of the other people to you?	
Q 27	How many crabs were caught and kept (by you and by the whole group)?	Cross-validation of 'on average' catch, also a more accurate (recent) measure of catch.
Q 28	Why did you stop fishing for crabs that day?	Barriers to getting more catch and possible explanation of likelihood to remove that barrier.
Q 29	Were you happy with the number of crabs you personally kept?	Measure of satisfaction with the crab fishery.
Q 30	Did you catch as many crabs as you thought you would?	Reflective view on expectation of catch.

Item	Question	Reasoning
Q 31	How far did you travel (from home and back to home) for the crabbing trip? (Include any side trips related to the crabbing trip, eg getting petrol for boat, getting bait, picking up mates, etc. Exclude travel in the boat on the water.	A measure of how far recreational crabbers will travel to fish for crab at Cockburn Sound. Goes towards the cost of the trip.

Costs of Crab Fishing in Cockburn Sound

Costs attributable to fishing in Cockburn sound encompass both boat related and non boat related costs. The questions presented below collected data on both type of costs and allow for apportioning boat costs where uses other than crab fishing are involved.

Item	Question	Reasoning
Q 32	Do you or anyone in your household own a boat that you take when fishing for crabs in Cockburn Sound?	Sets the scene for questions on capital boat costs.
Q 33	(Boat Owner) How long is the boat?	Check against licensing information for value of boat and licensing costs.
Q 34	(Boat Owner) Over the past twelve months, about what percentage of the boat's use was for fishing for crab in Cockburn Sound?	To apportion the value of the boat to efforts of fishing for crab in Cockburn Sound.
Q 35	(Boat Owner) What is the current market value of your boat including the motor?	Associated investment in a boat used for crab fishing. To be apportioned by amount of use for crab fishing in Cockburn Sound.
Q 36	(Boat Owner) How much money per annum do you spend on: *(round to the nearest $1)* a. Boat and trailer licence fees? b. Boat, motor or trailer maintenance? c. New equipment such as GPS or sounder or motor? d. Parts for boat, motor or trailer? e. Insurance for boat, motor or trailer? f. Boat club membership and pen fees?	Associated capital costs of crab fishing per annum to be used for economic modelling of recreational crab fishing.

Q 37	In the last twelve months, how much money did you spend on: *(round to the nearest $1)* a) Fishing-related equipment for a motor vehicle such as roof racks or a tow bar? b) Life jackets and safety gear? c) Recreational fishing club membership? d) Pots, nets or other crabbing equipment?	Associated annual costs of crab fishing not related to boat ownership. Item c will also determine whether the respondent is a member of any recreational fishing associations.
Q 38	In the last twelve months, how much on average did you spend per trip on the following for fishing for crabs in Cockburn Sound: *(round to the nearest $1)* a) Food, drink and refreshments? b) Transport - petrol for vehicle? c) Petrol for boat? d) Parking, access and boat launching fees? e) Special clothing, hats, footwear or sunglasses for fishing? f) Bait and ice?	Annual cost of items associated with crab fishing trips to be used for economic modelling of recreational crab fishing.

Willingness to Pay to Increase Catch in Cockburn Sound

The survey used a market price approach to eliciting a willingness to pay figure for additional recreational catch in Cockburn Sound. This approach to contingent valuation is based on offering respondents a price that would purchase the designated catch scenario. They can indicate a willingness to pay the assigned price (1=yes) or reject the price – scenario combination (0=no). The scenario and price questions are shown below.

Item	Question	Reasoning
Q 39	A fishery management strategy could be introduced to Cockburn Sound, which would aim to increase the number of crabs available to be caught by recreational fishers. This means that during the crabbing season, you will have a good chance of catching more crabs in the same amount of time that you fish for them. In your case, this would mean an extra (*LOOK-UP VALUE***) crabs on average per trip. The strategy could be funded by a daily trip fee of $\boxed{\$1^*}$ per person. The money collected would go into a special purpose recreational fishing fund to support the sustainable management strategy in the fishery. The alternative to the strategy is to leave things as they are, where no fee is charged to fish for crabs in the Cockburn Sound area and conditions will not be altered. Are you willing to pay the daily trip fee of $\boxed{\$1^*}$ to increase your catch size of crabs by (*LOOK-UP VALUE***) crabs?	This is a contingent valuation approach, which presents a scenario and associated costs and benefits to the respondent. Only one scenario is presented to the respondent, which is this case is the daily trip fee amount. The respondent can say yes or no to the scenario. The question aims to measure the marginal value of an extra Cockburn Sound crab to the fisher as the fundamental resource allocation pressure is for increased recreational allocation. In these circumstances, the value recreational fishers were willing to pay to retain their existing catch was incidental. In any event such values reflect the total consumer surpluses at current catch levels rather than the required marginal values. .**Alternative daily fees are $\boxed{\$1}$, $\boxed{\$2}$, $\boxed{\$3}$, $\boxed{\$4}$ and $\boxed{\$5}$. These will be randomly assigned to respondents across both survey waves.* *(In the second wave, values of $1, $2 or $3 only were presented.)* ***If Q12a = 0 to 4, LOOK-UP VALUE = 1; If Q12a = 5 to 9, LOOK-UP VALUE = 2; If Q12a = 10 to 19, LOOK-UP VALUE = 3; If Q12a = 20 to 28, LOOK-UP VALUE = 4.*
Q 40 (Wave 2)	(If not willing to pay) What are your reasons for not being willing to pay the daily trip fee? <u>(Probe fully)</u>	Explores the reasons why a respondent is not willing to pay the fee proposed.
Q 41 (Wave 2)	(If unwilling to pay $2 or $3) What daily trip fee would you be willing to pay to have a good chance at catching an extra (LOOK-UP VALUE**) crabs per trip on average?	To determine whether it is the fee value itself that is the driver in deciding whether a respondent is willing to pay the daily trip fee.

Demographics

The following information was collected to build a socio-demographic background of the survey group. The questions are aligned with ABS Census categories, or groupings of categories, where possible.

Item	Question	Reasoning
Q 42	Gender	Background on respondent. May provide reasoning of decision in contingent valuation question.
Q 43	Which of these age categories best describes you?	Background on respondent. May provide reasoning of decision in contingent valuation question.
Q 44	Which of the following best describes your situation? (labour force status and employment)	Background on respondent. May provide reasoning of decision in contingent valuation question. Describes amount of free time the respondent may have to fish for crabs in Cockburn Sound.
Q 45	What is your weekly personal income before tax? (annual income indicated in brackets)	Background on respondent. May provide reasoning of decision in contingent valuation question.
Q 46	Do you have any comments to make about recreational crab fishing in the Cockburn Sound fishery?	Opportunity for respondent to share their views.

Appendix 2: Descriptive Analysis of Crab Recreational Survey

Introduction

Waves one and two of the Cockburn Sound Recreational Crab Fisher Survey has been conducted and the results are presented in this report.

Analysis was carried out in SPSS, a standard statistical software package suitable for survey analysis.

Response Rates

A total of 24 completed interviews were achieved from the 54 households in the survey scope approached, resulting in a response rate of 44%. A breakdown of the sample and respondents by source of contact is provided below.

Breakdown of the Sample for Wave One.

	Initial List	Sample Approac h-ed[1]	Respond -ents	Respons e Rate
National Survey	17	16	8	50%
1996/97 Survey	86	77	16	21%
Total	**102**	**93**	**24**	**26%**

[1] 'Sample Approached' excludes contacts with no telephone details and one 1996/97 contact who removed himself prior to the start of fieldwork.

A better result of 58 completed interviews achieved from 64 in-scope households for Wave Two.

Fieldwork Statistics

The response rate for Wave One was somewhat lower than anticipated, however an analysis of the fieldwork statistics presented in the Results of Interviewer Contact provides an explanation of what may have happened. Around 42% of the sample was out of scope due to the respondent not having fished in Cockburn Sound for crabs in the last twelve months (35%) or in the last few years (6%).

Results of Interviewer Contact.

Total Households Attempted	**93**	**100.0%**	**69**	**100.0%**
In Scope:				
Completed Interview	24	44.4%	58	84.0%
Refused	14	25.9%	0	
Telephone disconnected	6	11.1%	2	2.8%
No contact after minimum of six calls	6	11.1%	3	4.3%
Away for duration	3	5.5%	1	1.4%
Language a barrier	1	1.9%	0	
Total In Scope	**54**	**58.1%**	**64**	**92.7%**
Out of Scope:				
Had not fished for crab in Cockburn Sound in last twelve months (Q4=0).	33	84.6%	0	
Had not fished in Cockburn Sound for crabs in last few years (Introduction screen).	6	15.4%	5	7.2%
Total Out of Scope	**39**	**41.9%**	**5**	**7.2%**

Wave Two, with a sample drawn from a recruitment over the 2001/2002 crabbing season, achieved a higher response rate as expected. Respondents were contacts made by Fisheries Department during a survey conducted at Cockburn Sound over the 2001-2002 crabbing season. Hence respondents in Wave Two were most likely to have crabbed recently and had already agreed to participate in this survey.

Survey Results

Note that in the following tables:

- The percentages may not add precisely to the given total due to rounding of percentages to one decimal place.
- Where the question allowed a respondent to give multiple responses, the totals for both counts and percentages are generally greater than the number of person responding. The percentages are the percentage of persons asked the question who gave each particular response.
- The percentages total by column unless stated otherwise.

Fishing Background

Q1. To start with, where have you gone fishing, crabbing or prawning in the last twelve months? (Multiple responses per respondent accepted.)

	Wave One		Wave Two	
	Count	**%**	**Count**	**%**
Cockburn Sound	23	95.8%	57	98.3%
Swan River	3	12.5%	13	22.4%
Geographe Bay			7	12.1%
Leschenault			4	6.9%
Peel - Harvey	7	29.2%	18	31.0%
Other	10	41.7%	41	70.7%
Total Respondents	**24**	**100.0%**	**58**	**100.0%**

Q2. Which of the following species have you tried to catch in the last twelve months? (Multiple responses per respondent accepted.)

	Wave One		Wave Two	
	Count	**%**	**Count**	**%**
Crabs	24	100.0%	58	100.0%
Other crustaceans (rock lobster, prawns)	9	37.5%	20	34.4%
Fin fish	17	70.8%	49	84.5%
Shellfish (eg mussels, oysters, clams)	4	16.7%	12	20.7%
Squid or octopus	15	62.5%	31	53.4%
Other			2	3.4%
Total Respondents	**24**	**100.0%**	**58**	**100.0%**

Q3. In the last twelve months, where have you fished for crabs? (Multiple responses per respondent accepted.)

	Wave One		Wave Two	
	Count	**%**	**Count**	**%**
Cockburn Sound	24	100.0%	57	98.3%
Swan River	3	12.5%	7	12.1%
Geographe Bay			5	8.6%
Leschenault			1	1.7%
Peel - Harvey	9	37.5%	14	24.1%
Other	3	12.5%	12	20.7%
Total Respondents	**24**	**100.0%**	**58**	**100.0%**

Q4. Over the last twelve months, how many times have you been fishing for crabs in Cockburn Sound?

	Wave One		Wave Two	
	Count	**%**	**Count**	**%**
Once	2	8.3%	5	8.6%
2 - 5 times	11	45.8%	23	39.7%
6 - 10 times	4	16.7%	19	32.7%
11 or more times	7	29.2%	11	19.0%
Total Respondents	**24**	**100.0%**	**58**	**100.0%**

The reported maximum number of times any respondent has gone fishing for crab in Cockburn Sound is 40 times for Wave One respondents and 35 times for Wave Two respondents.

Q5. Over the last twelve months, what percentage of your fishing trips were to fish for crab in Cockburn Sound?

	Wave One		Wave Two	
	Count	**%**	**Count**	**%**
1 - 10% of fishing trips	7	29.3%	10	17.2%
11 - 50% of fishing trips	8	33.5%	29	50.0%
51 - 99% of fishing trips	3	12.5%	14	24.1%
100% of fishing trips	6	25.0%	5	8.6%
Total Respondents	**24**	**100.0%**	**24**	**100.0%**

Crabbing in Cockburn Sound

Q6. How do you find out when the crabs are running in Cockburn Sound? (Multiple responses per respondent accepted.)

	Wave One		Wave Two	
	Count	**%**	**Count**	**%**
I don’t find out - just take pot luck	2	8.3%	15	25.9%
Word of mouth	14	58.3%	32	55.2%
Experience/I just know/habit	18	75.0%	28	48.3%
Newspaper	4	16.7%	10	17.2%
Other - At Cockburn there is a bait shop and I ask about it there.	1	4.2%	5	8.6%
Total Respondents	**24**	**100.0%**	**58**	**100.0%**

Q7. Do you generally fish for crabs by yourself or with others who are also fishing for crabs?

	Wave One		Wave Two	
	Count	%	Count	%
By myself	2	8.3%	13	22.4%
With others	22	91.7%	45	77.6%
Total Respondents	**24**	**100.0%**	**58**	**100.0%**

The next two questions relate to respondents that fish for Cockburn Sound crabs in a group.

Q8. Including yourself, how many people are usually in the group?

	Wave One		Wave Two	
	Count	%	Count	%
2 people	11	50.0%	31	68.9%
3 people	5	22.7%	10	22.2%
4 people	5	22.7%	3	6.7%
5 people	1	4.5%	1	2.2%
Total Respondents	**22**	**100.0%**	**45**	**100.0%**

Q9. What is the relationship of the other people to you? (Multiple responses per respondent accepted.)

	Wave One		Wave Two	
	Count	%	Count	%
Friend(s)	16	72.7%	27	72.7%
Spouse, partner or significant other	6	27.3%	11	27.3%
Parent(s)	2	9.1%	3	9.1%
Children	3	13.6%	11	13.6%
Extended family	5	22.7%	5	22.7%
Brothers			2	4.4%
Total Respondents	**22**	**100.0%**	**45**	**100.0%**

Q10. How long on average do you spend on the water actually trying to catch crabs?

	Wave One		Wave Two	
	Count	**%**	**Count**	**%**
1 hour	1	4.2%	1	1.7%
1.5 hours	5	20.8%	10	17.2%
2 hours	6	25.0%	5	8.6%
2.5 hours			11	19.0%
3 hours	6	25.0%	2	3.4%
3.5 hours	1	4.2%	11	19.0%
4 hours	4	16.7%	2	3.4%
4.5 hours			10	17.2%
5 hours	1	4.2%	4	6.9%
6 hours			2	3.4%
Total Respondents	**24**	**100.0%**	**58**	**100.0%**

Q11. On average, how long are you away from home when you go fishing for crabs at Cockburn Sound?

	Wave One		Wave Two	
	Count	**%**	**Count**	**%**
1 hour			4	6.9%
1.5 hours	1	4.2%	7	12.1%
2 hours	3	12.5%	4	6.9%
2.5 hours			4	6.9%
3 hours	3	12.5%	2	3.4%
3.5 hours	2	8.3%	7	12.1%
4 hours	4	16.7%	2	3.4%
4.5 hours	1	4.2%	8	13.8%
5 hours	7	29.2%	1	1.7%
5.5 hours			3	5.2%
6 hours			2	3.4%
6.5 hours			7	12.1%
7 hours			4	6.9%
8 hours	3	12.5%	2	3.4%
12 hours			1	1.7%
Total Respondents	**24**	**100.0%**	**58**	**100.0%**

Q12a. On average over the last twelve months, how many crabs did you catch and keep per day in Cockburn Sound?

	Wave One		Wave Two	
	Count	**%**	**Count**	**%**
None			3	5.2%
1 crab			2	3.4%
2 crabs			2	3.4%
3 crabs	1	4.2%	1	1.7%
4 crabs	1	4.2%	4	6.9%
5 crabs	1	4.2%	4	6.9%
6 crabs	4	16.7%	6	10.3%
7 crabs			6	10.3%
8 crabs	1	4.2%	3	5.2%
9 crabs	2	8.3%	1	1.7%
10 crabs	1	4.2%	2	3.4%
12 crabs	6	25.0%	6	10.3%
14 crabs	1	4.2%	2	3.4%
15 crabs	2	8.3%	8	13.8%
16 crabs	1	4.2%	1	1.7%
17 crabs	1	4.2%		
20 crabs	2	8.3%	6	10.3%
22 crabs			1	1.7%
Total Respondents	**24**	**100.0%**	**58**	**100.0%**

Q12b. On average over the last twelve months, how many crabs did your group catch and keep per day in Cockburn Sound?

	Wave One		Wave Two	
	Count	**%**	**Count**	**%**
None			1	2.2%
1 crab			1	2.2%
2 crabs			1	2.2%
4 crabs			1	2.2%
5 crabs			2	4.4%
6 crabs	1	4.5%		
7 crabs			1	2.2%
8 crabs	1	4.5%	2	4.4%
9 crabs			1	2.2%
10 crabs			2	4.4%
12 crabs	2	9.1%	6	13.3%
13 crabs			1	2.2%
14 crabs			1	2.2%
15 crabs	2	9.1%	5	11.1%
16 crabs			1	2.2%
17 crabs	1	4.5%		
18 crabs	2	9.1%	3	6.7%
20 crabs	2	9.1%	8	17.8%
24 crabs	3	13.6%	1	2.2%
25 crabs			2	4.4%
27 crabs			1	2.2%
30 crabs	3	13.6%	2	4.4%
32 crabs	1	4.5%		
36 crabs	1	4.5%		
40 crabs	1	4.5%	1	2.2%
45 crabs			1	2.2%
48 crabs	2	9.1%		
Total Respondents	**22**	**100.0%**	**45**	**100.0%**

Q13. (If respondent fishes for crab in a group) **How is the catch usually shared amongst you and the rest of the group?**

	Wave One		Wave Two	
	Count	**%**	**Count**	**%**
Divided out evenly amongst all crabbers	12	50.0%	27	60.0%
All eaten by my household	5	20.8%	10	22.2%
We eat them together	9	37.5%	14	31.1%
Boat owner gets set number, and the rest of the group shares			1	2.2%
Other	1	4.2%	2	4.4%
Total Respondents	**24**	**100.0%**	**45**	**100.0%**

Q14. On average in the last twelve months, why do you stop at the number you catch? (Multiple responses per respondent accepted.)

	Wave One		Wave Two	
	Count	**%**	**Count**	**%**
Caught the boat or bag limit	7	29.2%	1	1.7%
I only catch as many as I can eat or use	12	50.0%	20	34.5%
Only keep what I can catch in a set time	3	12.5%	19	32.8%
That's as many as I can catch	6	25.0%	12	20.7%
The availability of crabs	4	16.7%	16	27.6%
I have limited crabbing equipment (eg don't have full 10 nets)	2	8.3%		8.3%
Other			1	1.7%
Total Respondents	**24**	**100.0%**	**58**	**100.0%**

Q15. In the last twelve months, when did you usually fish for crab? (Multiple responses per respondent accepted.)

	Wave One		Wave Two	
	Count	**%**	**Count**	**%**
Weekdays	17	77.3%	26	44.8%
Weekends	11	50.0%	43	74.1%
Public Holidays	4	18.2%	14	24.1%
School Holidays	1	4.5%	5	8.6%
Total Respondents	**22**	**100.0%**	**58**	**100.0%**

Q16. What have you usually done in the last twelve months with the crabs you kept? (Multiple responses per respondent accepted.)

	Wave One		Wave Two	
	Count	%	Count	%
Eaten by my household	24	100.0%	52	89.7%
Give them away to friends/family (another household)	5	20.8%	18	31.0%
Other	1	4.2%	3	5.2%
Total Respondents	**24**	**100.0%**	**58**	**100.0%**

Q17. Of the crabs caught and kept on average in the last twelve months, what proportion would you say was:

WAVE ONE	Eaten by your household		Give to another household		Used as bait (by your household)		For some other purpose (eg pet food, fertiliser, etc)	
	Count	%	Count	%	Count	%	Count	%
0% of crabs			12	50.0%	23	95.8%	22	91.7%
10% of crabs			4	16.7%	1	4.2%		
15% of crabs							1	4.2%
20% of crabs	1	4.2%	2	8.3%			1	4.2%
25% of crabs			1	4.2%				
30% of crabs			1	4.2%				
50% of crabs	4	16.7%	3	12.5%				
70% of crabs	2	8.3%						
80% of crabs	2	8.3%	1	4.2%				
90% of crabs	3	12.5%						
100% of crabs	12	50.0%						
Total Respondents	**24**		**24**		**24**		**24**	

WAVE TWO	Eaten by your household		Give to another household		Used as bait (by your household)		For some other purpose (eg pet food, fertiliser, etc)	
	Count	%	Count	%	Count	%	Count	%
0% of crabs	2	3.4%	32	55.2 %	58	100.0 %	58	100.0 %
1% of crabs			1	1.7%				
5% of crabs	1	1.7%						
10% of crabs			4	6.9%				
20% of crabs	1	1.7%	4	6.9%				
25% of crabs			3	5.2%				
30% of crabs			3	5.2%				
40% of crabs			2	3.4%				
50% of crabs	5	8.6%	5	8.6%				
70% of crabs	3	5.2%						
75% of crabs	3	5.2%						
80% of crabs	4	6.9%	1	1.7%				
90% of crabs	4	6.9%						
95% of crabs			1	1.7%				
99% of crabs	1	1.7%						
100% of crabs	32	55.2 %	2	3.4%				
Total Respondents	**58**		**58**		**58**		**58**	

Q18. I am going to read out factors about crabbing in Cockburn Sound. As I read out each one, please tell me how important a role it plays in a successful crabbing trip, and how satisfied you are with each factor. (24 respondents per statement.) (Row percent.)

Importance

WAVE ONE	Not important at all	Not very important	Quite important	Very important	N/A
Being out in Cockburn Sound	3	4	9	8	
	12.5%	16.7%	37.5%	33.3%	
No congestion at the boat ramp	3	3	11	6	1
	12.5%	12.5%	45.8%	25.0%	4.2%
You catch as many crabs as you expect to	2	10	9	3	
	8.3%	41.7%	37.5%	12.5%	
The number of crabs you catch	3	8	8	5	
	12.5%	33.3%	33.3%	20.8%	
The size of the crabs you catch		2	6	16	
		8.3%	25.0%	66.7%	
The time it takes to catch the number of crabs you want	8	7	5	4	
	33.3%	29.2%	20.8%	16.7%	
You catch enough crabs for a decent feed	1	6	10	7	
	4.2%	25.0%	41.7%	29.2%	
Having a good time trying to catch the crabs regardless of how many you end up with	1		4	19	
	4.2%		16.7%	79.2%	
The social aspect of crabbing with friends or family	1	1	7	15	
	4.2%	4.2%	29.2%	62.5%	

Satisfaction

WAVE ONE	Very dissatis'd	2	Neutral	4	Very satisfied	N/A
Being out in Cockburn Sound	3	4	7	3	7	
	12.5%	16.7%	29.2%	12.5%	29.2%	
No congestion at the boat ramp	3	2	10	5	3	1
	12.5%	8.3%	41.7%	20.8%	12.5%	4.2%
You catch as many crabs as you expect to	1	4	5	6	8	
	4.2%	16.7%	20.8%	25.0%	33.3%	
The number of crabs you catch	2	5	4	11	2	
	8.3%	20.8%	16.7%	45.8%	8.3%	
The size of the crabs you catch		4	3	10	7	
		16.7%	12.5%	41.7%	29.2%	
The time it takes to catch the number of crabs you want		4	7	8	5	
		16.7%	29.2%	33.3%	20.8%	
You catch enough crabs for a decent feed		4	7	7	6	
		16.7%	29.2%	29.2%	25.0%	
Having a good time trying to catch the crabs regardless of how many you end up with		2	1	8	13	
		8.3%	4.2%	33.3%	54.2%	
The social aspect of crabbing with friends or family		1	4	7	12	
		4.2%	16.7%	29.2%	50.0%	

Importance

WAVE TWO	Not important at all	Not very important	Quite important	Very important	N/A
Being out in Cockburn Sound		3	23	32	
		5.2%	39.7%	55.2%	
No congestion at the boat ramp	3	5	13	33	4
	5.2%	8.6%	22.4%	56.9%	6.9%
You catch as many crabs as you expect to	5	23	25	5	
	8.6%	39.7%	43.1%	8.6%	
The number of crabs you catch	1	30	24	3	
	1.7%	51.7%	41.4%	5.2%	
The size of the crabs you catch	1	4	18	35	
	1.7%	6.9%	31.0%	60.3%	
The time it takes to catch the number of crabs you want	5	24	16	13	
	8.6%	41.4%	27.6%	22.4%	
You catch enough crabs for a decent feed	2	14	21	21	
	3.4%	24.1%	36.2%	36.2%	
Having a good time trying to catch the crabs regardless of how many you end up with			5	53	
			8.6%	91.4%	
The social aspect of crabbing with friends or family	3	1	9	45	
	5.2%	1.7%	15.5%	77.6%	

Satisfaction

WAVE TWO	Very dissatis'd	2	Neutral	4	Very satisfied	N/A
Being out in Cockburn Sound	4	1	2	26	25	
	6.9%	1.7%	3.4%	44.8%	43.1%	
No congestion at the boat ramp	6	8	10	18	11	5
	10.3%	13.8%	17.2%	31.0%	19.0%	8.6%
You catch as many crabs as you expect to	8	11	6	27	6	
	13.8%	19.0%	10.3%	46.6%	10.3%	
The number of crabs you catch	9	8	8	26	7	
	15.5%	13.8%	13.8%	44.8%	12.1%	
The size of the crabs you catch	2	10	8	31	7	
	3.4%	17.2%	13.8%	53.4%	12.1%	
The time it takes to catch the number of crabs you want	7	9	9	25	8	
	12.1%	15.5%	15.5%	43.1%	13.8%	
You catch enough crabs for a decent feed	4	8	13	22	11	
	6.9%	13.8%	22.4%	37.9%	19.0%	
Having a good time trying to catch the crabs regardless of how many you end up with		1	1	14	22	
		1.7%	1.7%	24.1	72.4%	
The social aspect of crabbing with friends or family	1	3	2	8	44	
	1.7%	5.2%	3.4%	13.8%	75.9%	

Most Recent Crabbing Trip at Cockburn Sound

Q19. When was the last time you fished for crabs in Cockburn Sound?

	Wave One		Wave Two	
	Count	**%**	**Count**	**%**
December 2000	1	4.2%		
January 2001	4	16.7%		
February 2001	5	20.8%		
March 2001	8	33.3%		
April 2001	2	8.3%		
July 2001	2	8.3%		
October 2001	1	4.2%		
November 2001			2	3.4%
December 2001	1	4.2%	3	5.2%
January 2002			12	20.7%
February 2002			18	31.0%
March 2002			23	39.7%
Total Respondents	**24**	**100.0%**	**58**	**100.0%**

Q20. Was fishing for crabs the main reason for you visiting Cockburn Sound that day?

	Wave One		Wave Two	
	Count	**%**	**Count**	**%**
Yes	17	70.8%	48	82.8%
No	7	29.2%	10	17.2%
Total Respondents	**24**	**100.0%**	**58**	**100.0%**

Q21. If not, what was your main reason for visiting Cockburn Sound that day?

	Wave One		Wave Two	
	Count	**%**	**Count**	**%**
To catch fish or squid	1	14.3%	6	60.0%
To visit friends or family	2	28.6%		
For a picnic or family outing	1	14.3%	3	30.0%
Other	3	42.9%	1	10.0%
Total Respondents	**7**	**100.0%**	**10**	**100.0%**

Main reason for visiting Cockburn Sound that day (Q20 and Q21)

	Wave One		Wave Two	
	Count	%	Count	%
To catch crabs	17	70.8%	48	82.8%
To catch fish or squid	1	4.2%	6	10.3%
To visit friends or family	2	8.3%		
For a picnic or family outing	1	4.2%	3	5.2%
Other	3	12.5%	1	1.7%
Total Respondents	**24**	**100.0%**	**24**	**100.0%**

'Other' included:

- It was just holiday time. We have a holiday house down there and I take the family.
- I have a shack down there I often visit.
- Volunteer rescue (Rockingham).

Q22. Why did you choose Cockburn Sound rather than some place else? (Multiple responses per respondent accepted.)

	Wave One		Wave Two	
	Count	%	Count	%
It is local/convenient	11	45.8%	31	53.4%
Not crowded			3	5.2%
Always go there	16	66.7%	17	29.3%
Got told to try that place	2	8.3%	4	6.9%
Doesn't cost anything to park or use the boat ramp			1	1.7%
Other	7	29.2%	35	60.3%
Total Respondents	**24**	**100.0%**	**58**	**100.0%**

'Other' included:

- There is no where else to go
- Protection from the wind.
- My mate has a holiday house there.
- Safety
- I like the crabs at Cockburn Sound.
- Time of year and availability of crabs.
- I've got a caravan down there and so that is a place to go from.

Q23. How did you fish for crabs that day?

	Wave One		Wave Two	
	Count	**%**	**Count**	**%**
Used crab nets from a boat	14	58.3%	40	69.0%
Dived for crabs from boat	8	33.3%	2	3.4%
Dived for crabs from boat	1	4.2%	10	17.2%
Dived for crabs from shore			5	8.6%
Other - Drop nets from the jetty.	1	4.2%	1	4.2%
Total Respondents	**24**	**100.0%**	**58**	**100.0%**

Q24. Did you fish for crabs by yourself or with others also fishing for crabs that day?

	Wave One		Wave Two	
	Count	**%**	**Count**	**%**
By myself	3	12.5%	14	24.1%
With others	21	87.5%	44	75.9%
Total Respondents	**24**	**100.0%**	**58**	**100.0%**

The next two questions relate to respondents that fish for Cockburn Sound crabs in a group.

Q25. Including yourself, how many people were in the group that day?

	Wave One		Wave Two	
	Count	**%**	**Count**	**%**
2 people	12	57.1%	27	61.4%
3 people	3	14.3%	10	22.7%
4 people	4	19.0%	4	9.1%
5 people	1	4.8%	1	2.3%
Don’t know	1	4.8%	2	4.5%
Total Respondents	**21**	**100.0%**	**44**	**100.0%**

Q26. What was the relationship of the other people to you? (Multiple responses per respondent accepted.)

	Wave One		Wave Two	
	Count	**%**	**Count**	**%**
Friend(s)	14	66.7%	23	52.3%
Spouse, partner or significant other	6	28.6%	10	22.7%
Parent(s)	2	9.5%	3	6.8%
Children	3	14.3%	10	22.7%
Extended family	3	14.3%	5	11.4%
Total Respondents	**21**	**100.0%**	**44**	**100.0%**

Q27a. How many crabs were caught and kept that day by you?

	Wave One		Wave Two	
	Count	%	Count	%
None			7	12.1%
1 crab	1	4.2%	3	5.2%
2 crabs			2	3.4%
3 crabs	2	8.3%	1	1.7%
4 crabs	1	4.2%	4	6.9%
5 crabs	1	4.2%	7	12.1%
6 crabs	4	16.7%	4	6.9%
7 crabs	1	4.2%	2	3.4%
8 crabs	1	4.2%	4	6.9%
9 crabs	1	4.2%	2	3.4%
10 crabs	3	12.5%	1	1.7%
11 crabs			3	5.2%
12 crabs	5	20.8%	3	5.2%
14 crabs			2	3.4%
15 crabs	1	4.2%	4	6.9%
16 crabs	1	4.2%	2	3.4%
17 crabs			1	1.7%
18 crabs	1	4.2%	5	8.6%
20 crabs			1	1.7%
Don’t know	1	4.2%		
Total Respondents	**24**	**100.0%**	**58**	**100.0%**

Q27b. How many crabs were caught and kept that day by the whole group?

	Wave One		Wave Two	
	Count	**%**	**Count**	**%**
None			3	6.8%
1 crab			1	2.3%
2 crabs			1	2.3%
4 crabs			2	4.5%
5 crabs			3	6.8%
6 crabs	2	9.5%	4	9.1%
7 crabs			1	2.3%
8 crabs	1	4.8%	2	4.5%
9 crabs	1	4.8%		
10 crabs			3	
12 crabs	5	23.8%	2	4.5%
13 crabs			1	2.3%
14 crabs	1	4.8%	1	2.3%
15 crabs	2	9.5%	2	4.5%
16 crabs	1	4.8%	3	6.8%
18 crabs	1	4.8%	5	11.4%
19 crabs			1	2.3%
20 crabs	2	9.5%	1	2.3%
22 crabs			2	4.5%
24 crabs	2	9.5%	2	4.5%
29 crabs			1	2.3%
30 crabs	1	4.8%	1	2.3%
46 crabs	1	4.8%		
48 crabs	1	4.8%		
51 crabs			1	2.3%
55 crabs			1	2.3%
Total Respondents	**21**	**100.0%**	**44**	**100.0%**

Q28. Why did you stop fishing for crabs that day? (Multiple responses per respondent accepted.)

	Wave One		Wave Two	
	Count	%	Count	%
Caught the boat or bag limit	2	8.3%	2	3.4%
Ran out of time	7	29.2%	21	36.2%
Did not catch any crabs that day	6	25.0%	16	27.6%
Caught enough for a feed	10	41.7%	22	37.9%
Other - Had enough, been out there long enough.	1	4.2%		
Other			11	19.0%
Total Respondents	**24**	**100.0%**	**58**	**100.0%**

Q29. Were you happy with the number of crabs you personally kept that day?

	Wave One		Wave Two	
	Count	%	Count	%
Yes	16	66.7%	40	69.0%
No	8	33.3%	18	31.0%
Total Respondents	**24**	**100.0%**	**58**	**100.0%**

Q30. Did you catch as many crabs as you thought you would?

	Wave One		Wave Two	
	Count	%	Count	%
No, thought I'd catch more	12	50.0%	33	56.9%
No, thought I'd catch less			4	6.9%
Yes, got as many as I thought I would	12	50.0%	21	36.2%
Total Respondents	**24**	**100.0%**	**58**	**100.0%**

Q30. Did you catch as many crabs as you thought you would? BY Q29. Were you happy with the number of crabs you personally kept that day? (Table %)

WAVE ONE	No, thought Id catch more		Yes, got as many as I thought I would		Total Respondents	
	Count	%	Count	%	Count	%
Happy with the number caught	4	16.7%	12	50.0%	**16**	**66.7%**
Not happy with the number caught	8	33.3%			**8**	**33.3%**
Total Respondents	**12**	**50.0%**	**12**	**50.0%**	**24**	**100.%**

WAVE TWO	No, thought Id catch more		No, thought I'd catch less		Yes, got as many as I thought I would		Total Respondents	
	Count	Count	%	%	Count	%	Count	%
Happy with the number caught	16	27.6%	4	6.9%	20	34.5%	**40**	**69.0%**
Not happy with the number caught	17	29.3%			1	1.7%	**18**	**31.0%**
Total Respondents	**33**	**56.9%**	**4**	**6.9%**	**21**	**36.2%**	**58**	**100.%**

Q31. How far did you travel (from home and back to home) for the crabbing trip? (Include any side trips related to the crabbing trip, eg getting petrol for the boat, getting bait, picking up mates, etc. Exclude travel in the boat on the water.)

	Wave One		Wave Two	
	Count	%	Count	%
1 km			1	1.7%
2 kms			1	1.7%
3 kms			2	3.4%
4 kms	3	12.5%	5	8.6%
5 kms			1	1.7%
6 kms	1	4.2%	2	3.4%
7 kms	1	4.2%		
8 kms	2	8.3%		
10 kms	2	8.3%	7	12.1%
12 kms			3	5.2%
14 kms			1	1.7%
15 kms	2	8.3%	2	3.4%
16 kms			1	1.7%
17 kms			1	1.7%
20 kms	1	4.2%	4	6.9%
25 kms			2	3.4%
28 kms			1	1.7%
30 kms	2	8.3%	3	5.2%
35 kms	1	4.2%	1	1.7%
40 kms	1	4.2%	5	8.6%
44 kms			1	1.7%
45 kms			2	3.4%
50 kms	2	8.3%	4	6.9%
60 kms	3	12.5%		
64 kms	1	4.2%		
65 kms			1	1.7%
75 kms				
80 kms	2	8.3%	4	6.9%
100 kms			2	3.4%
Total Respondents	**24**	**100.0%**	**58**	**100.0%**

Cost of Crab Fishing

Q32. Do you or anyone in your household own a boat that you take when fishing for crabs at Cockburn Sound?

	Wave One		Wave Two	
	Count	**%**	**Count**	**%**
Yes	23	95.8%	51	87.9%
No	1	4.2%	7	12.1%
Total Respondents	**24**	**100.0%**	**58**	**100.0%**

The next four questions relate to respondents that own a boat that is used for crab fishing at Cockburn Sound.

Q33. How long is the boat?

	Wave One		Wave Two	
	Count	**%**	**Count**	**%**
Feet	9	39.1%	22	43.1%
Metres	14	60.9%	29	56.9%
Total Respondents	**23**	**100.0%**	**51**	**100.0%**

	Wave One		Wave Two	
	Count	**%**	**Count**	**%**
12 feet	2	22.2%	2	2.9%
13 feet			1	4.5%
14 feet	2	22.2%	5	22.7%
15 feet	1	11.1%	2	9.1%
16 feet			4	18.2%
17 feet	1	11.1%		
18 feet	1	11.1%	4	18.2%
19 feet	1	11.1%	2	9.1%
21 feet	1	11.1%	1	4.5%
23 feet			1	4.5%
Total Respondents	**9**	**100.0%**	**22**	**100.0%**

	Wave One		Wave Two	
	Count	**%**	**Count**	**%**
3.4 metres	1	7.1%		
3.5 metres			1	1.7%
3.8 metres			1	1.7%
3.9 metres	1	7.1%	1	1.7%
4.0 metres	2	14.3%	1	1.7%
4.1 metres			1	1.7%
4.2 metres			3	5.2%
4.3 metres			2	3.4%
4.5 metres	2	14.3%		
4.6 metres	1	7.1%		
4.7 metres			3	5.2%
4.8 metres	1	7.1%		
5.0 metres	2	14.3%	7	14.3%
5.2 metres			4	6.9%
5.6 metres			1	1.7%
5.8 metres	1	7.1%		
6.0 metres	1	7.1%	2	3.4%
6.4 metres			1	1.7%
6.5 metres	1	7.1%		
7.0 metres	1	7.1%		
7.2 metres			1	1.7%
Total Respondents	**14**	**100.0%**	**29**	**100.0%**

Q34. Over the past twelve months, about what percentage of your boat's use was for fishing for crab at Cockburn Sound?

	Wave One		Wave Two	
	Count	**%**	**Count**	**%**
Boat not used for crabbing at Cockburn Sound	1	4.3%	1	2.0%
1 - 10% of boat's use for crabbing at Cockburn Sound	9	39.0%	6	11.8%
11 - 40% of boat's use for crabbing at Cockburn Sound	5	21.7%	21	41.2%
41 - 99% of boat's use for crabbing at Cockburn Sound	4	17.4%	18	35.3%
Boat solely used for crabbing at Cockburn Sound	4	17.4%	5	9.8%
Total Respondents	**23**	**100.0%**	**51**	**100.0%**

Q35. What is the current market value of your boat including the motor? (Wave 1 respondents = 22, Wave 2 respondents = 51.)

	Minimum	Maximum	Mean	Std. Dev.
Wave One				
Unadjusted	$800.00	$55,000.00	$12,150.00	$13,244.40
Adjusted for Cockburn Sound crabbing use	$0.00	$30,000.00	$3,420.00	$6,273.23
Wave Two				
Unadjusted	$1,000.00	$50,000.00	$12,562.75	$10,366.98
Adjusted for Cockburn Sound crabbing use	$0.00	$25,000.00	$4,111.69	$4,718.88

Q36. In the last twelve months, how much money did you spend on: (Wave 1 respondents = 23, Wave 2 respondents = 48-51.) UNADJUSTED.

	N	Minimum	Maximum	Mean	Std. Dev.
Wave One					
a. Boat and trailer licence fees	23	$0.00	$400.00	$102.74	$88.45
b. Boat, motor or trailer maintenance	23	$0.00	$6,000.00	$682.61	$1,233.68
c. New equipment such as GPS or sounder or motor	23	$0.00	$18,000.00	$1,073.91	$3,774.46
d. Parts for boat, motor or trailer	23	$0.00	$2,000.00	$238.91	$472.06
e. Insurance for boat, motor or trailer	23	$0.00	$650.00	$205.22	$203.90
f. Boat club membership and pen fees	23	$0.00	$150.00	$9.83	$33.85
Total	**23**	**$50.00**	**$20,300.00**	**$2,313.22**	**$4,291.11**
Wave Two					
a. Boat and trailer licence fees	48	$0.00	$1,000.00	$145.81	$166.27
b. Boat, motor or trailer maintenance	51	$0.00	$16,000.00	$545.94	$2,255.04
c. New equipment such as GPS or sounder or motor	51	$0.00	$4,000.00	$215.69	$690.32
d. Parts for boat, motor or trailer	51	$0.00	$800.00	$148.55	$209.35
e. Insurance for boat, motor or trailer	50	$0.00	$850.00	$185.82	$208.64
f. Boat club membership and pen fees	51	$0.00	$220.00	$36.39	$64.28

Total	**48**	**$0.00**	**$17,600.00**	**$1,277.62**	**$2,573.50**

Q37. In the last twelve months, how much money did you spend on: (Wave 1 respondents = 24, Wave 2 respondents = 51.) UNADJUSTED.

	Minimum	Maximum	Mean	Std. Dev.
Wave 1				
a. Fishing-related equipment for a motor vehicle such as roof racks or a tow bar	$0.00	$150.00	$6.25	$30.62
b. Life jackets and safety gear	$0.00	$250.00	$41.67	$73.23
c. Recreational fishing club membership	$0.00	$120.00	$11.67	$28.80
d. Pot, nets or other crabbing equipment	$0.00	$200.00	$31.67	$53.62
Total	**$0.00**	**$350.00**	**$91.25**	**$103.46**
Wave 2				
a. Fishing-related equipment for a motor vehicle such as roof racks or a tow bar	$0.00	$2000.00	$75.78	$298.70
b. Life jackets and safety gear	$0.00	$110.00	$43.71	$154.90
c. Recreational fishing club membership	$0.00	$200.00	$6.38	$30.59
d. Pot, nets or other crabbing equipment	$0.00	$300.00	$31.55	$57.83
Total	**$0.00**	**$2,400.00**	**$157.41**	**$397.51**

Q38. In the last twelve months, how much did you spend on average per trip on the following for fishing for crabs in Cockburn Sound? (Wave 1 respondents = 24, Wave 2 respondents = 58.) UNADJUSTED.

	Minimum	Maximum	Mean	Std. Dev.
Wave 1				
a. Food, drink and refreshments	$0.00	$300.00	$24.79	$62.16
b. Transport - petrol for vehicle	$0.00	$200.00	$24.29	$45.79
c. Petrol for boat	$0.00	$200.00	$31.04	$45.08
d. Parking and boat launching fees	$0.00	$10.00	$0.83	$2.82
e. Special clothing, hats, footwear or sunglasses for fishing	$0.00	$200.00	$26.71	$59.91
f. Bait and ice	$0.00	$100.00	$16.67	$27.63
Total	**$2.00**	**$450.00**	**$80.12**	**$116.56**
Wave 2				
a. Food, drink and refreshments	$0.00	$30.00	$8.43	$8.75
b. Transport - petrol for vehicle	$0.00	$45.00	$9.71	$9.53
c. Petrol for boat	$0.00	$80.00	$15.05	$15.44
d. Parking and boat launching fees	$0.00	$5.00	$0.17	$0.92
e. Special clothing, hats, footwear or sunglasses for fishing	$0.00	$100.00	$2.83	$13.50
f. Bait and ice	$0.00	$50.00	$6.69	$8.34
Total	**$2.00**	**$110.00**	**$33.19**	**$24.14**

Q39. A fishery management strategy could be introduced to Cockburn Sound, which would aim to increase the number of crabs available to be caught by recreational fishers. This means that during the crabbing season, you will have a good chance of catching more crabs in the same amount of time that you fish for them. In your case, this would mean an extra ## crabs on average per trip.

The strategy could be funded by a daily trip fee of $X per person. The money collected would go into a special purpose recreational fishing fund to support the sustainable management strategy in the fishery.

The alternative to the strategy is to leave things as they are, where no fee is charged to fish for crabs in the Cockburn Sound area and conditions will not be altered.

Are you willing to pay the daily trip fee of $X to increase your catch size of crabs by ## crabs?

	Wave One		Wave Two	
	Count	**%**	**Count**	**%**
Yes, willing to pay	6	25.0%	26	44.8%
No, not willing to pay	18	75.0%	32	55.2%
Total Respondents	**24**	**100.0%**	**58**	**100.0%**

Random allocation of daily trip fee

	Wave One		Wave Two	
	Count	**%**	**Count**	**%**
$1	4	16.7%	19	32.8%
$2	7	29.2%	15	25.9%
$3	6	25.0%	24	41.4%
$4	3	12.5%	-	
$5	4	16.7%	-	
Total Respondents	**24**	**100.0%**	**58**	**100.0%**

Number of extra crabs per trip on average

	Wave One		Wave Two	
	Count	**%**	**Count**	**%**
1	2	8.3%	12	20.7%
2	8	33.3%	20	34.5%
3	12	50.0%	19	32.8%
4	2	8.3%	7	12.1%
Total Respondents	**24**	**100.0%**	**58**	**100.0%**

Willingness to pay (Q39) by daily trip fee proposed by number of extra crabs per trip on average (BOTH WAVES)

	Number of extra crabs				Total Respondents	
Daily trip fee	**1**	**2**	**3**	**4**	**Count**	**%**
Yes, willing to pay						
$1	3	5	3	2	**13**	**15.9%**
$2	2	2	6		**10**	**12.2%**
$3	2	4	1	2	**9**	**11.0%**
Total Respondents	7	11	10	4	**32**	**39.0%**
No, not willing to pay						
$1	1	2	4	3	**10**	**12.2%**
$2	1	4	6	1	**13**	**15.8%**
$3	4	9	7	1	**21**	**25.6%**
$4	1		2		**3**	**3.7%**
$5		2	2		**4**	**4.9%**
Total Respondents	7	17	21	5	**50**	**61.0%**
Total Respondents	**14**	**28**	**31**	**9**	**82**	

Q40. What are your reasons for not being willing to pay the daily trip fee? (WAVE TWO ONLY)

- I am willing to pay the extra $1 per person per trip, but not for an extra bag limit. The current bag limit is plenty. So what if they can't get the bag limit every trip, it works out fine the way it is. I'm sick of people taking females, undersized and over the limits and would like some resources going to more inspectors, the dollar per trip could help fund it.
- Because I spend enough money already. Between the fuel for my boat and the bait I have no money left over. That's all the reason I'll say. No need to pay when I have a boat and can go myself. Nothing else.
- I'm paying too much tax as it is, you people from the government can do without it, as I am paying too much tax as it is.
- Once you start getting into these fees, every fee keeps going up and up. It takes away from the simple pleasures of crabbing for nothing. There are starting to be too many licenses. The current bag limits are enough, and the proposed reduced limits would still be enough for me.
- It is recreational, something you go out to enjoy and you don't want to have to pay every time you do it. I wouldn't mind the bag limits being brought down I don't feel the need to catch another two crabs each trip.
- It is just another revenue raising exercise. It's just another way for them to get money out of us, it's not worth it. I'm sure the sufficient groups when they find out about this will be opposed to it and I will be supporting it. It's just the fisheries department trying to put a fee on this, when it's one of the last free recreational activity left. No, that's all I want to say for now.
- Because I'm not interested in catching more crabs. What would I do with 48 crabs?, put them on the garden?
- It is an added expense. $3 per person could add up to a bit of money if you go most weekends. perhaps one dollar would be better.

- Once things like that are brought in, it goes to people with cushy jobs at the top, and not to people policing it. I would stop going there if that happened. I use Cockburn Sound now because of the free boat launch, partly. If they are going to charge per trip people would stop going there. These ideas are always brought in by people on cushy jobs getting a squillion dollars a year, and the policing of it would be left to volunteers.
- I think you could improve the amount of fish in the sound by other means. We don't take females, and I think the bag limit could be decreased to 20 per person, with 40 per boat. If implemented across the board, I think that this would increase the crab population.
- I don't think it would do anything. It would need to be monitored that people would pay the $3 every time they used a private boat ramp, or every time they dive off the beach. It is also a 24 hour thing, with people diving at night. The collection is a problem and people would go elsewhere to avoid the fee.
- Crabs are a thing that come and go. You will have a bad season one year and a good season another year. The crabs have the highest recovery rate of any crustaceans apart from prawns. Mandurah has just had a very good couple of seasons, and although Cockburn has had a bad season this year, it will have a good season soon, I'm not sure when. It is a cyclical thing sometimes the season is only late, not a bad season, last year was like that.
- No. Because I can catch the amount I want at the moment without any problems, so I don't see any need for that, for me personally. That's all.
- Because I wouldn't want to go somewhere else for nothing. Like, you could go to Rockingham or Mandurah and only pay the ramp fees and still get a good amount of crabbing done. I don't think it is worth it because of that. That's all.
- I feel that the limit which is current is sometime attainable but usually not. This proposal would not alter my catch rate. I usually don't want to catch 20, I usually manage to catch as many as I wish currently, so an extra 2 or 3 crabs wouldn't help and I have to get out of the water after an hour in any case, paying an extra fee won't make me warmer.
- I'd rather pay for a crabbing license to recoup the costs. Easier to control, how would you get $2 per person per trip. Easier to collect, you would just need to check licenses. Too many ways to avoid it on a per visit basis. I would be willing to pay the equivalent in a license system.
- I think Australia and the freedom of people being free to do what they want without monitory penalties. I think that people should be allowed to go about their recreational activities without paying any fee or penalty, it just gets out of hand. That's all.
- I get my quota myself on my boat. That's the only reason.
- It should be recreational, not expensive. I go fishing and crabbing to get away from my stresses, not to have more stress with paying money each time. Also, crabbing is usually a sideline to my fishing, so if I have to pay for the crabbing, I wouldn't do it. I wouldn't object to an annual license fee of around $15, like the marron fees.
- I'd like to leave it like it was. Probably because I don't actually eat the crabs, but give them away, it would be easier for me if it was left as it is. If I had to pay the $1, it wouldn't really be a problem, though.
- I just believe that the resource is there for us to use. I don't believe licences should be imposed, not for crabs anyway.
- Because I wouldn't have a clue how they could possibly police it and if they are not going to police it would not be fair. I just can't imagine how they could police it.
- I pay enough now. I'm only a pensioner. How could it help me catch more crabs, when there are professional crabbing fishers coming between me and the marina with only one hundred metres from the right hand wall?
- How would it be administered? There must surely be a management strategy in place already, which should be supported financially by the professional fishers. I would query how the fees would be collected by the amateur fishers, I would think the administration costs of enforcing the $2 per person per trip would use up most of the funds raised.

- If I catch a few I am happy with that so I have no need to pay any fee. No, reason I am just not interested in that idea. That's all.
- I don't think they can control that. The only thing they can do would be to stop the amount that the professional fisherman take, that's my opinion. I can't see that this is a practical solution, and I am not wasting my money. Try and solve the problem with the Dolphins, which are the bait eaters. Fix that problem and maybe there might be a chance of amateurs scoring some crabs with some bait! I think they should take industry out of Cockburn. Because it is ruining a beautiful area. Go down there and take a look for yourself, I think that's enough.
- I reckon we can catch enough, if everyone just catches enough for a feed there would be no need to do this. I think personally I wouldn't have to do that to get enough crabs. That's all.
- Crabbing is really a pleasure, we live for the boating and fishing and all that. A daily fee I disagree with because as a family man, paying that fee per person would be too expensive, but a yearly license, a Cray license I could handle. Say fifteen dollars a year fee. That's all.
- Because I think we need a licence for crabbing and fishing. I just think there needs to be one recreational licence of a reasonable amount, say $25 per year, to cover both fishing and crabbing and then they could also take away the ramp fees. This per boat for 12 months. If they make it per person they would have to have concessions for pensioners and children.
- Because it doesn't bother me whether I get one crab or the allotted limit. I really don't care how many I get. It's fine for me. If there was a per person fee, I'd probably stop crabbing because I just do it for pleasure. I don't care if I catch any or not. I would probably agree to the point of a fee for the boat going out, but not per person.
- $2 isn't much, but what use do we have for three more crabs, and how would we get three more crabs? How would we pay it? Is it paid per year or each trip? It would be difficult to police, and cause trouble.
- I can't see the need for it. It is a seasonal thing. Sometimes there are heaps and heaps and next year there is not many. I suspect that there is not the research which would show that paying $3 would make a difference. I'm all for conservation measures, and if it could be shown that a strategy costing $3 per person would have some effect, I'd gladly pay it. It's not a matter of 50cents or $3.

Q41. (If unwilling to pay $2 or $3) **What daily trip fee would you be willing to pay to have a good chance at catching an extra *<u>(LOOK-UP VALUE**)</u>* crabs per trip on average?**

	Wave One		Wave Two	
	Count	**%**	**Count**	**%**
$1.00			1	4.2%
Nothing			22	91.7%
Other			1	4.2%
Total Respondents			**24**	**100.0%**

Demographics

Q40. Gender

	Wave One		Wave Two	
	Count	%	Count	%
Male	24	100.0%	54	93.1%
Female			4	6.9%
Total Respondents	**24**	**100.0%**	**58**	**100.0%**

Q41. Which of these age categories do you belong to?

	Wave One		Wave Two	
	Count	%	Count	%
20 to 29 years	1	4.2%	5	8.6%
30 to 39 years	6	25.0%	11	19.0%
40 to 49 years	2	8.3%	16	27.6%
50 to 59 years	5	20.8%	13	22.4%
60 to 69 years	7	29.2%	7	12.1%
70 years and over	3	12.5%	6	10.3%
Total Respondents	**24**	**100.0%**	**58**	**100.0%**

Q42. Which of the following best describes your situation?

	Wave One		Wave Two	
	Count	%	Count	%
Full time paid employment	9	37.5%	39	67.2%
Part time or casual paid employment	3	12.5%	4	6.9%
Unemployed, looking for work	1	4.2%	1	1.7%
Home duties			1	1.7%
Retired	8	33.3%	9	15.5%
Pensioner (disability, illness, age etc)	3	12.5%	4	6.9%
Total Respondents	**24**	**100.0%**	**58**	**100.0%**

Q43. What is your personal weekly income before tax?

	Wave One		Wave Two	
	Count	%	Count	%
Nil income			1	1.7%
($1 - $79 per week) $1 - $4,159	1	4.2%		
($80 - $159 per week) $4,160 - $8,319	1	4.2%	3	5.2%
($160 - $299 per week) $8,320 - $15,599	3	12.5%	5	8.6%
($300 - $499 per week) $15,600 - $25,999	2	8.3%	6	10.3%
($500 - $699 per week) $26,000 - $36,399	6	25.0%	4	6.9%
($700 - $999 per week) $36,400 - $51,999	3	12.5%	15	25.9%
($1,000 - $1,499 per week) $52,000 - $77,999	3	12.5%	14	24.1%
($1,500 - or more per week) $78,000 or more	2	8.3%	5	8.6%
Don’t know			1	1.7%
Refused	3	12.5%	4	6.9%
Total Respondents	**24**	**100.0%**	**58**	**100.0%**

Q44. Do you have any comments to make about recreational fishing in the Cockburn Sound fishery? (WAVE TWO COMMENTS ONLY

- No. But I am pleased to see people take an interest in it. Crabbing. In keeping it sustainable. With those organisations like yourself that are doing research about this, to keep the fishing going for years to come. Nah, that's all.
- We need more inspectors. I'm willing to pay two dollars per visit to pay for more inspectors. The people going snorkeling without a dive flag or some other visual identification is a problem, and is dangerous for people maneuvering their boats.
- Yes. A big comment. I would like to see all the professionals stop catching the female crabs, amateur and professional fishers. It doesn't matter what size they are, because it's for the future coming. We need to keep the females so we can still have crabs to fish for in the future. Nothing else, I am quite happy other than that. I like to go crabbing with my wife!. That's all.
- The drag nets used by professionals in the sound should be banned. Not only are they catching more numbers, but they destroying the eggs laid on the bottom. It is destroying the environment as well, once you agitate the weeds on the bottom of the sound the weeds are not happy.
- The characters in the sound using tangle nets are ruining the crabbing. They are destroying a lot of crabs because they are smashing the undersized crabs rather than taking the time to remove them gently.
- No. I think the fisheries department are doing a good job. With the rules and regulations they keep up with, making the area a lovely place to bring the family and a nice place to fish and try crabbing, which is what everyone needs to keep things flowing. That's all, I have no complaints or anything.
- They could limit the professionals, they could go further out, they are fishing it out.
- I think they are using this as a foot in the door to charge people for recreational fishing, it's a bad idea and I am opposed fully. Nothing else, I think I said all I need to.
- I think what you's people are doing is great, finding out all this stuff! It's good to see people care where these crabs are up to! And I think the idea of the trips are a great idea and will save people a lot of money. I like the fact that you can get more crabs, sounds exciting. Nothing else.

- It is the only place around, particularly to go diving from a boat.
- I'm pretty happy with it, the size and bag limits are well policed. This summer it has been difficult to reach the bag limits.
- It is more successful diving for crabs, using nets damages the eggs, and you have a problem of a shag following your boat and taking your bait or any crab thrown back in the water. usually I dive for crabs.
- It has been bad last season, and even worse this season. I think it has to do with the number of professionals which has seemed to increase in the last couple of seasons. There seem to be more crabs in Mandurah because there are less professionals there.
- I would pay the three dollars per trip only on condition that all that money goes towards maintaining the fishery.
- I would prefer an annual fee to a daily fee, daily fees are impossible to police, the money would not be paid or would be knocked off if an honour system was implemented. A daily fee would also cause frustration for fishers. The licence could be per boat, people free diving off the shore shouldn't have to pay it. I'm a very strong believer in leaving female crabs in the water, I think most people don't bother leaving them. The female is easy to identify, most people don't bother to the work happening in the Sound is damaging, the limestone groyne is damaging the shallow seagrass. I saw a lot less crabs in the Sound this year, and I attribute this to the works..
- A bad season, the pros are hitting it twice as much as everyone else is. People seem conscious of taking only what they want and putting the small ones back but it doesn't seem to be making a difference to the numbers. I always put the females back.
- It was good to have someone coming up to measure the crab we caught. I notice when I am down at Dawesville, some people come away with crabs which must be very close to undersized.
- I think if they are looking at that idea of increasing the crabs, it could be a good idea. For a cheap fee like that and getting a few extra crabs, I'd pay for that!. That's all.
- Cockburn Sound is a wonderful area, and gives a lot of enjoyment to a lot of people. People have become a lot better at keeping to size limits and bag limits and people will now report other people who they notice taking undersize crabs. A lot of people are keen to report Asians, because they have been used to having smaller crabs in their country of origin, but I think that will change soon with a couple of recent fines being given out. It won't take much to let every one have the message that undersized catches won't be tolerated.
- Just that the amount of crabs have actually dropped and the professional fisherman should not be in there crabbing. Nothing else.
- I am in full support of random checks on areas in and around Cockburn Sound to monitor amateur fishers catches, limits and sizes. I was more than happy to see the ranger out the other day, and would like to see more of them.
- Dredging in Cockburn Sound has to be stopped, if they think that destroying the grass and weed beds doesn't have a big effect on the squid, mussels and crabs then they need to think again. The grass beds are a place for the crabs to hide as well as feed. The long term effects of having professional fishers in the Cockburn Sound will be very detrimental. I strongly believe there needs to be a license introduced for crabbing, and the current bag limits are too high.
- Nothing really, but it would be nice to see how much the professional fisherman catch. That's all.
- I think there is still a few females getting whipped out of there, and maybe it's because people are taking them. And The Mussel farms. there is another three they have added there in the last three or four months and I don't know where they have come from. Near Garden Island and there is one near the Wheat Bin, it's a bulk handling terminal and there is another one on the Northern end of Garden Island. And I think there are a few near the Causeway end of town, two or three in there. I just wanted to know if they were going to

take over the Sound. Also, How about they put in some decent boat ramps so we can get in and out of there. That's all.

- It has been a bad season, perhaps the professional fishers are cleaning it out a bit, it is over fished by those fellows, although they have to earn a living, I suppose.
- I'd like to see more of the Voluntary fishing Inspectors to inspect the fishers who catch the under sized crabs. That's it. I'm all for abiding by the rules and I think those who don't stick by them should be stopped by these inspectors. Nothing else.
- Only there is too many skin divers that get all the crabs. That's all.
- In the last decade, the crabs have diminished in numbers. The area has been raped, people are taking undersized crabs and have no regard for the future.
- I reckon the pros are putting the females in an ice slurry when they are caught, and then released afterwards. This means that the eggs are frozen and killed. This is having an effect on the numbers of crabs at Cockburn Sound.
- Just keep it as it is. I think the dredgers could do with looking at because they destroy the sea grass in the Sound. Otherwise it's pretty good.
- Mainly the divers should be more regulated. They just swim down and grab them.[the crabs].. They swim alongside the pots and because the bait in the pots attracts the crabs, the divers swim along and pick them [the crabs] up before the crabs get into the pots. I don't know how they could be regulated, but what they do is very annoying and should be stopped.
- I think pollution and controlling of the existing environment is important. Maintaining the sea grass for the crabs to feed and breed is important.
- It's very pleasurable.
- I tend to think that the professionals are raping the Sound a bit. I think that if there are controls put on then it needs to be across the board.. I think that the limitations seem to be aimed at the recreational fishers where the professionals seem to get a relatively free hand.. No, I just think that if there are to be controls they should be aimed at everyone including the professionals.
- I want to relay an incident which happened recently at Cockburn Sound. I was crabbing 100 metres off from the right hand wall, when a professional crab fisher bloke comes between me and the rocks, and drops his pots. Why are they allowed so close? I would have thought that the limit in Cockburn Sound would have been 30 rather than 20. In Mandurah it makes sense that the limit is 20, because most of the crabs there have been bred in the estuary, but the Sound crabs have come in from the ocean. The Fisheries Dept are concentrating too much on the amateurs, and not enough on the professionals.
- Nothing. Only that I am a bit concerned about the amount of crabs left in the water, and I'm not sure if it's the progress of the professional fisherman's. Nothing else to say thanks.
- Yes. I would like to see the commercial Inspectors having a better check on the Professional Crabbers. I'm sure they are keeping a check on it all, but I haven't seen any visible proof that something is being done so there's a decent amount of crabs left for people like me who only do it for fun. I think the Fisheries Inspectors, just need to keep a closer eye on the amount of crabs they catch each round. Perhaps at this stage just stricter monitoring. That's all for now thanks.
- I certainly have. I think the sooner they get rid of the profession fisherman down there the better. Particularly Cockburn. Every time I go out there and get a good spot and come back another time to crab again, there are always a row of new nets there that the pro's have put up, they get all the crabs every time!. It just seems that the amateurs get hit for fishing. And a lot of the crabs now that the pro's catch go for fishing bait. Give the amateurs a go and get rid of the pro's I say. that's all.
- The catch seems down over recent years. I would question the impact and monitoring of professional crab fishers in the Sound. It seems to have been down over the last four years.
- Professional crab fishers should be concentrated on as well, decreasing professional boat limits and to monitor the sizes that they are taking.

- The professionals are working the area and I don't mind that, I understand that they have to make a living. The season has been very poor, and I don't really know the reason for that, I hear a lot of different theories about it. I understand the Cray fishing season has been low, and similar reasons for the Cray catch may be responsible for the crab catch the Leeuwin current having an effect is one theory I've heard.
- The crab limit should be brought down a little because I think there are too many crabs for too little people. I think the limit is fourty eight and I would like it down by at least ten or fifteen. Nothing else.
- Only that I think it is decreasing over the last five or six years with the amount of crabs. That's all.
- It is pretty healthy, the crabs. But there's always complaints about the professionals that take too many with their traps and nets. Nothing else. I think if everyone was responsible then we'd all be getting enough crabs each. That's it.
- Yes I do. I am not happy with the amount of the professional fishers in the Cockburn area. Their nets catch twenty four hours a day, and that's what I'm not happy with. If they piss all them off I'll be happy. Nothing else.
- First, I think they should ban scuba diving for crabs and crustaceans in Cockburn Sound.. Because it is too dangerous. Because a lot of them drift a long way away from their boats where their diving flags are displayed and I would say about 50% of them don't display diving flags at all. Also I believe they come and take crabs out of nets that people put down. They just cruise along, and there's no one to say what they are up to. And I think another issue is the jet skis who do disturb the crabs and fish and cut the fishing lines. They are a real annoyance. They should be confined to Shoal Water Bay. There are too many professional fishers fishing close to the entrance of Cockburn Sound. They just come too close where it is shallow and they net everything. Fish, crabs crustaceans, the lot. There was a case a few months ago where one went aground and that was in the reserve by Garden Island. So the question is what the hell was he doing there? They are there all the time. I am out every weekend so I see them all the time.
- The only comment I can make is one that applies to the allotted amount of crabs that people can take. The allotment that they have now needs to stay in force regardless of whether they charge extra fees or not.. I think that with the situation as I know it, if that allotment is sustainable then keep it. But then I guess that even that amount depends on the number people who come. If a lot more people started coming then that would have to influence the limit. If too many come then it gets over fished, but for the casual person I think it is a reasonable amount. If someone was going out daily and couldn't eat what they catch then I think it is really important to monitor that.
- No, I just enjoy it for the swim. I'd go for the swim regardless of the crabs.
- Cockburn Sound is where we prefer to go for our crabs. It is not as crowded as Mandurah, and so is more relaxing. It is nice being on the ocean. The Cockburn crabs taste better than the Mandurah crabs, the Mandurah crabs taste of water, we belong to the power boat club, and use their ramp. The public ramp next to the power boat club ramp is always very busy, and I'm glad I don't have to use that one.
- Professional fishers in Cockburn Sound should be kept offshore more, kept a couple of kilometres offshore, they are coming within a couple of hundred metres at the moment the professionals have an average of 100 pots each and there are 14 licences, so it is no wonder that this season has been so bad. This season has been as bad as any I've seen, last season wasn't good, but this is worse. I think the increase in professional fishers has a lot to do with it, plus the fact that the professionals aren't policed when it comes to being close to shore. There have been some spillages recently in the Sound, so pollution might also be partly to blame for the low numbers. But all in all, I think there are bad times ahead for the amateur crab fisher.
- I prefer to fish for crabs at Mandurah, I find it more peaceful and you can use scoops rather than drop nets. It is more relaxing to wade through the water than scoop from the jetty at Cockburn. I basically use my crab fishing at Cockburn to tell me when the crabs are big

enough and when they are running, and then go down to Mandurah. Plus I work at Cockburn, and knows what goes into the water, and wouldn't want to eat crabs from there.

Appendix 3: Logistic Regression Analysis of Willingness to Pay by Recreational Fishers

Logistic regression was performed to investigate the relationship between willingness to pay for additional crab bag limits and characteristics that may predict a recreational crab fisher's willingness to pay the proposed daily trip fee. The dependent variable is based on the notion that a respondent can answer yes (1) or no (0) to a suggested fee.

Hence the basic model is of the form P (Yes=1)= f{the daily trip fee, income, gender, age, distance travelled, number of trips, number and size of crabs, time taken to achieve the desired catch, etc The logistic regression it takes the following form: when only trip fee is included.

*Willingess to Pay (1=yes, 0=no) = Exp(b*Trip Fee + Constant*

The result of this model is given below.

Variables in the Equation

The proposed daily trip fee is significant (at the 005 level)and has the expected negative sign indicating that the higher the daily trip fee, the less likely a respondent will be willing to say 'yes" to a given fee.

The value of Exp(B) for the daily trip tree gives a measure of the proportional increase or decrease of the probability of willingness to pay. In the above results, for every dollar increase, the probability of the respondent being willing to pay the daily trip fee is decreased by 0.489. In other words, a respondent is 48.9% less likely to pay a $2 daily trip fee than a $1 daily trip fee.

The log likelihood describes the 'goodness of fit' of the model. Based on a chi-square (χ^2) distribution, the log likelihood gives an indication of how well the factors in the model (eg the value of the daily trip fee) explain the variation in values of the response variable (willingness to pay). To determine whether the goodness of fit is acceptable, the -2 Log Likelihood was compared to an expected χ^2 value given the degrees of freedom. There are 80 degrees of freedom in the base model above (82 respondents less 2 degrees of freedom in the model itself). In this case the observed z =1.62 .A value close to 0 (or a log likelihood value closer to 90) would indicate that the model was a very good fit. A value of 2 or higher would suggest a very poor model fit. Given the low number of respondents, it is difficult to achieve a better fitting model.

The survey was conducted in two waves. A test using logistic regression was carried out to test the hypothesis that the respondents from the two waves are significantly different to each other. This was done by adding a variable that represents which wave a respondent was interviewed into the model. As the trip fees presented to respondents was restricted in the second wave to values no higher than $3, the interaction between the interview wave and trip was also included as a variable in the model. The number of extra crabs on average per trip that the respondent would be likely to have the opportunity to catch was also included in the model as a further determinant of the possible differences between the two waves.

Variables in the Logistic Regression Equation

	B	S.E.	Wald	df	Sig.	Exp(B)
Wave	**-0.028**	**1.419**	**0.000**	**1**	**0.984**	**0.972**
Trip Fee	-0.652	0.329	3.932	1	0.047	0.521
Wave*Trip Fee	**-2.070**	**0.594**	**0.122**	**1**	**0.727**	**0.813**
Extra Crabs	-0.249	0.273	0.832	1	0.362	0.780
Constant	1.725	1.044	2.731	1	0.098	5.611

The significance values for interview wave (0.984) and the interaction between survey wave and trip fee (0.727) are not less than 0.05, the most common level used to decide significance. Hence the hypothesis that the groups of respondents from the two survey waves are different can be rejected.

The survey wave that the respondent participated in and also the interaction between the survey wave and the proposed daily trip fee are not statistically significant factors for explaining the variation in willingness to pay. That is, respondents in both waves are not statistically significantly different from each other in their overall opinion on this subject and hence the two waves can be combined together to form a single dataset and this dataset was used to estimate the willingness to pay regressions discussed above.

Factors that Explain Willingness to Pay

There were other explanatory (quantitative) variables considered as explanatory factors for a respondent's willingness to pay the daily trip fee. However only the trip fee was significant and none of the additional variables considered were significant.

Crabbing Habits

The number of crabbing trips made to Cockburn Sound, distance travelled, proportion of fishing trips a year that are for Cockburn Sound crabs and similar variables all proved to be not statistically significant when explaining willingness to pay the daily trip fee.

The number of extra crabs obtained for a nominated (daily trip fee) price also turned out to be not statistically significant. This indicates that the number of crabs associated with that price did not influence the probability of a respondent saying 'yes' to a nominated (daily trip fee) price.

Demographics

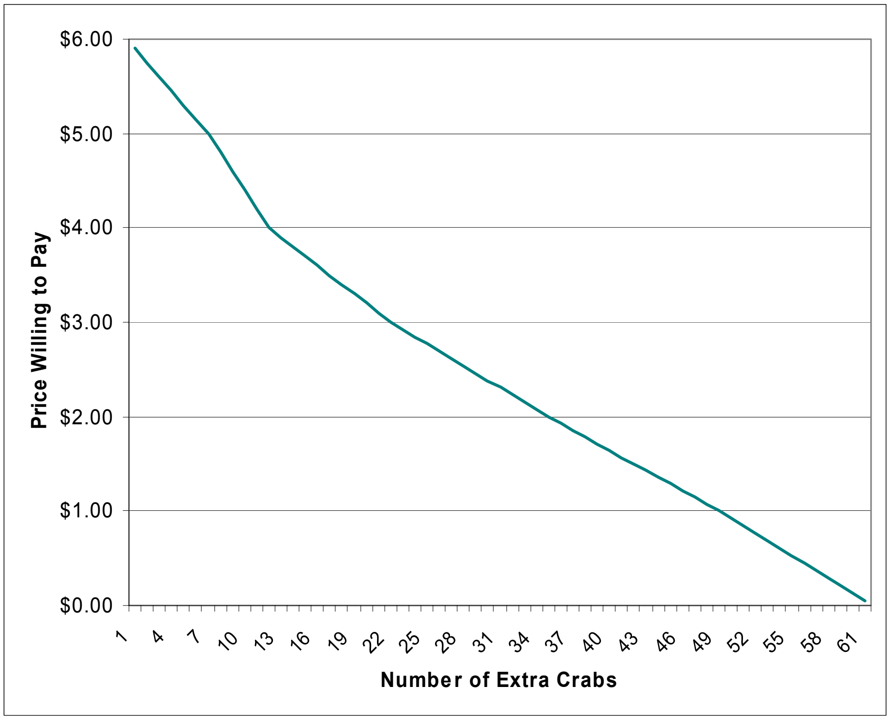
None of the demographic variables, that is age, income and labour force status, were statistically significant factors.

Derivation of Demand Function

A probability density function for the base model is graphed in the following figure. The gradient starts at a probability of 0.7 (to pay a daily trip fee of 50 cents), progresses constantly downward and then tapers off to a probability of less than 0.1 at around the $5 mark.

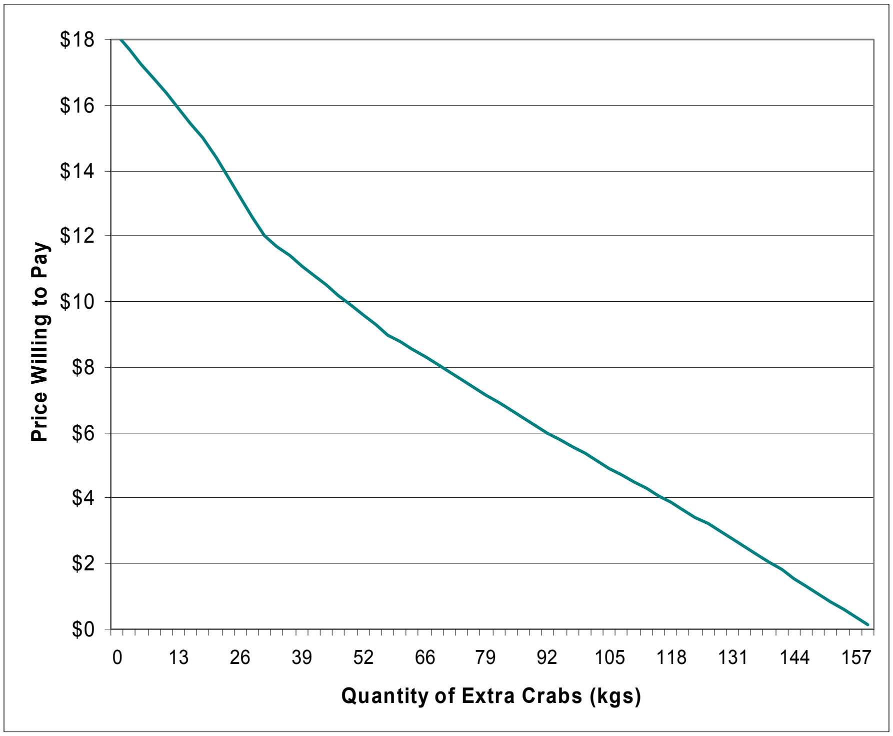
Probability of Willingness to Pay the Daily Trip Fee.

From the probability density function a demand function can be derived for the surveyed crab fishers. For example, there is a probability of 0.7 that a fisher will say 'yes' to a $0.50 daily trip fee. This means 0.7 of the 82 respondents to the survey, that is 57 fishers, can be expected to say 'yes', that is 57 extra crabs at $0.50 where a 'yes' response is interpreted as a 'yes' for a minimum one extra crab. This derived demand function for the survey group is shown in the figure below.



Extra crabs by daily trip fee for survey group.

The derived demand function for the survey group was scaled up to estimate the demand curve for the population of Cockburn Sound recreational crab fishers. The scaling up factor was based on the proportion that the survey groups last annual crab catches represented of the twenty tonne annual recreational crab catch estimated by the Fisheries Department of Western Australia. This demand function is shown in the following figure on a kilogram basis. (A conversion factor of three crabs to the kilogram was assumed.)



Population demand curve (kilos of crabs)

Appendix 4: Travel Cost Data

Travel cost models are a common approach to estimating recreation demand for activities (such as fishing) at a particular site. The basic premise underlying a travel cost model is that individual fishers access a fishing opportunity by paying a de facto access fee comprised of the money and time costs of travel. People living closest to the site will have the lower per access prices and will therefore tend to visit the site more frequently than those which live further away. That is because the access price as measured by the travel costs of a return trip to the site is higher for those living further away and they will 'demand' fewer trips.

This being the case there is an expected negative relationship between travel costs and trips per person. Once estimated this has all the feature of a conventional demand curve and can be used to determine price elasticity for demand. Adjusted for population in each distance zone, this can be the basis of an aggregated demand curve and the estimation of consumer surplus from access.

The implementation of the model is based on the assumption of a normally distributed spatial demographic of the population of potential recreational users to a site in a statistical sense. This type of modelling has been successfully in a variety of applications, especially for well-defined sites such as wildlife parks and reserves and lakes in the United States.

Travel cost data was collected as part of the survey of crab fishers in Cockburn Sound. The data collected from Cockburn Sound recreational crab fishers are presented in Appendix 2. Data was collected on distances travelled, on the various costs, including transport costs, incurred for an average per trip to fish for crab in Cockburn Sound, and the number of crab fishing trips to Cockburn Sound in the last twelve months.

Analysis of these data indicated the travel cost model is not appropriate for the Cockburn Sound crab fishers. Basic statistical analysis (correlation and regression) was applied to appropriate variable in the data set to determine whether there was any statistically significant relationship between the distance travelled per crab fishing trip, the cost per trip and the number of trips made by fishers. Correlation with some key socio economic variables like income was also tested. These variables are the ones expected to be significant in any travel cost model.

Our correlation and regression analysis did not indicate any statistically significant relationship present in the travel cost data set. The correlation analysis results are shown in the following table.

Correlations

		Trips per year Cockburn Sound	% trips to Cockburn Sound	Kms to Fishing Trip to Cockburn Sound	Transport Cost per trip	Parking and Boat Fees per trip	Income
Trips per year Cockburn Sound	Pearson Correlation	1	.428**	-.046	.002	-.154	-.078
	Sig. (2-tailed)	.	.000	.684	.989	.167	.484
	N	82	82	82	82	82	82
% trips to Cockburn Sound	Pearson Correlation	.428**	1	.043	-.103	.023	.141
	Sig. (2-tailed)	.000	.	.703	.355	.837	.206
	N	82	82	82	82	82	82
Kms to Fishing Trip to Cockburn Sound	Pearson Correlation	-.046	.043	1	.477**	.021	-.142
	Sig. (2-tailed)	.684	.703	.	.000	.850	.202
	N	82	82	82	82	82	82
Transport Cost per trip	Pearson Correlation	.002	-.103	.477**	1	-.019	-.076
	Sig. (2-tailed)	.989	.355	.000	.	.867	.500
	N	82	82	82	82	82	82
Parking and Boat Fees per trip	Pearson Correlation	-.154	.023	.021	-.019	1	-.062
	Sig. (2-tailed)	.167	.837	.850	.867	.	.579
	N	82	82	82	82	82	82
Income	Pearson Correlation	-.078	.141	-.142	-.076	-.062	1
	Sig. (2-tailed)	.484	.206	.202	.500	.579	.
	N	82	82	82	82	82	82

**. Correlation is significant at the 0.01 level (2-tailed).

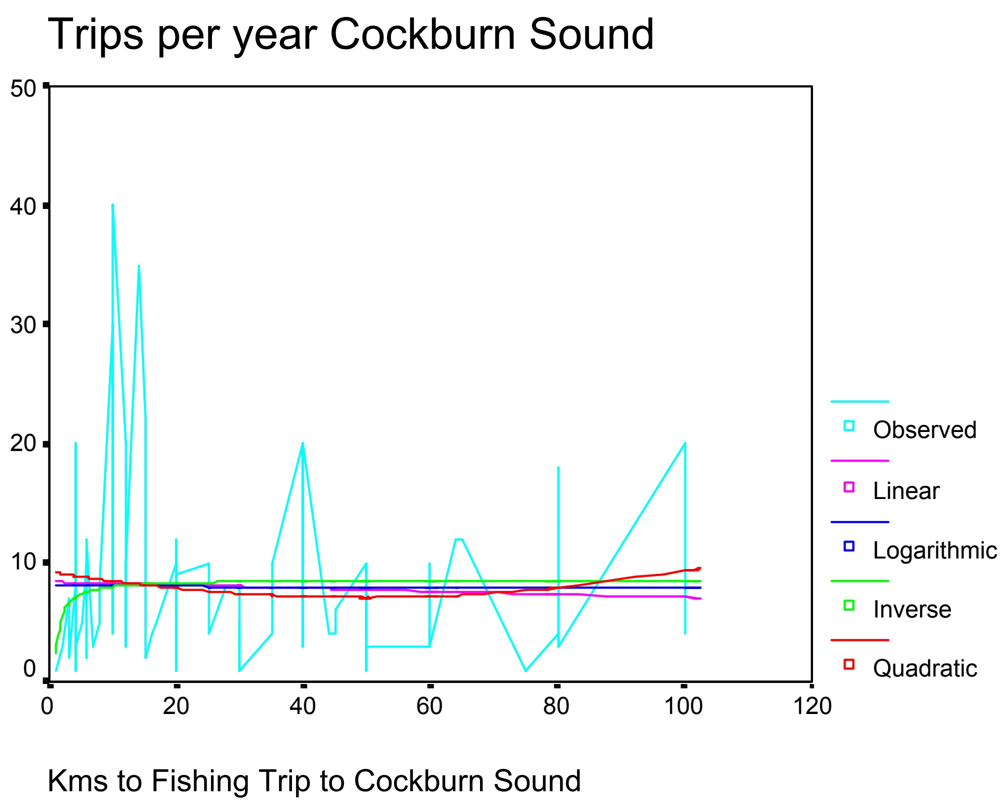
Number of trips per year is not significantly correlated with distance (kms), transport cost per trip nor associated costs in the form of parking and boat fees. This suggests that a meaningful travel cost model does not exist in this case. The R-square tests of the regressions between number of trips and these variables had values of around 0.10 and 0.15 with no statistically significant independent variables. There were some clear outliers in the data but even with these outlying observations excluded the R-square values were around 0.20 and the resultant relationship was not statistically significant. A summary of the actual trips data is presented in the figure below.

In the light of these results it was concluded that a travel cost model was not appropriate for the Cockburn Sound Crab Fishery.

Further consideration of the characteristics of this fishery indicates that this not surprising. Travel Cost Models are most appropriate in circumstances where there is a normal distribution relative to the spatial demographic of the population of potential recreational consumers of a natural resource site and the population of users is spread over a significant distance. In this fishery, the survey population was concentrated in close locational proximity to the Cockburn Sound site. Consequently, there was not a great variation in travel distances and hence in expected cost per trip. Most respondents lived with 15 to 30 minutes of the site.

Where travel cost modelling applies, the presence of alternatives sites is important. When such sites are available they usually have to be modelled explicitly as substitutes and their availability will affect demand by people at varying distances from the site of interest.

Alternative sites to the case study fishery exist at the Swan River, the Peel-Harvey Inlet or Geographe Bay. However inclusion of these sites would not be expected to have any profound impact on the results because the potential recreational users to these sites, especially the Swan River and Peel Harvey are still likely to come from Perth and are concentrated within a very narrow distance and travel cost range. This may well be true to many Western Australian fisheries given the State's population demographics and the concentration of population of people in Perth.



Appendix 5: Cockburn Sound Commercial Fishing Survey

We are seeking information regarding your business's financial accounts and crabbing activities in the Cockburn Sound Crab Fishery. All figures should relate to the 2000/01 financial year and encompass as far as possible the 2000/01 crabbing season, namely December 2000 to September 2001.

Your information will be treated in the strictest of confidence. The data will be aggregated with that provided by other licensed crab fishermen in Cockburn Sound and used by the research team for aggregate statistical analysis only. Individual questionnaire responses will not be stored and will be used for the purposes of the research project only; that is they will not be released or the content divulged to any other party. We would be happy to make a copy of the outcome of the data analysis available before it is published to those commercial fishermen who participate.

If you have any queries regarding the survey, please contact John Nicholls at Economics Research Associates on 9386 2464.

Please complete the questionnaire by ticking boxes or providing the requested details where indicated. Please return your completed questionnaire in the enclosed reply paid envelope (addressed to Data Analysis Australia, PO Box 3258, Broadway Nedlands, WA, 6009) by **Friday 21st December 2001.** Completed questionnaires marked for Rebecca Gordon's attention can also be faxed to (08) 9386 3202.

1. BUSINESS ENTERPRISE

Q1 What is the business enterprise structure for activities in the Cockburn Sound Commercial Crab Fishery? *(Please tick one box only.)*

- Sole trader .... ☐.1
- Family Partnership....... ☐.2
- Other Partnership .... ☐.3
- Incorporated Company ☐.4
- Other(please specify) ________________________ ☐.( )

Q2 How many crew and others are employed by this business enterprise for activities in the Cockburn Sound Commercial Crab Fishery? Include owner/operator if they draw salary payments.

		Number of Employees
Crew:	Full Time	
	Part Time	
	Casual	
Other employee	Full Time	

s:	Part Time	
	Casual	
Total:		

Q3 Please indicate the closing date of the financial year for the business enterprise mentioned in Question 1: / /

2. BUSINESS ENTERPRISE INCOME

Q4a What percentage of the <u>annual income</u> for the business enterprise mentioned in Q1 is derived from commercial fishing activities? %

Q4b What percentage of this is attributable to Cockburn Sound crabs? %

Q5 Please provide the following income details for the business enterprise you mentioned in Q1. If the Cockburn Sound crabs are sold at different places, please indicate the different prices, quantity and total income received for each point of sale.

Cockburn Sound crabs:	(1) **Quantity** (kg liveweight)	(2) **Price Received** ($ per kg liveweight)	(3) **Point of Sale** (eg. factory door, beach, wharf, etc)	(4) **Total Income** (Qty * Price)	
Caught and sold	kg	$		$	(a)
	kg	$		$	(b)
Purchased from others and sold	kg	$		$	(c)
	kg	$		$	(d)
Sold on behalf of others	kg	$		$	(e)
	kg	$		$	(f)
Other (please specify) ____________	kg	$		$	(g)

3. COSTS INCURRED

Q6 Please specify in the table below the costs incurred in the Cockburn Sound crab catching activities. *(**NOTE**: Where Cockburn Sound crab catching activities are only a part of the total business activities, please apportion costs for the business enterprise as appropriate. Best estimates will suffice. Not every box needs to be completed, just those where costs have been incurred.)*

	Cockburn Crab Fishery				Business Enterprise Total
	Catching	**Processing**	**Distribution & Marketing**	**Total**	
(a) Boat Fuel	$	$	$	$	$
(b) Vehicle Fuel	$	$	$	$	$
(c) Wage and salary payments (include owner/operator)	$	$	$	$	$
(d) Bait	$	$	$	$	$
Repairs and Maintenance:					
(e) Boats	$	$	$	$	$
(f) Pots	$	$	$	$	$
(g) Other fishing gear & equipment	$	$	$	$	$
(h) Vehicles	$	$	$	$	$
(i) Premises	$	$	$	$	$
(j) Other equipment	$	$	$	$	$
Depreciation:					
(k) Boats	$	$	$	$	$
(l) Pots	$	$	$	$	$
(m) Other fishing gear & equipment	$	$	$	$	$
(n) Vehicles	$	$	$	$	$
(o) Premises	$	$	$	$	$
(p) Other equipment	$	$	$	$	$
(q) Insurance	$	$	$	$	$
(r) License Fees (inc. Transport & Fisheries)	$	$	$	$	$
(s) Interest Payments	$	$	$	$	$
Lease payments:					
(t) Boats: Lease Rate ________________	$	$	$	$	$
(u) Pots: Lease Rate ________________	$	$	$	$	$

(v)	Other ____________________________ Lease Rate ________________________	$	$	$	$	$
(w)	Rental payments on premises	$	$	$	$	$
(x)	Rates and taxes on premises	$	$	$	$	$
(y)	Electricity, Gas and Water	$	$	$	$	$
(z)	Packaging for processing	$	$	$	$	$
(aa)	Office Administration costs	$	$	$	$	$
(bb)	Payroll tax, banking, accountant fees, etc	$	$	$	$	$
(cc)	Stationary, postage, couriers, etc	$	$	$	$	$
(dd)	Telephone, facsimile, internet access	$	$	$	$	$
	Other (*please specify item if more than 10% of total costs*):					
(ee)	Item: ______________________________	$	$	$	$	$
(ff)	Item: ______________________________	$	$	$	$	$
(gg)	TOTAL					

4. CRAB DISTRIBUTION AND MARKETING ACTIVITIES

Q7 On average, what percentage of your Cockburn Sound crab catch did you sell green or processed? (Include catch obtained from other fishers as well.)

Green	%	(a)
Processed	%	(b)
Total	**100 %**	

Q8 On average, what percentage of your Cockburn Sound crab catch is sold directly to the following?

Processor	%	(a)
Wholesaler/distributor	%	(b)
Retailer (including restaurants)	%	(c)

Other *(please specify: ______________________________)* | % | (d)

Total **100 %**

5. CRAB PROCESSING

Q9a	**What quantity of your caught Cockburn Sound crabs were consigned to another party for processing on your behalf?**	kg
Q9b	**What was the total processing cost to the business enterprise of the Cockburn Sound crab catch which was consigned to another party for processing on your behalf?**	$

6. OWNER/OPERATORS TIME

Q10a	**How much of the owner/operator's time is spent on crab fishing in Cockburn Sound not covered by wage and salary payments given in Q6?**	hrs
Q10b	**How much of the owner/operator's time is spent in the management of the business specified in Q1?**	hrs
Q10c	**What percentage of owner/operator time spent on management (Q10b) is attributable to Cockburn Sound crab business activities?**	%

7. EQUIPMENT USED

Q11 Please specify in the following questions details of equipment used in Cockburn Sound crab business activities during the 2000/01 season.

Item	Description	(1) Replacement Cost	(2) Expected Life	(3) % Attributable to Cockburn Sound crab fishing activities
a) Boats		$	yrs	%
b) Dinghies & Outboard Motors		$	yrs	%
c) Pots	Number of pots:	$	yrs	%
d) Vehicles	Make:_________________________ Model: ________________ Year: _______	$	yrs	%
	Make:_________________________ Model: ________________ Year: _______	$	yrs	%
e) Other fishing gear & equipment		$	yrs	%
		$	yrs	%
f) Land (at current market value)		$	yrs	%
g) Buildings		$	yrs	%
h) Other equipment		$	yrs	%
		$	yrs	%
		$	yrs	%
		$	yrs	%

Appendix 6: Retailing Survey Questionnaire

Fishing Research and Development Corporation Funded
Economic Research Project (2001/065)
Cockburn Sound Crab Case Study
Retailing Questionnaire

Note:
Information you provide will be treated in the strictest of confidence and used for aggregate and statistical purposes only. You data will be used for the purposes of the project only and the data will not be released or divulged to any other party.

Q1 Business Details

(a) Name ______________________

(b) Telephone ( ) ______________________

(c) Contact Person ______________________

Q2 Cockburn Sound Cooked Crab – Retail Sales

Could you please select any week in each of the months from December 2001 to June 2002 when you offered Cockburn Sound Crab for sale, and for each of these weeks provide daily quantity and price information in the table below

- ***Data for weeks when the crab were in short or plentiful supply would be most helpful***

Day	December		January		February		March		April		May		June	
	Qty Sold (kg)	Daily Price ($/kg)	Qty Sold (kg)	Daily Price ($/kg)	Qty Sold (kg)	Daily Price ($/kg)	Qty Sold (kg)	Daily Price ($/kg)	Qty Sold (kg)	Daily Price ($/kg)	Qty Sold (kg)	Daily Price ($/kg)	Qty Sold (kg)	Daily Price ($/kg)
1														
2														
3														
4														
5														
6														
7														

Could you please return the completed questionnaire in the provided reply paid envelope

If you have any queries could you please contact John Nicholls on **9386 2464 (ERA)**

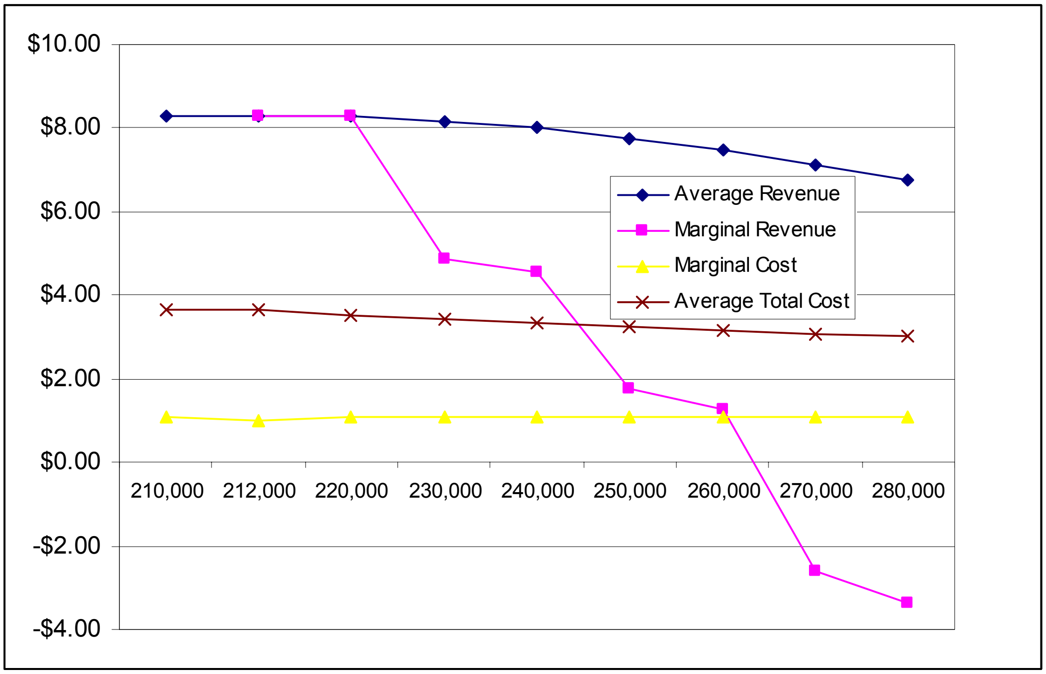
Appendix 7: Industry Cost and Revenue Data

The table below shows the basic cost and revenue data for commercial crab fishing as estimated from the available data. The cost and revenue curves are plotted in the associated figure.

Cost and Revenue Data

Catch (kgs)	Price	Total Cost	Average Total Cost	Variable Cost	Average Variable cost	Marginal Cost
210,000	$8.30	$768,080	$3.66	$224,806	$1.07	$1.08
212,000	$8.30	$770,220	$3.63	$226,840	$1.07	$1.02
220,000	$8.30	$778,674	$3.54	$235,400	$1.07	$1.07
230,000	$8.15	$789,374	$3.43	$246,100	$1.07	$1.07
240,000	$8.00	$800,074	$3.33	$256,800	$1.07	$1.07
250,000	$7.75	$810,774	$3.24	$267,500	$1.07	$1.07
260,000	$7.50	$821,474	$3.16	$278,200	$1.07	$1.07
270,000	$7.13	$832,174	$3.08	$288,900	$1.07	$1.07
280,000	6.75	$842,874	$3.01	$299,600	$1.07	$1.07
Catch (kgs)	**Price**	**Total Revenue**	**Average Revenue**	**Marginal Revenue**		
210,000	$8.30	$1,743,000	$8.30			
212,000	$8.30	$1,759,600	$8.30	$8.30		
220,000	$8.30	$1,826,000	$8.30	$8.30		
230,000	$8.15	$1,874,500	$8.15	$4.85		
240,000	$8.00	$1,920,000	$8.00	$4.55		
250,000	$7.75	$1,937,500	$7.75	$1.75		
260,000	$7.50	$1,950,000	$7.50	$1.25		
270,000	$7.13	$1,923,750	$7.13	-$2.62		
280,000	6.75	$1,890,000	$6.75	-$3.38		

Average Revenue, Marginal Revenue and Average Total Cost and Marginal Cost



Appendix 8: Net Benefits From Commercial Activity

Net Benefits From Commercial Activity

Catch Quantity (kgs)	Quantity Sold Locally (kgs)	Retail Consumer Surplus ($)	Producer Surplus ($)	Aggregate of Retail Consumer Surplus and Producer Surplus ($)	Aggregate Unit		
					Consumer Surpluses $/kg	Producer Surpluses $/kg	Commercial Use $/kg
(1)	(2)	(3)	(4)	(5) = (3)+(4)	(6) = $^{(3)}/_{(2)}$	(7) = $^{(4)}/_{(1)}$	(8) = $^{(5)}/_{(1)}$
210,000	75,103	414,276	1,520,470	1,934,746	5.52	7.24	9.21
220,000	77,487	432,271	1,585,730	2,018,001	5.58	7.21	9.17
230,000	79,870	450,267	1,632,470	2,082,737	5.64	7.10	9.06
240,000	85,000	488,998	1,660,690	2,149,688	5.75	6.92	8.96
250,000	92,800	547,888	1,670,390	2,218,278	5.90	6.68	8.87
260,000	101,250	611,686	1,661,570	2,273,256	6.04	6.39	8.74
270,000	113,440	703,720	1,634,230	2,337,950	6.20	6.05	8.66
280,000	125,304	793,293	1,588,370	2,381,663	6.33	5.67	8.51

Appendix 9: Marginal Net Benefits From Commercial and Recreational Use

Marginal Net Benefits from Recreational and Commercial Use per Additional Kg Allocated

Catch Quantity (kgs)	Quantity Sold Locally (kgs)	Additional Quantity Allocated to Recreational Sector (kgs)	Aggregate Recreational Consumer Surplus from Additional Allocation ($)	Retail Consumer Surplus ($)	Producer Surplus ($)	Aggregate of Retail Consumer Surplus and Producer Surplus ($)	Marginal Recreational Consumer Surplus ($/per kg) (a)	Marginal Surplus from Commercial Activity ($/per kg) (b)
210,000	75,103	201	1,686	414,276	1,520,470	1,934,746		
220,000	77,487	196	1,660	432,271	1,585,730	2,018,001	5.19	8.33
230,000	79,870	191	1,633	450,267	1,632,470	2,082,737	5.24	6.47
240,000	85,000	186	1,607	488,998	1,660,690	2,149,688	5.29	6.70
250,000	92,800	181	1,580	547,888	1,670,390	2,218,278	5.35	6.86
260,000	101,250	176	1,553	611,686	1,661,570	2,273,256	5.41	5.50
270,000	113,440	171	1,526	703,720	1,634,230	2,337,950	5.47	6.47
280,000	125,304	166	1,498	793,293	1,588,370	2,381,663	5.53	4.37

- The marginal recreational consumer surpluses (or the marginal net benefit) for extra crabs equal the change in the aggregate recreational surpluses from additional allocation divided by the additional quantity allocated to recreational use. For example, 1686 – 1660/201-196 = $5.19/kg

- The marginal surpluses (or marginal net benefits) from additional commercial use equals the change in aggregate retail and producer surpluses divided by the additional catch. For example, $2018001 - $1,934,746/220,000 – 210,000 = $8.33 per kg

Appendix 10: Producer and Consumer Surplus at 280,000 kgs of Catch

Producer and Consumer Surplus for Commercial Activity at 280,000 Kgs of Catch

Catch Quantity	Local Quantity	Retail Consumer Surplus from Current Allocation	Marginal Retail Consumer Surplus	Producer Surplus from Current Catch	Marginal Producer Surplus	Aggregate Surplus
280,000	125,304	480,903		1,588,370		2,069,273
280,005	125,309	480,926	4.59	1,588,342	-5.51	2,069,269
280,010	125,314	480,949	4.59	1,588,315	-5.51	2,069,264
280,015	125,319	480,972	4.58	1,588,287	-5.51	2,069,260
280,020	125,324	480,995	4.58	1,588,260	-5.52	2,069,255
280,025	125,329	481,018	4.58	1,588,232	-5.52	2,069,250
280,030	125,334	481,041	4.58	1,588,205	-5.52	2,069,246
280,035	125,339	481,064	4.58	1,588,177	-5.52	2,069,241
280,040	125,344	481,087	4.58	1,588,149	-5.52	2,069,236
280,045	125,349	481,110	4.58	1,588,122	-5.52	2,069,231
280,050	125,354	481,133	4.58	1,588,094	-5.52	2,069,227
280,055	125,359	481,156	4.58	1,588,067	-5.52	2,069,222
280,060	125,364	481,178	4.58	1,588,039	-5.52	2,069,217
280,065	125,369	481,201	4.58	1,588,011	-5.52	2,069,213
280,070	125,374	481,224	4.58	1,587,984	-5.52	2,069,208
280,075	125,379	481,247	4.58	1,587,956	-5.53	2,069,203
280,080	125,384	481,270	4.58	1,587,928	-5.53	2,069,199
280,085	125,389	481,293	4.58	1,587,901	-5.53	2,069,194
280,090	125,394	481,316	4.58	1,587,873	-5.53	2,069,189
280,095	125,399	481,339	4.58	1,587,846	-5.53	2,069,184
280,100	125,404	481,362	4.58	1,587,818	-5.53	2,069,180
280,105	125,409	481,385	4.58	1,587,790	-5.53	2,069,175
280,110	125,414	481,407	4.58	1,587,763	-5.53	2,069,170
280,115	125,419	481,430	4.58	1,587,735	-5.53	2,069,165
280,120	125,424	481,453	4.58	1,587,707	-5.53	2,069,160
280,125	125,429	481,476	4.58	1,587,680	-5.53	2,069,156
280,130	125,434	481,499	4.58	1,587,652	-5.54	2,069,151
280,135	125,439	481,522	4.58	1,587,624	-5.54	2,069,146
280,140	125,444	481,545	4.58	1,587,597	-5.54	2,069,141
280,145	125,449	481,568	4.58	1,587,569	-5.54	2,069,136
280,150	125,454	481,590	4.57	1,587,541	-5.54	2,069,132
280,155	125,459	481,613	4.57	1,587,513	-5.54	2,069,127
280,160	125,464	481,636	4.57	1,587,486	-5.54	2,069,122
280,165	125,469	481,659	4.57	1,587,458	-5.54	2,069,117
280,170	125,474	481,682	4.57	1,587,430	-5.54	2,069,112
280,175	125,479	481,705	4.57	1,587,403	-5.54	2,069,107
280,180	125,484	481,728	4.57	1,587,375	-5.54	2,069,103
280,185	125,489	481,751	4.57	1,587,347	-5.55	2,069,098

280,190	125,494	481,773	4.57	1,587,319	-5.55	2,069,093
280,195	125,499	481,796	4.57	1,587,292	-5.55	2,069,088
280,200	125,504	481,819	4.57	1,587,264	-5.55	2,069,083

Producer and Consumer Surplus for Commercial Activity at 240,000 Kgs of Catch

Catch Quantity	Local Quantity	Retail Consumer Surplus from Current Allocation	Marginal Retail Consumer Surplus	Producer Surplus from Current Catch	Marginal Producer Surplus	Aggregate Surplus
240,000	85,000	208,447		1,660,690		1,869,137
240,005	85,005	208,497	9.96	1,660,699	1.90	1,869,196
240,010	85,010	208,547	9.96	1,660,709	1.89	1,869,256
240,015	85,015	208,597	9.96	1,660,718	1.89	1,869,315
240,020	85,020	208,646	9.96	1,660,728	1.89	1,869,374
240,025	85,025	208,696	9.96	1,660,737	1.89	1,869,434
240,030	85,030	208,746	9.96	1,660,747	1.89	1,869,493
240,035	85,035	208,796	9.96	1,660,756	1.89	1,869,552
240,040	85,040	208,846	9.96	1,660,766	1.89	1,869,611
240,045	85,045	208,895	9.96	1,660,775	1.89	1,869,671
240,050	85,050	208,945	9.95	1,660,785	1.89	1,869,730
240,055	85,055	208,995	9.95	1,660,794	1.89	1,869,789
240,060	85,060	209,045	9.95	1,660,803	1.89	1,869,848
240,065	85,065	209,094	9.95	1,660,813	1.88	1,869,907
240,070	85,070	209,144	9.95	1,660,822	1.88	1,869,966
240,075	85,075	209,194	9.95	1,660,832	1.88	1,870,026
240,080	85,080	209,244	9.95	1,660,841	1.88	1,870,085
240,085	85,085	209,293	9.95	1,660,850	1.88	1,870,144
240,090	85,090	209,343	9.94	1,660,860	1.88	1,870,203
240,095	85,095	209,393	9.94	1,660,869	1.88	1,870,262
240,100	85,100	209,443	9.94	1,660,879	1.88	1,870,321
240,105	85,105	209,492	9.94	1,660,888	1.88	1,870,380
240,110	85,110	209,542	9.94	1,660,897	1.88	1,870,439
240,115	85,115	209,592	9.94	1,660,907	1.88	1,870,498
240,120	85,120	209,641	9.94	1,660,916	1.87	1,870,558
240,125	85,125	209,691	9.94	1,660,926	1.87	1,870,617
240,130	85,130	209,741	9.94	1,660,935	1.87	1,870,676
240,135	85,135	209,790	9.93	1,660,944	1.87	1,870,735
240,140	85,140	209,840	9.93	1,660,954	1.87	1,870,794
240,145	85,145	209,890	9.93	1,660,963	1.87	1,870,853
240,150	85,150	209,939	9.93	1,660,972	1.87	1,870,912
240,155	85,155	209,989	9.93	1,660,982	1.87	1,870,971
240,160	85,160	210,039	9.93	1,660,991	1.87	1,871,030
240,165	85,165	210,088	9.93	1,661,000	1.87	1,871,089
240,170	85,170	210,138	9.93	1,661,010	1.86	1,871,148
240,175	85,175	210,188	9.93	1,661,019	1.86	1,871,207
240,180	85,180	210,237	9.92	1,661,028	1.86	1,871,265
240,185	85,185	210,287	9.92	1,661,038	1.86	1,871,324
240,190	85,190	210,336	9.92	1,661,047	1.86	1,871,383
240,195	85,195	210,386	9.92	1,661,056	1.86	1,871,442
240,200	85,200	210,436	9.92	1,661,065	1.86	1,871,501

Producer and Consumer Surplus for Commercial Activity at 212,000 Kgs of Catch

Catch Quantity	Local Quantity	Retail Consumer Surplus from Current Allocation	Marginal Retail Consumer Surplus	Producer Surplus from Current Catch	Marginal Producer Surplus	Aggregate Surplus
212,000	75,103	96,823		1,535,004		1,631,826
212,005	75,108	96,886	12.76	1,535,039	7.08	1,631,925
212,010	75,113	96,950	12.76	1,535,074	7.08	1,632,025
212,015	75,118	97,014	12.76	1,535,110	7.08	1,632,124
212,020	75,123	97,078	12.76	1,535,145	7.08	1,632,223
212,025	75,128	97,142	12.76	1,535,181	7.08	1,632,322
212,030	75,133	97,205	12.76	1,535,216	7.08	1,632,421
212,035	75,138	97,269	12.75	1,535,251	7.08	1,632,520
212,040	75,143	97,333	12.75	1,535,287	7.07	1,632,620
212,045	75,148	97,397	12.75	1,535,322	7.07	1,632,719
212,050	75,153	97,460	12.75	1,535,357	7.07	1,632,818
212,055	75,158	97,524	12.75	1,535,393	7.07	1,632,917
212,060	75,163	97,588	12.75	1,535,428	7.07	1,633,016
212,065	75,168	97,652	12.74	1,535,464	7.07	1,633,115
212,070	75,173	97,715	12.74	1,535,499	7.07	1,633,214
212,075	75,178	97,779	12.74	1,535,534	7.07	1,633,313
212,080	75,183	97,843	12.74	1,535,570	7.07	1,633,412
212,085	75,188	97,906	12.74	1,535,605	7.07	1,633,511
212,090	75,193	97,970	12.74	1,535,640	7.07	1,633,610
212,095	75,198	98,034	12.73	1,535,676	7.06	1,633,709
212,100	75,203	98,097	12.73	1,535,711	7.06	1,633,808
212,105	75,208	98,161	12.73	1,535,746	7.06	1,633,907
212,110	75,213	98,225	12.73	1,535,781	7.06	1,634,006
212,115	75,218	98,288	12.73	1,535,817	7.06	1,634,105
212,120	75,223	98,352	12.73	1,535,852	7.06	1,634,204
212,125	75,228	98,416	12.72	1,535,887	7.06	1,634,303
212,130	75,233	98,479	12.72	1,535,923	7.06	1,634,402
212,135	75,238	98,543	12.72	1,535,958	7.06	1,634,501
212,140	75,243	98,606	12.72	1,535,993	7.06	1,634,600
212,145	75,248	98,670	12.72	1,536,028	7.06	1,634,698
212,150	75,253	98,734	12.71	1,536,064	7.05	1,634,797
212,155	75,258	98,797	12.71	1,536,099	7.05	1,634,896
212,160	75,263	98,861	12.71	1,536,134	7.05	1,634,995
212,165	75,268	98,924	12.71	1,536,170	7.05	1,635,094
212,170	75,273	98,988	12.71	1,536,205	7.05	1,635,193
212,175	75,278	99,051	12.71	1,536,240	7.05	1,635,291
212,180	75,283	99,115	12.70	1,536,275	7.05	1,635,390
212,185	75,288	99,178	12.70	1,536,311	7.05	1,635,489
212,190	75,293	99,242	12.70	1,536,346	7.05	1,635,588
212,195	75,298	99,305	12.70	1,536,381	7.05	1,635,686
212,200	75,303	99,369	12.70	1,536,416	7.05	1,635,785

A Socio-Economic Valuation of Resource Allocation Options between Recreational and Commercial Sectors

FRDC Project 2001/065

Part Three
THE PERTH ABALONE FISHERY CASE STUDY WESTERN AUSTRALIA

Dr P McLeod and J Nicholls

Economic Research Associates

Australian Government

Fisheries Research and Development Corporation

A Socio-Economic Valuation of Resource Allocation Options between Recreational and Commercial Sectors

Dr P. McLeod[1] and J. Nicholls[2]

The Fisheries Research and Development Corporation plans, invests in and manages fisheries research and development throughout Australia. It is a federal statutory authority jointly funded by the Australian Government and the fishing industry.

Key Words: Fisheries Economics; resource allocation; evaluation framework; socially optimal allocations

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Nedlands, Perth, Western Australia
September 2004

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[2] Research Associate, Economic Research Associates. Recently retired Executive Level Agricultural and Fisheries policy advisor to the Australian and Western Australian Governments.

SOCIO-ECONOMIC VALUATION OF RESOURCE ALLOCATION OPTIONS BETWEEN RECREATIONAL AND COMMERCIAL SECTORS

THE REPORT

The report is presented in four parts. These parts are as follows:

Part One: The General Theoretical Framework;
Part Two: The Western Australian Cockburn Sound Crab Fishery Case Study;
Part Three: The Perth Abalone Fishery Case Study; and
Part Four: The West Coast Wetline Fishery Case Study.

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This study was greatly assisted by:

- The joint contribution from Guy Leyland (Western Australian Fishing Industry Council), Frank Prokop (Recfishwest), and Peter Rogers, Dr Rick Fletcher and Neil Sumner (Fisheries Department of Western Australia) through their participation as members of the Interested Parties Consultative Group formed for this project;

- The cooperation of recreational fishers as well as commercial fishers and post harvest operators in our endeavors to discover the required socio-economic data;

- Our associates at Data Analysis Australia, Dr John Henstridge, Jodie Thompson and Rebecca Gordon, for their practical guidance in survey design and the evaluation and choice of data collection methods, assistance with survey data collection and analysis, and their perseverance with our supplementary data demands as we developed the analysis; and

- Carole Lefort and Terri Burgess who provided typing and secretarial support to this project.

The achievements that have been made in this case study are in no small way attributable to the contribution and support they have provided. For this support and assistance we are most grateful.

FOREWORD

This case study is part of a wider project focused on ‘socio-economic’ valuation methodologies for evaluating resource allocation options between commercial and recreational use of fish resources. It is the second of three case studies to demonstrate the practical application of socio-economic valuation methodologies within a general theoretical framework. The framework was developed as the first stage of the project.

The general theoretical framework was formulated in terms of use values associated with fishing activity. These values focus on the uses of the fish resource by commercial or recreational fishers. The framework identifies appropriate values needed to enable meaningful comparisons between these uses that can be the basis for optimizing net benefits to society from alternative allocations of fish resources between such uses.

The overall objective of the project, as explained above, is methodological. The case studies are designed to test aspects of the theoretical framework. Therefore, the empirical outcomes for this case study are primarily illustrative of the application of the framework. These applications occur at a point in time, and, therefore, provide only a snapshot of the circumstances in the fishery. This case study is not designed to be the basis for actual allocation decisions.

If ultimately there is a desire to adopt the proposed framework and associated valuation methods as input into any future resource allocation considerations in this fishery (either within existing or under any revised catch and effort controls adopted for sustainability reasons), there will be a need for:

- Further research to obtain up-to-date and more exact information which might help to more exactly identify contemporary supply and demand equations associated with commercial and recreational use; and

- A ‘due diligence’ process to independently validate the robustness of this or any further research and its outcomes relative to the net benefits to society from these extractive uses.

In addition, the approach to illustrate the framework is static. Therefore, there would also be a need to inject a dynamic component into these models to capture underlying changes, which can be expected to impact on social and economic values of commercial and recreational use over time. How best to include a dynamic component was beyond the scope of this project

The scale of the Perth abalone case study fishery (in terms of both commercial and recreational use) is small. The size of the net benefits to society (under existing or alternative allocation options) is small when considered in the wider fisheries context in Western Australia. Nevertheless, the case study is important from two perspectives.

First, the outcomes of this study show the general framework is sound and the results are consistent with economic theory and the proposed framework.

Second, this fishery is typical of many fisheries where allocation issues will arise now and in future. Although relatively small, it is a valued fishery to both commercial and recreational sectors and contributes significantly to the well being of several commercial harvest and post harvest business activities as well as many recreational fishers and their respective families. The fishery is the subject of ongoing debate about the appropriate resource shares.

Whilst the focus of this case study has been on use values (and as it turned out these and option values were the dominant values in this fishery), this is not to say other social values (for example, other non-consumptive values, including conservation and preservation uses, experiential values such as catch and release values, as well as inter-generational values and the like) may not be important. Where there are '*a priori'* grounds to believe such values are likely to be significant in a particular fishery, they can be handled within the general theoretical framework outlined in the first phase of this project.

Consistent with the objective for the overall project, this case study report is a 'warts and all' presentation as a learning experience in the application of socio-economic valuation methodologies within the general theoretical framework outlined in the earlier part of this project. It is hoped that others may benefit from the experience.

TABLE OF CONTENTS

TABLE OF FIGURES

EXECUTIVE SUMMARY

This study is one of three case studies to demonstrate the application of socio-economic valuation methodologies for evaluating resource allocation options and of a general theoretical framework for considering the optimization of social and economic benefits from resource use. The methodology was outlined in the first phase of this project.

The general framework focuses on use values associated with commercial and recreational activities. As such it provides a basis for making sound, consistent, and 'like-with-like' comparisons between commercial and recreational uses of fish resources.

Availability of Socio-Economic Data

Typical of many fisheries there is a dearth of relevant socio-economic data relating to the Perth Abalone Fishery. Hence, it is not possible to undertake benefit-cost analyses of resource allocation options in this fishery with the publicly available data. The official data sets, which were available for the fishery, were either incomplete or inappropriate.

The lack of relevant socio-economic data is, with hindsight, not surprising. The sort of evaluation framework proposed in this project is not currently applied in the resource allocation decision-making processes and neither is broad benefit-cost analysis. Hence, managers and agencies have not had any particular need to routinely produce this sort of data.

Discovery of Relevant Socio-Economic Data

The lack of data meant that original data collection was required for virtually all aspects of the case study. Relevant economic data were required for harvest and post-harvest businesses as well as recreational fishers associated with the Perth Abalone Fishery. These data were collected through surveys of businesses and recreational fishers. The survey implementation, including survey design, evaluation and selection of survey method (telephone, mail or face-to-face surveys) and associated original data collection, is discussed in the main body of the report.

During the design phase, considerable attention was given to the survey content and the choice of survey method and we called on experiences gained during the first case study. There are different benefits and costs associated with different survey methods as well as different statistical and sampling issues. The choice of the most cost-effective method involves trade-offs between data quality and collection costs.

Given the demonstration purposes of this project, methods were adopted that kept overall collection costs to a minimum. As a general rule, it is often better to have a few, quality observations than many poor ones.

A number of unexpected gaps and inconsistencies were identified in the commercial data sets during the analysis of the commercial survey results. In these instances, discussions were held with survey respondents and others with industry knowledge to resolve these gaps to the greatest extent possible. Ultimately, the commercial data set was adequate for the demonstration purposes of this project.

However, if the methodologies and framework were to be used as input into a process considering future allocations in this fishery, further work to refine the supply and demand functions for commercial and recreational use of Perth roe's abalone would be worthwhile.

Valuing Recreational Use for Perth Abalone Fishery

Our survey of recreational fishers in the Perth Abalone Fishery was developed against a widely held belief among all interested parties that the existing constraints (bag limits, fishing days and times, etc) were universally binding on recreational fisher's behaviour and that there was universally unsatisfied demand for extra abalone among recreational fishers. Ultimately the survey results challenged the validity of this belief.

The survey results indicate clearly that recreational fishers' trips to the Perth Abalone Fishery were primarily for the purposes of taking abalone for consumptive use. This was consistent with our prior understanding of the nature of the fishery.

The marginal values that the recreational survey respondents ascribed to additional catch limits for roe's abalone in the Perth fishery included elements of both extractive use and option values. The option value reflects a catch entitlement that they may exercise in the future. Experiential and other non-use values do not appear to play a significant role for recreational fishers, and, therefore, are not reflected in the values that the recreational fishers ascribe to fishing trips to the Perth Abalone Fishery.

The analysis of recreational values relied on the use of the stated preference approach and contingent valuation surveys. Reliance on revealed preference approaches using alternatives such as a recreational travel cost model was discounted in this case study. Such methods work best where there is a normal spatial distribution of the population in statistical terms with respect to distance from the fishing location of interest. In this case study, the surveyed recreational fishers were located in very close proximity to preferred abalone fishing locations. This meant that there is not a sufficient range of travel distances and costs to produce a meaningful result from the application of a travel cost model.

The contingent valuation modelling indicates that most survey respondents were currently optimizing within existing constraints, although the others were not. A majority turned out to be satisfied with their abalone catch, even though entitlements (as reflected in bag limits and fishing days) were not fully exercised. There was a much smaller group (less than 3 per cent of the sample) who fully exercised their entitlements (catch limits and fishing days) and were dissatisfied.

In economic terms, this means that most recreational fishers were optimizing utility (satisfaction or well being) within their current preferences and existing budget (money and time) constraints, whilst a smaller group were not. Consequently, we expected to find recreational fishers who place high value on catch limit increases and others who do not. This distribution of recreational values was confirmed by the survey data.

The data showed that, using the model specifications that were most consistent with economic theory, the marginal willingness to pay for one extra abalone in their daily bag limit (six extra abalone over the season) was greater than $25, falling to around $5 for an extra 4 or 5 abalone, and little (if any) at an extra 10 abalone.

The aggregate willingness to pay to increase the daily bag limit by 5 abalone (30 over the six day season) is around $0.4 million.

Valuing Commercial Use

The commercial use of the Perth Abalone Fishery is export based with little (if any) product sold for consumption in Western Australia. Consequently, the net benefits from commercial use reflect the aggregate producer surpluses of harvest and post harvest activities in Western Australia associated with the Perth roe's abalone catch. In the absence of any significant local consumption of commercially taken abalone, there are no consumer surpluses from this consumption to be included in the benefit from commercial use.

The net benefit from commercial use (that is, the aggregate producer surpluses for harvest and post-harvest activities in Western Australia) was estimated to be around $1.3 million or $36.32 per kilogram of whole abalone. This corresponds to an annual quoted commercial catch of 36 tonnes and to the 2001-2002 financial year. Export sales trend to be in US dollars. The US/Australian exchange rate averaged around $US1 to $A0.54 over the period.

The marginal benefit from commercial use was estimated to be around $A43.38 per kilogram of whole abalone. Assuming 8 to 9 abalone to the kilogram of commercial take, this represented a marginal value of around $A4.82 to $5.42 per abalone taken for commercial use. Assuming the industry to be a 'price taker' (that is, changes in catch volumes do not impact on market returns) and given that the estimated marginal cost is constant across the analysed volume range, the marginal benefit from commercial use is effectively constant across the relevant volume range for this study.

The marginal values from commercial use were sensitive to $US/$AUS exchange movements. For the purposes of our analysis, we used the rate that was incorporated in to the 2001-2002 financial data provided by commercial sector for the study.

Optimising Net Benefits from Commercial and Recreational Use

The aggregate net benefits from commercial use were estimated to be around $1.3 million for the total commercial catch for the 2001-2002 year. The aggregate surplus in recreational fishing has not been calculated. However, as the framework paper makes clear, comparing two aggregate net values does not explain what should happen to resource allocation at the margin.

The important values in a benefit-cost analysis of resource allocation options are not the aggregate but marginal net benefits for the respective uses. The optimum allocation occurs where the marginal 'net' benefits from each of the resource uses are the same. Our modelling focused on the marginal benefits.

The modelling shows that, at an extra 4 to 5 abalone in the daily catch limit, the marginal net benefit from recreational use becomes broadly similar to the marginal benefit from commercial use, that is around $A5.00 per abalone. Assuming the total existing commercial and recreational catches of 76 tonnes represent the sustainable catch, a reallocation to recreational use of up to 4.5 tonnes could increase the overall net benefit to society from the combined commercial and recreational use.

Underlying Assumptions for Applying Inter-Sectoral Allocation Models

This analysis is based on certain assumptions. It assumes that:

- The combined existing commercial and recreational catch is all that is sustainable and available for inter-sectoral allocation,
- All recreational participants are subject to binding constraints (catch limits, fishing days and fishing times, etc), that is, there is no unused or spare capacity,
- For all commercial operators it is optimal to take the current total allowable catch, that is, there is no spare capacity, and
- All commercial operators are internally structured to maximize producer surpluses from roe's abalone catches in the Perth fishery.

If any of the above assumption do not hold, the immediate allocation issue may be an intra- rather than inter- sectoral allocation issue.

There is currently ambiguity around the total sustainable catch in this fishery. Also, the results of our analysis indicate that, whilst the assumptions relating to the commercial activity most likely do hold, there are clear indications that those relating to recreational use do not.

Inter-Sectoral Allocation Issues

In the particular case of the Perth roe's abalone fishery, the survey results indicate that recreational fishers are not fully exploiting their entitlements (catch limit, fishing days and fishing times) and that the existing constraints are non-binding for many fishers. This implies that an intra-sectoral reallocation among recreational fishers from low to high value users of the abalone resource may increase the overall benefits from recreational use within the existing catch constraints.[1] This could increase the combined benefit to society from commercial and recreational use without requiring any immediate inter-sectoral reallocation.

For fisheries management, this poses an immediate intra-sectoral allocation issue. This is because, based on economic theory and the principle of diminishing marginal utility, the marginal benefit of additional recreational catch (following any intra-sectoral reallocation within the recreational sector) is likely to decline. As existing recreational fishers with high marginal values move closer to satisfying their individual preferences under a more flexible recreational fishing management regime, the marginal values of an extra abalone post intra-sectoral reallocation would be expected to fall.

Once the intra-sectoral reallocation opportunities have had time to work, the static analysis would need to be repeated to determine whether an inter-sectoral reallocation issue remains at that time. In this study we consider both intra- and inter- sector allocation issues.

Reality Checking of Model Outcomes

The results of the modelling are illustrative only and a 'snapshot' in time. The outcomes are dependent on the robustness of the assumptions behind the models. Nevertheless, we did undertake a series of 'reality checks' of the data sets and statistical outputs in the course of the assessment to ensure the results appeared consistent with what was happening in the industry. This focused on whether the results appeared sensible and rational in economic terms, made sense in terms of the actual operation of the market and was consistent with the overall circumstances in the fishery.

Injection of a Dynamic Component

As already noted, for any actual implementation, the analysis would need to be updated (and recalibrated) after intra-sectoral reallocation issues are addressed and as the underlying conditions behind economic and social values change over time.

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[1] An intra-sectoral re-allocation could be achieved by a management regime that provided individual recreational fishers with more flexible allocation choices that can more closely reflect their individual preferences within the existing recreational catches available to the recreational sector. However, the more flexible regime would need to be designed in a way that the additional administration and compliance costs of the more flexible system do not exceed the recreational sectors utility gains.

While the development of a dynamic element would be required to ensure that the analysis approximates more closely contemporary circumstances as they change over time, it is beyond the scope of the current study.

Where commercial use values are sensitive to foreign exchange rate movements as highlighted by this study, the socially optimal allocations based on longer-term rates may be an appropriate benchmark for fisheries management purposes.

Overview

The case study demonstrates that the general theoretical framework based on economic principles is applicable. The results are broadly consistent with economic theory and can be the basis for developing allocation policy.

1 Background

This case study applies the theoretical economic framework for evaluating the net benefits to society of resource allocation options developed in Part One of this project to the Perth Abalone Fishery[3]. It is one of three case studies that demonstrate the application of the framework to resource sharing options in fisheries management.

Consistent with the objectives of the overall project, this application to the Perth Abalone Fishery emphasizes methodological and practical issues in the application of the framework as much as actual results.

Lessons for the practical application of the valuation methodologies that form part of this project are considered. In particular, the principles incorporated into data collection for commercial and recreational activities along with survey design, analytical models, statistical analyses, together with survey and analytical lessons learned, form the basis of this case study and the overall report.

1.1 Management Framework

The Perth Abalone Fishery, for the purposes of this report, is the commercial and recreational abalone fishery located on the West Coast of Australia. This extends from the mouth of the Moore River 100 kilometres north of Perth to Cape Bouvard 80 kilometres south of Perth.

Commercial fishing is managed under the Abalone Management Plan 1992 as amended in accordance with the Western Australian *Fish Resources Management Act 1994*. This case study focuses on a subset of this managed fishery and is based on Roe's abalone fishing in what is referred to as (Perth) Area 7 of the managed fishery.

There is no explicit total allowable catch (TAC) covering both commercial and recreational abalone take in Western Australia, although there are commercial catch quotas, including 36 tonnes of Roe's abalone allowed from Area 7. According to the Fisheries Department of Western Australia, the recreational catch is around 40 tonnes suggesting an overall implicit TAC of around 76 tonnes. This is open ended because of the potential for increasing recreational participation with population growth.

The most sought after catches of commercial and recreational fishers are located on the reefs and adjacent near shore waters off Perth beaches and these areas are subject to intensifying resource-sharing pressures.

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[3] P.McLeod and J Nicholls "A Socio-Economic Valuation of Resource Allocation Option between Commercial and Recreational Use: Part One-A General Theoretical Framework" (March 2002) FRDC Project 2001/065

1.1.1 Commercial Fishing

Abalone Managed Fishery Area 7

A total of 13 managed fishery licences (MFL) authorise fishing within the Perth Area 7, although only nine licensed operators are effectively utilizing all of the entitlements in the area once entitlement transfers among licensees are taken into account.

Each license holder may have up to two divers endorsed on a license. There have been fifteen divers (apart from license holders) endorsed on these Perth area licenses.

Abalone managed fisheries licenses are effective from 1 April to 31 March in the following year. Licenses and unit entitlements are transferable.

Output Controlled

The commercial Roe's abalone take in the Perth Area 7 was limited to 36 tonnes of whole abalone for the 2001-2002 season. This is reflected in 7200 Roe's unit allocations (where one unit equals 5 kilograms with 8 to 9 abalone to a kilogram of whole abalone according to commercial operators in the Perth fishery). Individual licensees' unit holdings in the Perth Area 7 ranged from 200 units to 700 units with 600 unit holdings being the most frequent.

A minimum unit holding of 800 units overall in the Abalone Managed Fishery applies in order to operate a commercial abalone managed fishery license.

Within Area 7 and specifically between Hillarys Boat Harbour and Cape Bouvard commercial fishers are not permitted to stand or remain on the reef top while fishing for abalone, they must only fish from a boat. In addition, commercial Roe's abalone fishing is not permitted between the north Mole at Fremantle and Trigg Island at any time.

Size Limitation

A commercial legal minimum shell size of 70 mm applies within Area 7.

Seasonal Restriction

Commercial Roe's abalone fishing is not permitted in the Perth Area 7 at weekends and public holidays and is also not allowed during an eight-week period corresponding to the November/ December Perth recreational abalone season (including 2 weeks prior to the start of the recreational season).

Management Fees

Commercial licensees pay a managed fishery licence fee. This fee consists of two components; a cost recovery component, which represents the full accrual cost of management, compliance and research services provided to the fishery, plus a Development and Better Interest contribution, which is a return to the community.[4]

Commercial Catch Value

According to data available, a 36 tonnes annual commercial Perth Roe's abalone catch was estimated to be worth around $1.6 million at average 'beach prices' for 2001-2002.

1.1.2 Recreational Fishing

There is no restriction on recreational fishers participation in the Perth Abalone Fishery subject to a willingness to pay $35 for a seasonal recreational abalone license. There were around 15,200 license holders listed as being eligible to participate in the Perth abalone fishery during the 2002 season according to data made available by the Fisheries Department. This consisted of those who held a specific license for the Perth abalone fishery only as well as those who held an umbrella recreational license that entitled them to fish in the Perth abalone fishery. Around 82 per cent of these entitlement holders were located in the Perth metropolitan area.

Seasonal Limitation

Recreational abalone license holders in the Perth Roe's abalone area were restricted to fishing for one-and- a half hours on each of six (6) consecutive Sunday mornings over a November/December period during the 2002 season.

Daily Bag Limits

Each recreational license holder is limited to a maximum daily take of 20 Roe's abalone per Sunday in the Perth area. The bag limit is not cumulative. As the fishing season is capped at six Sundays, the potential recreational catch is limited to 120 abalone per license holder over the season.

Size Limitations

A legal minimum shell size of 60 mm applies to Roe's abalone recreational fishers in the Perth area.

Recreational Catch

There is no explicit total allowable catch for recreational Roe's abalone fishing in the Perth area. According to Fisheries Department research, the recreational Roe's abalone

[4] Hon M House MLA, then Minister for Fisheries presentation on the "*Future Direction for Fisheries Management in Western Australia" September 1995, page 24.*

catch in the Perth area is around 40 tonnes. The mean whole weight of recreational roe's abalone taken in the Perth fishery is estimated to be around 0.09165 kg according to Fisheries Department research data. This suggests around 11 abalone per kilogram of recreational fishers' catch.

Participation Rates

The participation rate of license holders in the abalone fishery was not available for the 2002 season at the time of our survey work. Data became available subsequently regarding the participation rates of license holders for the 2001 season. This indicated that the participation by those holding the specific license to fish for abalone in the Perth metropolitan area and who were located in the metropolitan area was around 75 per cent. For those located in the country, the participation rate in the Perth fishery was only 1.5 per cent. For eligible umbrella license holders, the participation rates were 28 per cent for those located in the Perth area and 3 per cent for those located in the country. These participation rates were used in our analysis of aggregate recreational catch and allocation.

1.2 Resource Sharing Setting

This study considers the marginal net benefit from commercial and recreational use on the assumption that existing effort and catch of around 76 tonnes in the Perth roe's abalone fishery is sustainable. It focuses on use values of commercial and recreational fishing.

1.3 Underlying Settings

The study was carried out within the fisheries management arrangements and the social and economic climate prevailing at the time of the study. We also did so against the choices implicit in the commercial and recreational fishers' intentions to fish for roe's abalone in the Perth area.

Of particular significance is the non-existence of a single, discrete and realizable total allowable catch within which to analyze the net benefits of changes in share allocations between commercial and recreational use. The combined aggregate total catches for these uses in uncertain.

There was an explicit total allowable commercial roe's abalone catch in the Perth area that is reflected in individual quota unit allocations to commercial fishers. However, there was much less certainty around the magnitude of the sustainable recreational roe's abalone catch in the Perth area of the fishery.

There were statistically significant survey data collected by the Fisheries Department on the recreational roe's abalone catch in the Perth area. Based on the survey results the Department estimated the abalone catch to be around 40 tonnes. However, the magnitude of this catch may change over time, if participation and entitlement utilization increases among eligible license holders, and if participation increases in a fishery where access is not restricted subject to the payment of a fee for a recreational abalone license.

In circumstances where the combined catch level and shares were uncertain, this case study considered values and allocations at the margin for commercial and recreational use. In this context, the size of the overall recreational catch became less significant. The important values were the marginal benefits of commercial and recreational use and the way they varied at different potential catch levels.

2 Valuing Benefits From Commercial Use

The commercial Perth roe's abalone fishery is export based with little (if any) product destined for final consumption in Western Australia. Where there is no final consumption locally, the benefits from commercial use consist of the combined 'producer surpluses' from commercial roe's abalone catching in the Perth fishery and the 'producer surpluses' associated with post-harvest processing and exporting activities in Western Australia.

The paucity of information on recreational fishing values is generally recognized in fisheries management, but there is little recognition given to the data issues in respect of commercial activities. The resource-sharing framework requires that marginal values for recreational and commercial activities be compared on a 'like-with-like' basis. As the framework paper[5] makes clear, this requires a producer surplus calculation for commercial activities.

The industry data needed to estimate 'producer surpluses' were not readily available from official databases. Hence, the data required for the estimation of the relevant 'producer surpluses' for both the commercial Perth roe's abalone fishing sector and the associated post-harvest processing and exporting activities had to be based on data collected specifically for this study.

The required price and cost data (including the estimated sensitivity of prices and costs to changes in abalone catch quantities) together with relevant social information such as business structures and employment, had to be collected directly from industry sources using a survey of commercial operators.

[5] Op cit 1

2.1 Data Collection

In developing the survey questionnaire, we incorporated our experience from the first of the three case studies together with input from the Interested Parties Consultative Group and feedback from the Chairman of the Abalone Divers Association. This process helped to ensure that the questionnaire was unambiguous and that the questions were couched in a way that they would be easily understood and consistently interpreted by commercial fishers (and others). The survey questionnaire used is shown in Appendix 1.

Where surveys seek disclosure of private and commercially confidential business information, there in a natural and understandable predisposition towards non-disclosure. In such circumstances, voluntary disclosure should not be readily expected.

Such circumstances usually necessitate a process that attempts to build a rapport with, and gain the confidence of, the potential respondents. For this case study, a pre-survey meeting was held with Abalone Divers Association. The meeting was designed:

- To explain the objectives of the research project;
- To outline the particular data which would be needed to complete the study and to explain that the data would be used for aggregate statistical analysis purposes only;
- To provide assurances that individual enterprise data would be used for the purposes of this project only and treated in the strictest of confidence; and
- To seek their cooperation in the provision of survey information and to gauge the extent of the likely willingness to participate (which may be used to judge what might be the most cost effective survey method to be adopted).

Independently, key position holders in the industry body extended a testimonial regarding the researchers and the integrity of our ‘confidentiality assurances’ as well as highlighting the need for industry to provide the requested data so that this research would be based on a sound, and, as accurate as possible, picture of the commercial industry.

The survey questions did not easily lend themselves to telephone collection methods. It was decided that a mail survey and subsequent telephone contact would be most appropriate both in terms of costs and securing good data. The result was a combination of phone interview and face-to-face follow up where needed.

Our correspondence that accompanied the mail survey formally reaffirmed our ‘confidentiality assurances’ to provide the requisite comfort to industry and to increase industry confidence with the view to achieving a reasonable response.

2.2 Data Analysis

Survey returns combined with industry discussions provided us with adequate quality data for the harvest and post-harvest activities related to commercial Perth roe's abalone fishery to meet the demonstration objectives of this project. These data covered prices and costs for both harvest and post-harvest activities associated with this fishery. For reasons of commercial confidentiality, individual and aggregated returns for each of the harvest and post harvest activities could not be published. Consequently, all data presented in this report is 'scaled-up' and presented for the combined harvest and post harvest activities.

The surveys produced data across a range of abalone fishing enterprises of varying scales of operation in Perth roe's abalone fishery and in the overall enterprise size. Also, the survey data covered the range of post-harvest activities associated with the commercial Perth roe's abalone catch that were carried out in Western Australia. Cost apportionment between various activities were involved. This was the case across both the harvest and post-harvest activities.

2.2.1 Markets for Commercial Catches

The commercial Perth roe's abalone harvest and associated post-harvest activities are geared to servicing Asian export markets. The Perth roe's catch is either:

- Sold to a local processor where the roe's abalone meat is extracted, canned and exported; or
- Forwarded to inter-State processors for canning and export after the roe's abalone have been 'shucked' (i.e. meat extraction) in Western Australia.

2.2.2 Cost Data and Resource Costs

In economic terms, the relevant cost to use in a resource-sharing analysis is the resource (or opportunity) cost of inputs used. This is defined to be the cost that reflects the value that the inputs committed to commercial catch and subsequent processing would have in their next best alternative use. As is standard in economic studies, this often requires some adjustments to collected data so that they better approximate the underlying resource or opportunity costs from society's viewpoint.

To achieve this, adjustments were made to submitted industry cost data in order:

- To remove transfer payments such as interest and lease payments, taxes (like fuel excise) and other Government levies (except for the component of the managed fisheries fee that was directly attributable to the cost of services to manage the fishery), as well as those included in insurance premiums (where the real service cost included in paid premiums is typically around 8 per cent);

- To ensure consistency in the treatment of capital items in terms of replacement values, expected life, and depreciation method;

- To standardize labour inputs, particularly in the catching sector, to reflect the time and labour units typically required to catch the quota unit entitlements and to manage the business operation; and

- To reflect the opportunity (or resource) cost of inputs used as defined above. In particular for labour, where owner operators were common, appropriate market place benchmark earnings were taken as indicative of the opportunity cost of committing this labour to catching and processing of abalone. There was no apparent indication that other expenditures were not reasonable measures of resource or opportunity costs.

The adjusted cost data enabled an estimate of the total (resource) cost for commercial activity based on the submitted returns. These estimates were ‘scaled-up’ to derive ‘ball park’ estimates of the total resource costs for the harvest and post-harvest activities based on the 2001-2002 Perth roe’s abalone catch and costs. Scaling factors were used based on volume, individual quota unit holdings and the aggregate returns as appropriate. These combined ‘scaled-up’ estimates for harvest and post harvest activities related to the Perth roe’s abalone catch are shown in Table 1.

Table 1: Scaled-Up Estimates of the Catch and Processing Costs associated with the 2001-2002 Roe's Abalone Catch in the Perth Abalone Fishery

Catch and Processing Value	
Total Revenue[1]	$1,801,000
Expenses	
Packaging Cost	$9,100
Ice	$3,900
Energy	$2,600
Wages/Salaries	$218,692
Fuel	$9,874
Repairs and Maintenance	$11,570
Depreciation	$59,229
Fees & Taxes	$93,088
Insurance	$732
Freight	$29,000
Office Administration	$25,800
Other	$30,011
Total Expenses (inc. salaries)	$493,597
Aggregate Surplus	$1,307,403

1. Total value was taken to be the processing value of catch, which intrinsically includes catching value. The data reflects an average exchange rate of $US1= $AUS0.54 over the financial period.

The surveys produced estimated for the way total costs vary with volume of catch (or throughput). This allowed an analysis of those cost items that remain fixed over a volume range and those that are variable over that range for both the harvest and post-harvest activities.

Based on the data collected, it appears that there is no significant scale economies in harvesting, as no changes in major equipment are needed to handle the range of catch volume variations considered in this study. The same also appears true for processing. On this basis, we estimated the cost structures of the combined harvest and post-harvest activities related to the 2001-2002 Perth commercial roe's abalone catch and cost data. These estimates are shown in Appendix 2 and diagrammatically in Figures 1 and 2 below.

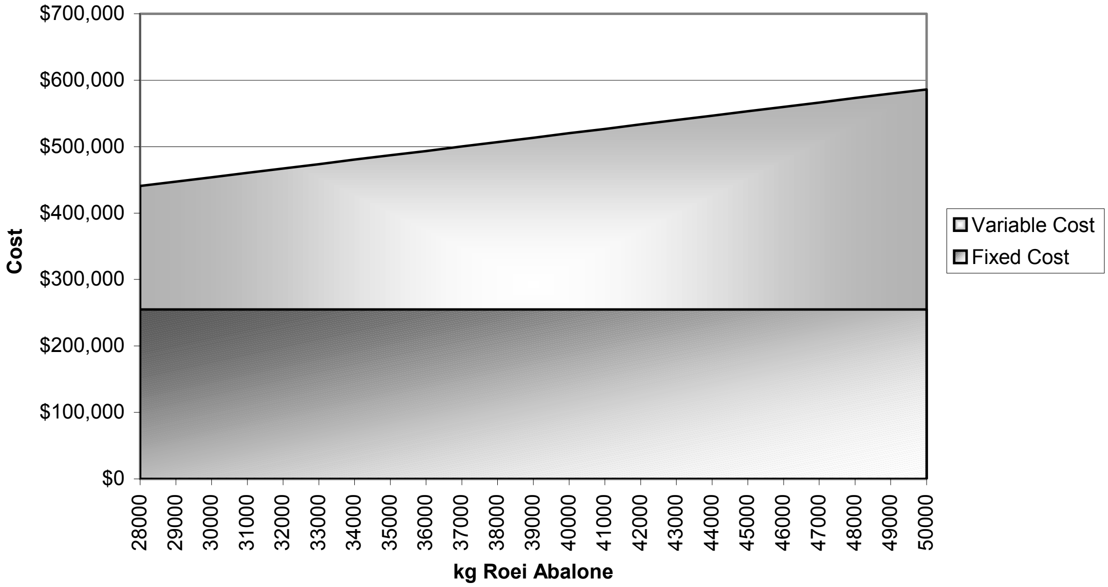

Figure 1: Perth Abalone Fishery Harvest and Post Harvest Total Cost Curve

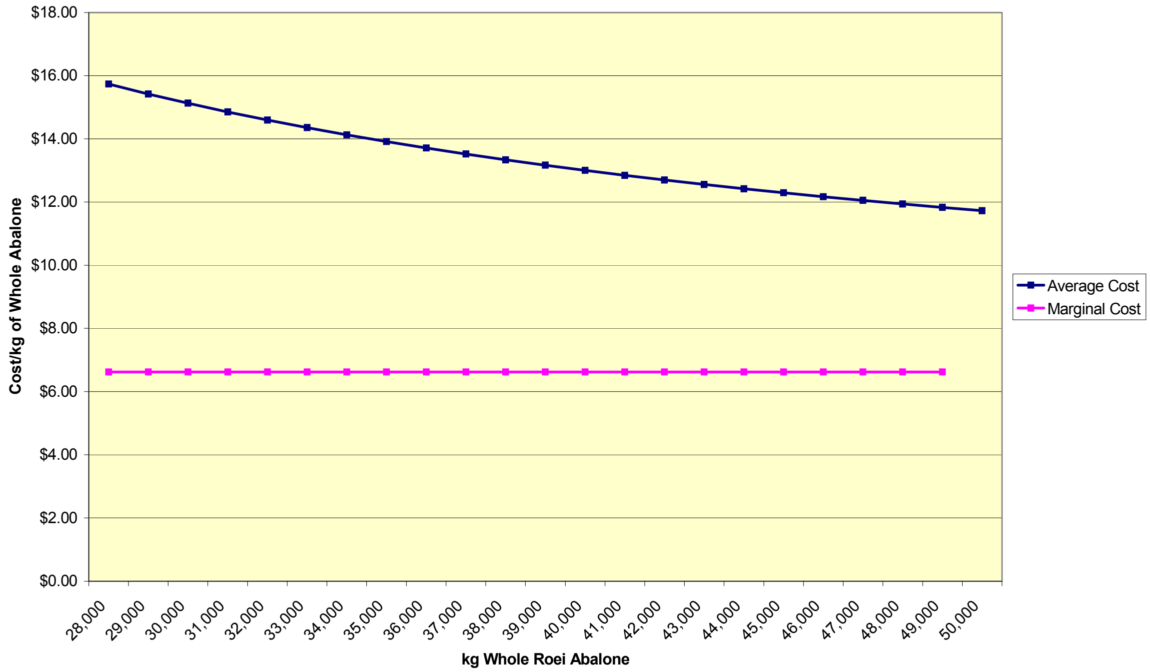

Figure 2: Perth Abalone Fishery Harvest and Post-Harvest Average and Marginal Cost Curves

2.2.3 Prices and Revenue Data

Price data were also available for harvest and post-harvest sector for the 2001-2002 Perth commercial roe's abalone catches. These data enabled us to estimate the aggregate revenue for the harvest and post-harvest returns. These estimates were then 'scaled-up' (in a similar manner to that used on the cost side of the equation) to estimate the aggregate 'industry' revenue for the harvest and post-harvest activities associated with the 2001-2002 Perth commercial roe's abalone harvest. These estimates are also shown in Table 1 above.

The surveys produced estimates on the likely sensitivity of prices received by industry for a given range of changes in commercial catch volumes of roe's abalone in the Perth abalone fishery. Given the magnitude of the change are small by comparison with total volumes of Australian abalone and the world market supplies, these volume changes were not expected to have any material impact on prices received. These estimates across a volume range are shown in Figure 3 below.

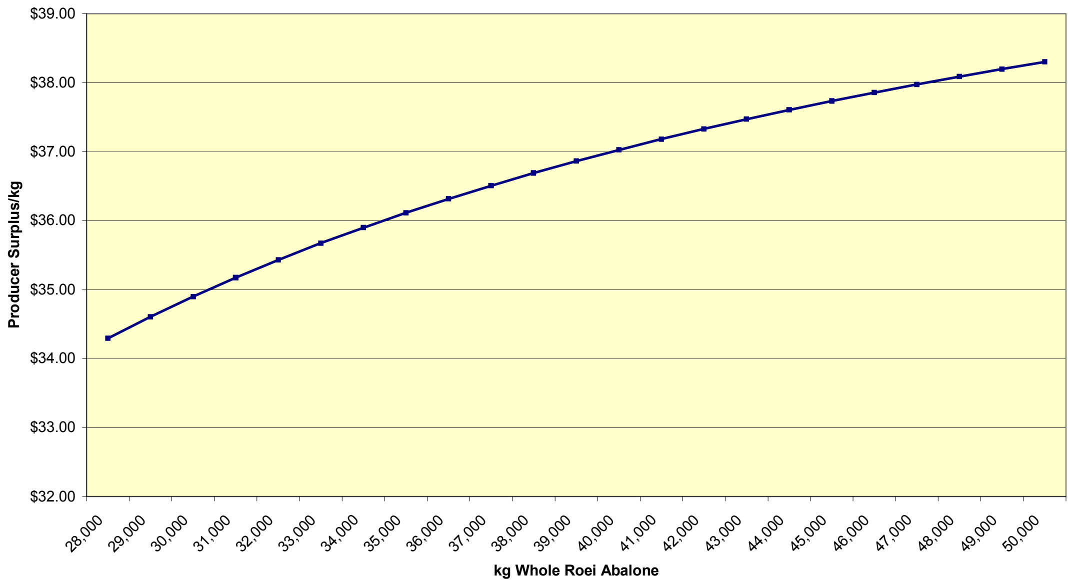

Figure 3: Perth Abalone Fishery Harvest and Post Harvest Producer Surplus

These estimates are based on the assumption that:

- all Perth roe's abalone catch is exported
- changes in the volume of roe's abalone exported by industry will not impact on price, that is, the local industry is a 'price taker',
- all sales are made in US dollars, and
- the average US/Australian exchange rate experience over the 2001-2002 financial year, that is, around $A0.54 to the $US1 remained unchanged across the volume projections.

The movement in the $US/$AUS exchange rate has far greater impact on prices received in Australian dollar terms than changes in catch volumes in this fishery.

2.3 Net Benefits from Commercial Use

As mentioned previously, the abalone fishery is predominantly an export fishery. In this case, the net benefits from commercial use consist of the 'producer surpluses' of the harvest and post harvest activities carried out in Western Australia. In this case study, where there is no final local consumption in Western Australia, there are no domestic 'consumer surpluses' to be taken into account.

The ‘producer surpluses’ from commercial use based on the 2001-2002 roe’s abalone catches from the Perth fisheries were shown previously in Table 1. These estimates suggest that the combined harvest and post-harvest ‘producer surpluses’, was of the order of $1.3 million or $36.32 per kilogram of whole abalone for the 2001-2002 harvest. This is not profit in the accounting sense. As explained previously, adjustments to recorded costs were made so that costs better reflected opportunity costs of inputs used and the net benefits measure value added by the industry.

These combined ‘producer surplus’ estimates for a range of commercial catches are presented in Figure 4 below and Appendix 2.

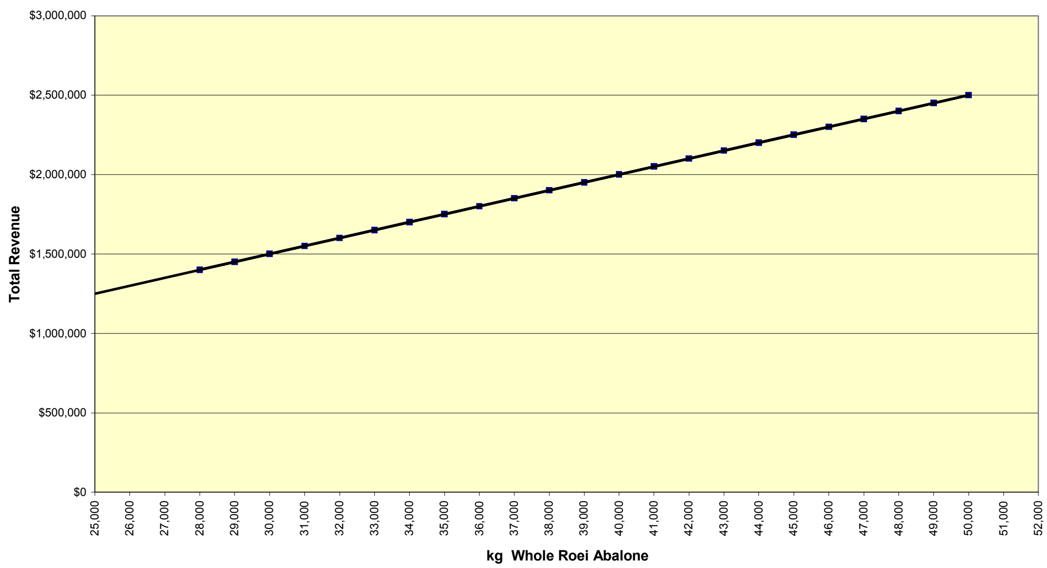

Figure 4: Perth Abalone Fishery Harvest and Post Harvest Total Revenue

In an industry where returns are dependent on the $US/$AUS exchange rate, short-term movements in the rate will impact on the size of the ‘producer surplus’. A depreciation of the $A against the $US will increase the size of the ‘producer surplus’ as a sale in the same US dollar will return more in Australian dollar terms. On the other hand, an appreciation of the Australia dollar against the US dollar with the same US dollar sales value will return less in Australian dollars. Resource allocation decisions based on short-term movements in the $US/$A exchange rate would be administratively impractical and socially and economically unnecessary. For the purposes of resource allocation, ‘producer surpluses’ should be based on underlying longer-term exchange rates.

3 VALUING RECREATIONAL USE

As with many recreational fishing activities, there is no well-established market where the values that recreational fishers place on roe's abalone catches in the Perth area may be observed. Whilst past surveys have collected data on recreational effort and catches in the Perth area of the roe's abalone fishery, there is no appropriate socio-economic data set which would enable an estimation of the values placed on these recreational abalone catches. Hence, to develop estimates of the recreational fishing values for roe's abalone catches in the Perth area, original data collection was required. As explained below, a contingent valuation survey was assessed as the most appropriate data collection technique.

3.1 Data Collection

Valuing recreational abalone catches is an application of the theory of valuing non-market goods. This requires careful consideration of what data are needed and how to collect the required valuation data in a theoretically valid and cost effective way. It also needs to reflect the objectives of the project which are to demonstrate the application of the valuation methodologies based on revealed and stated preferences using surrogate and simulated market approaches.

3.1.1 Survey Content

As noted a contingent valuation survey was assessed as the most appropriate technique for collecting the recreational valuation data. The survey questionnaire used took into account our experiences with the first[6] of the three case studies associated with this project. It also benefited from the assistance of an Interested Parties Consultative Group that comprised people with a sound knowledge of fisheries. This helped to ensure that, as far as possible, the proposed questionnaire was clear and unambiguous, and, in particular, the contingent valuation question posed a believable and realistic scenario. The questionnaire is presented in Appendix 3.

The contingent valuation scenario used was developed around a widely held perception among all interested parties that existing catch (daily bag) and time limits for recreational abalone fishers in the Perth area were binding and that there was generally unsatisfied catch demands among these fishers. There was also a widely held view that there was little difference between individual fishers, that is, their utility functions were broadly similar or homogeneous. In these perceived circumstances, the contingent valuation

[6] 0p cit 1

scenario was designed to ascertain recreational values at the margin around increased or reduced catch limits

3.1.2 Survey Size and Method

In this case study, we were able to draw from a list of around 15,500 persons that held a recreational fishing license that entitled them to fish for roe's abalone in the Perth fishery during the 2002 season. This list was provided by the Department of Fisheries in Western Australia as a co-sponsor of this research.

A sample survey group of 500 license holders was randomly identified from the population for survey purposes. An introductory letter was sent to each of the selected license holders informing them of their selection for a forthcoming telephone survey and seeking their participation.

The survey data were collected by telephone interviews using Computer Assisted Telephone Interviewing techniques. This survey method was judged to be the most cost effective data collection method for the demonstration purposes of this project and expected to achieve a reasonable number of observation for analytical purposes. 'Mail out' survey methods typically achieve a 30 per cent response rate, whilst 'face-to-face' interview methods were clearly too costly for the purposes of this project. These other survey methods may be cost effective data discovery methods in other circumstances. The choice of survey method will be a case-by-case decision depending on the circumstances at the time.

Because a significant proportion of the survey were expected to be persons with a non-English speaking background, the telephone survey needed to be assisted by interviewers skilled in the required languages. This added to the survey costs.

3.2 Data Analysis

The key outcomes of the telephone survey are outlined below:

3.2.1 General Population and the Sample Group

- The total population of licensed recreational fishers that was entitled to fish for roe's abalone in the Perth area during the 2002 season was around 15,200 persons. These data were available from the Department of Fisheries in Western Australia as a co-sponsor of this project.

- Out of this population a sample group of 500 license holders were randomly identified for contact purposes and 434 responded to the questionnaire. This represented a 87 per cent response rate. The balance consisted of those who could not be contacted after five attempts, those with incorrect or disconnected telephone numbers, and those who declined to participate in the survey.

- Of the 434 respondents, 364 completed the full questionnaire, whilst the remaining 73 indicated that they had not fished for roe's abalone in the Perth fishery during the 2002 season and the interviews were terminated.

- The total roe's abalone catch of the respondents was estimated to be around 2.4 tonnes for the 2002 season, applying the mean whole weight provided by the Fisheries Department. This suggests the roe's abalone catch by respondents to our survey represented about 6 per cent of the estimated recreational catch.

3.2.2 Respondents Fishing Background

- For two-thirds of the respondents, recreational abalone fishing in the Perth area was their sole fishing experience. In the case of the remainder, roe's abalone fishing in the Perth area represented 20 per cent or less of their fishing trips.

- The respondents' abalone fishing trips were predominately roe's abalone fishing in the Perth area. Only 5 per cent of the respondents fished for abalone outside the Perth area. These other abalone trips were mostly to the South Coast of Western Australia.

- Out of the survey respondents, 109 or 30 per cent were female. Almost 90 per cent were between the ages of 20 and 59 years. Those in the 30 to 39 age group were the most frequent age group of the respondents.

- Incomes of the respondents were broadly indicative of the wider community.

Personal Weekly Income (Annual Income)	**Frequency (%)**
Negative or Nil	17
$1-$79 ($1-$4159)	2
$80-$159 ($4160-$8319)	9
$160-$299 ($8320-$15599)	10

$300-$499 ($15600-$25999)	17
$500-$699 ($26000-$36399)	17
$700-$999 (36400-$51999)	12
$1000-$1499 ($52000-$77999)	9
$1500 or more ($78000 or more)	7

3.2.3 Abalone Fishing Experience

- Out of the survey respondents, 43 per cent fished for roe's abalone in the Perth area for the six times permitted under the recreational license for the 2002 season. One-quarter fished three times or less. The difficult ocean conditions on the reefs off Perth beaches on three of the six days may partly explain the underutilization of the number of allowable fishing days by the survey group. From an economic perspective, we assume that each individual has alternative activities that they can pursue, and, that, for those who fished less than the six days, it was because the net marginal utility of fishing the additional days did not justify giving up the alternative activities. For the 43 per cent who fished all six days the net marginal utility of fishing additional days was higher than the marginal utility from alternative activities right up to the sixth day.
- For the 2002 Perth abalone season, the catch per trip averaged just over 18 abalone. This was similar to the results obtained by the Department of Fisheries' survey results. Only thirty-eight per cent of the respondent's averaged bag limit catches of 20 abalone per trip for the season. For 60 per cent of the respondents, catches per trip averaged 15 or more, whilst 80 per cent averaged 10 or more per trip.
- Over 90 per cent of the respondents spent one hour or less actually fishing on the reefs off Perth beaches for abalone. This was less than the permitted time of one and one-half hours.
- For 84 per cent of the respondents the overall time away from home on abalone fishing trips in the Perth area was three hours or less.
- Roe's abalone catches in the Perth area were mostly eaten by the household (over three-quarters) or shared with family and friends (23 per cent)

- The size of the abalone caught, having a good time regardless of actual numbers of abalone caught, and the social interaction with family and friends were important.

- Surprisingly, the respondents were in the main evenly divided on the importance of the number of abalone caught; 55 per cent indicated that it was not important, whilst 45 per cent rated it as important. For 25 per cent the number taken was very important but not at all important for 20 per cent.

- Interestingly, for the 2002 season overall, the majority of the respondents were satisfied with the number and size of abalone caught and thought they had caught "enough for a decent feed" even though the majority had taken less than the aggregate catch limit for the season.

- Some 90 per cent of the respondents indicated that they "had a good time catching abalone regardless of the number of abalone caught".

- Over 80 per cent of the respondents were satisfied with social interaction with family and friends whilst fishing for roe abalone in the Perth area.

3.2.4 Most Recent Abalone Fishing Trip in the Perth Area

- For more than 87 per cent of the respondents the main reason for their most recent trip was to catch abalone.

- Unlike the aggregate outcomes for the 2002 season, three-quarters of the respondents caught the daily bag limit on their most recent abalone-fishing trip in the Perth area.

- Over 90 per cent of the respondents were happy with the number and size of abalone caught on their last abalone fishing trip in the Perth area.

- Indeed, 88 per cent thought they had caught as many abalone as they expected to or more.

- Around 50 per cent of the respondents were located 10 kilometres or less of where they fished for abalone in the Perth area and more than three-quarters were within 15 kilometres or less.

3.2.5 Overview

Contrary to widely held perceptions, the survey results suggest that:

- Most recreational abalone fishers' average take per trip in the Perth fishery during the 2002 season was less than the bag limit and they fished for fewer days and spent less fishing time than that allowable under the license conditions. Nevertheless, they indicated that they were generally satisfied with their fishing experience, that is, for those factors, which they rated as important, they were moderately satisfied and for those where they were most satisfied, they rated as moderately important. This indicates most recreational roe's abalone fishers in the Perth fishery are optimising their utility within existing catch, time, and budget (money and time) limits.

- As the satisfaction questions preceded the contingency valuation scenarios this result may reflect 'constrained satisfaction'. That is satisfaction within the existing bag and time limits in the belief that the restrictions were there for sound resource sustainability reasons in the broader community interest and applied equally to all recreational fishers

- Factors other than the number abalone caught are important and significant to a majority of recreational abalone fishers in the Perth area. This suggests changes in management rules other than catch limits may increase recreational fishers utility or satisfaction.

- The utility functions of individual recreational abalone fishers in the Perth area vary. Recreational abalone fishers cannot be treated as having homogeneous preferences. This suggests that a more flexible intra-sectoral allocation policy may result in the overall utility or satisfaction of recreational abalone fishing in the Perth area being higher than it is under the uniform allocation treatment of the current management regime. A management regime that provided individual recreational fishers with more flexible allocation choices would allow fishers to more closely match their individual preferences with actual fishing and catch outcomes while maintaining the total sustainable catch limit would potentially increase overall utility for the recreational sector.

3.3 Revealed Travel Costs and Demand

The travel cost method was deemed unsuitable for valuing recreational fishing for abalone in the Perth abalone fishery.

The underlying premise of the travel cost model (TCM) when used to value natural resource use is that the cost (a combination of out-of-pocket and time costs) of accessing the recreational activity site can be taken as a proxy for the 'price' paid to access the site and the associated recreational activity.

This being the case, those people living closest to the site will have a lower per trip access price and therefore tend to visit the site more frequently than those who live further away from the site That is, because the access price as measured by travel (out-of-pocket and time) costs of a return trip to the site is higher for those living further away, they will demand fewer trips to the site. This relationship has the form of a conventional demand function and can be used in the same way to infer economic consumer surplus values for the activity at the site. This type of modeling has been successfully in a variety of applications, especially for well-defined sites such as wildlife parks and reserves and lakes in the United States.

The implementation of the model requires an appropriate spatial distribution of users in terms of distance to the site so that users of the site are in effect paying a range of 'prices' measured on a travel cost basis.

Our survey respondents provided us with information on the number of trips to their preferred abalone fishing site in the Perth area, the time spent away from home on these fishing trips and the distances traveled for a return trip to that site.

Basic statistical analysis did not indicate any statistically significant relationships between the number of abalone fishing trips and the distance traveled and the distance traveled per trip, the number of trips and socio-economic variables like income. These latter variables are the ones typically expected to be significant in a travel cost model.

On reflection this result is not surprising. Travel cost models are most appropriate in circumstances where the population of the actual and potential fishers is spatially distributed over a significant distance from the recreational fishing site. This ensures the required variability in distance and in access time. In this fishery, the survey respondents were concentrated in close proximity and time to the abalone site fished. Consequently, there was no great variation in travel distances and access times and hence the travel costs per trip.

The inappropriateness of the travel cost method has meant that the analysis below is based on use of a contingent valuation survey to estimate the social valuation at the margin for recreational abalone fishing in the Perth roe's abalone fishery.

3.4 Stated Preference and Contingency Valuation Modeling

Assuming sustainability is not an issue under the existing combined commercial and recreational roe's abalone catches and effort in the Perth fishery, the options considered in this study are the possible reallocations at the margin (rise or fall) around the existing bag (catch) limit. These options were chosen because they reflected a widely held perception among all interested parties that the recreational demand for roe's abalone in the Perth fishery was largely unsatisfied at the existing catch limits and time constraints. Hence, the focus of our research was on the values that recreational fishers placed on roe's abalone catch limits at the margin and the comparison between the marginal values of catches for recreational and commercial uses. As outlined in the general theoretical framework[7], the economic benefits of these resource uses are optimized, in theory, when the marginal values of each of the two uses are the same.

The marginal values recreational fishers place on achieving increased or avoiding reduced bag limits at the margin rather than the values placed on retention of all of the existing abalone catches were the key values explored in this case study. In particular, if there were uniformly unsatisfied demand among recreational roe's abalone fishers in the Perth fishery, then, in economic theory, there would 'willingness to pay' for increased catch limits and an even a stronger 'willingness to pay' to avoid reductions to catch limits.

Figure 5 below illustrates this using three hypothetical situations. There is a demand for abalone fishing (DD') and a catch constraint (SS'). At SS' the catch constraint is at quantity Q1. If the catch available were increased to Q2 there would be a positive willingness to pay for this. As the binding catch constraint is eased (Q1 to Q2) and the consumer moves from E to G, there is a willingness to pay (equal to the gain in consumer surplus) measured by the area under the demand curve between Q1 and Q2. As the existing bag limit is tightened (Q1 to Q3) and the consumer moves from E to F, there is a loss of consumer surplus measured by the area under the demand curve between Q1 and Q3 and this indicates the maximum amount that the consumer would be willing to pay to avoid the cut from Q1 to Q3.

[7] op cit 1

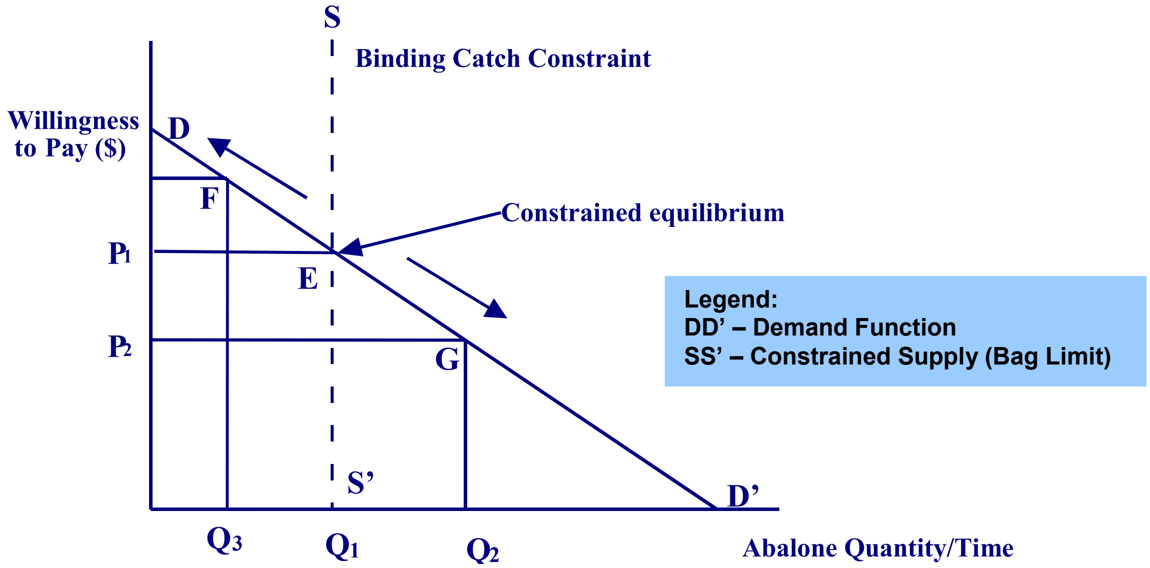

Figure 5 Hypothetical Demands Under Binding Catch (Supply) Constraints

This interpretation is dependent on the consumer being initially at SS', that is, on the constraint so that a change in the bag limit up or down from the existing prescribed level is meaningful for the consumer. This is, the widely held view regarding recreational abalone fishers in Perth. That is recreational roe's abalone fishers in the Perth fishery are perceived to be at E but have a demand closer to point 'G' in Figure 5, and, in this case, contingent valuation questions relating to a rise and fall in the bag limit are expected to produce a set of consistent valuations for both willingness to pay to achieve an increase in catch limits and to avoid bag limit reductions. On the assumption that there is a diminishing marginal utility for abalone, we would expect that the marginal willingness to pay would decline as consumers were offered additional abalone catch.

3.4.1 Consumer Choice Model

As already noted, contingent valuation surveys are used in this study to estimate the recreational fishers marginal willingness to pay for abalone in the Perth abalone fishery. The application of this technique is based on an underlying model of consumer choice and the notion of an individual recreational fisher "optimizing" their fishing behaviour in a way that reflects their underlying preferences for fishing versus other activities and the constraints (such as dollars and time) that they face. Based on the analysis just presented the surveys must deal with the marginal valuation or willingness to pay for an increase in abalone fishing activity and the marginal valuation or willingness to pay to avoid a reduction in abalone fishing activity.

The underlying model is based on the assumption that individual Perth abalone fishers undertake fishing to maximize utility in the form:

$$u(x,q,z). \quad (1)$$

subject to the budget constraint,

$$y=px+z; \quad (2)$$

where x is abalone fishing trips, q is a measure of abalone quality (catch and size) achieved on each trip, z is expenditures on all other goods (pz=1), y is income and p is the average price (cost) of a trip to the beach to fish for abalone, including license fee costs.

This choice framework leads to an indirect utility function, which we can specify in the form;

$$v(p,q,y). \quad (3)$$

where p, q and y are as defined above.

In the context of these two scenarios, the abalone fisher survey respondent is faced with the following problem:

$$\Delta.v = v(p,q,y\text{-}A) - v(p,q=0,y) \neq 0 \quad (4)$$

where Δ.v is the change in utility associated with a change in fishing activity or entitlement, q=0 indicates that the abalone fisher does not have the opportunity to catch any more fish (the status quo), A is the price to increase abalone catch activity or entitlement or avoid a reduction and y-A is the income after paying A for an increased abalone bag limit or two avoid a reduction.

When an increase in abalone fishing activity or entitlement is offered to the individual fisher, the model is based on the fisher making a direct trade-off between maintaining current consumption as opposed to having less general consumption but greater abalone fishing activity. Where a decrease in abalone fishing activity or entitlement is concerned, for the individual fisher, the model is based on the direct trade-off between having current general consumption but less abalone fishing activity as opposed to having less general consumption but retaining access to the current abalone fishing activity. These are markedly different trade-offs and are reflected in Scenarios A and B discussed below.

3.4.2 The Two Contingent Valuation Scenarios Used

To implement these model abalone fishers were subjected to a phone survey that included a referendum style of contingent valuation. Each contingent valuation survey values a particular scenario. Two scenarios were used. These are shown in Appendix 3 and were randomly assigned to our survey respondents.

Scenario A

The first scenario (Scenario A in the recreational questionnaire) was presented in terms of the respondents willingness to pay an additional recreational abalone license fee (a proxy marginal price) above the existing fee for an increased bag limit (marginal quantity). This scenario was against the background that there were no changes to the existing number of days and time that they could fish for abalone in the Perth fishery or the minimum size of the abalone, which they could catch and keep. The number of extra abalone per trip and the amount of the additional license fee were varied and randomly assigned to respondents. Each was asked to give a 'yes' or 'no' answer. The 'yes' and 'no' responses were then 'teased out' to test the respondent's true stated preference. This is because a 'yes' response to a particular price for a given extra quantity may not be a true reflection of whether the individual respondent is willing to pay more than the price offered for that quantity. Similarly, a 'no' response may not be an indication of a willingness to pay a lower price for the quantity offered.

Scenario B

The second scenario (Scenario B) asked respondents about their willingness to pay an additional recreational abalone license fee above the existing fee to avoid a reduced catch limit. Like Scenario A, this scenario was presented against the background that there were no changes to the number of recreational fishing days and times nor the minimum size of abalone they could catch and keep. The reduced number of abalone per trip and the amount of the additional license fee were varied and randomly assigned to respondents. Each respondent was asked to give a 'yes' and 'no' answer. Similar to Scenario A, the 'yes' and 'no' responses were 'teased out' to ascertain the respondents true stated preference for the same reasons and using a similar approach to that applied in Scenario A.

Both scenarios amount to an increase in the average cost of each abalone fishing trip and each abalone caught and can be given a direct interpretation in terms of the choice model.

3.4.3 Interpretation of Scenario A: Estimating the Marginal Willingness to Pay for Increased Catch Limits

For scenario A, if the two indirect utility functions are equal so that $\Delta.v$ in equation (4) above is zero, then the abalone fisher is indifferent between having a higher bag limit with the higher fee and not having a higher bag limit. If the utilities are not equal then the fisher will accept or reject the higher bag limit/higher fee combination offered. That is,

If $v(p,0,y) > v(p,q,y-A)$, then the utility without the bag limit increase is greater than the utility with the higher bag limit and the respondent will answer 'NO' to the survey question.

If v (p,0,y) < v (p,q,y-A), the respondent will answer 'YES' because the utility with the higher bag limit is greater than without it.

The probability of a 'YES' response takes the form:

Pr (YES) = P (Δ.v + ε> 0)

where ε is a random error. If the random error is distributed logistically then the probability can be estimated with logistic regression of the form:

Pr (YES) = (1 + exp (-Δ.v))-1

Median willingness to pay can be found by setting the probability of a 'yes' response equal to .5 (indifference in indirect utility) and solving for the increase in total cost that makes the respondent indifferent between having and not having the bag limit increase.

Δv or the difference in utility is usually posited to depend on the fee nominated, the quantity-quality available and a range of socio-demographic and attitudinal variables. The model is then estimated as a logistic regression with a form:

$$Log[\frac{\Pr ob(yes)}{1-\Pr ob(yes)}] = \alpha_0 - \beta_1 FEE + \beta_2 QTY + \sum \beta_i SOCIO_i$$

The estimated equation can be used to determine average willingness to pay and marginal or "part worth" willingness to pay.

The median willingness to pay is found by finding the fee that would make the probability of a 'yes' equal to 0.5 which is the point at which the abalone fisher would be indifferent between having the extra catch or not. This median willingness to pay cannot be generalized to the population. For this a mean willingness to pay is needed and this in turn requires integration to get the area under the logistic curve.

However, it can be shown that using the above specification, the untruncated mean willingness to pay is:

$$\text{Mean Maximum WTP} = \frac{1}{\beta_1}[ln(1 + e^{\alpha_0 + \beta_2 QTY + \sum \beta_i SOCIO_i})]$$

Where, in the above, FEE is the specified fee, QTY is the specified quantity, and SOCIO is set of socio demographic and attitudinal variables. This means estimate can be generalized to the population.

While the above is illustrated as a linear specification, non-linear specifications are allowable. Each equation then implies different marginal willingness to pay. The marginal willingness to pay or part worth is defined in terms of the trade off between quantity and price which is of the form:

Marginal willingness to pay = $(\partial(\Delta V)/\partial QTY)/(\partial\Delta V/\partial Fee)$,

Which for the linear case is β_2/β_1

Results: Scenario A

Of the 364 respondents, 193 were presented with Scenario A, that is, there willingness to pay for an increased bag limit. This provided us with a substantial data set for analytical purposes. The variables used in the analysis for Scenario A and their descriptive statistics are shown in Appendix 4.

Using these survey data, a number of logistic specifications were investigated. A linear version was tried, as were non-linear versions. Logistic regression results for the best performing equations are shown in Appendix 5.

The models vary in terms of the specification of the quantity offered which is included as a linear specification in equation 1, through a quadratic in equation 2, a natural log in equation 3 and an inverse in equation 4. The models have similar performance in terms of coefficients significant at the 10% level, but equations 1 (linear) and 4 (inverse) perform better on the classification test. Pseudo R^2 is higher for each of equations 1, 2 and 3 than for equation 4.

Using the mean maximum willingness to pay equation as discussed above, yields the estimates given below in Appendix 6. The estimates vary considerably across the model specifications. At 5 abalone, which is close to the average number offered in the survey, the mean maximum willingness to pay is \$26.63 for the linear model, \$26.88 for the quadratic estimate, \$24.91 for the log model and \$27.78 for the inverse specification.

The scenario offered an increase in the daily bag limit. The mean values can be scaled to the population estimates based on the 15,227 metropolitan licenses. This being the case, the aggregate willingness to pay to increase the daily bag limit by 5 abalone (30 over a six day season) is between $317,224 and $617,836 depending on the specification. These results are shown in Table 2 below

Table 2: Recreational Abalone Fishers Aggregate Willingness to Pay to Increase Daily Bag Limits under Different Model Specifications

	Linear Equation 1	Quadratic Equation 2	Log Equation 3	Inverse Equation 4
Daily Increase in Limit. Abalone				
1	$274,781	$147,139	$143,879	$50,158
5	$405,447	$409,242	$379,247	$415,458
10	$617,836	$317,224	$532,434	$506,646

Using the part worth equation as discussed above yields the marginal willingness to pay results shown in Appendix 7. The willingness to pay is constant at $4.43 in the linear version and starts at $15.97 for equation 2, $24.59 for equation 3 and $91.83 for equation 4. For the quadratic it falls to $5.00 at just over 5 extra abalone per day. For the log equation it falls to $5 at just under 5 abalone per day and for the inverse it falls to $5 at just over 4 abalone per day.

The change in the marginal willingness to pay under different model specifications is illustrated in Figure 6 below.

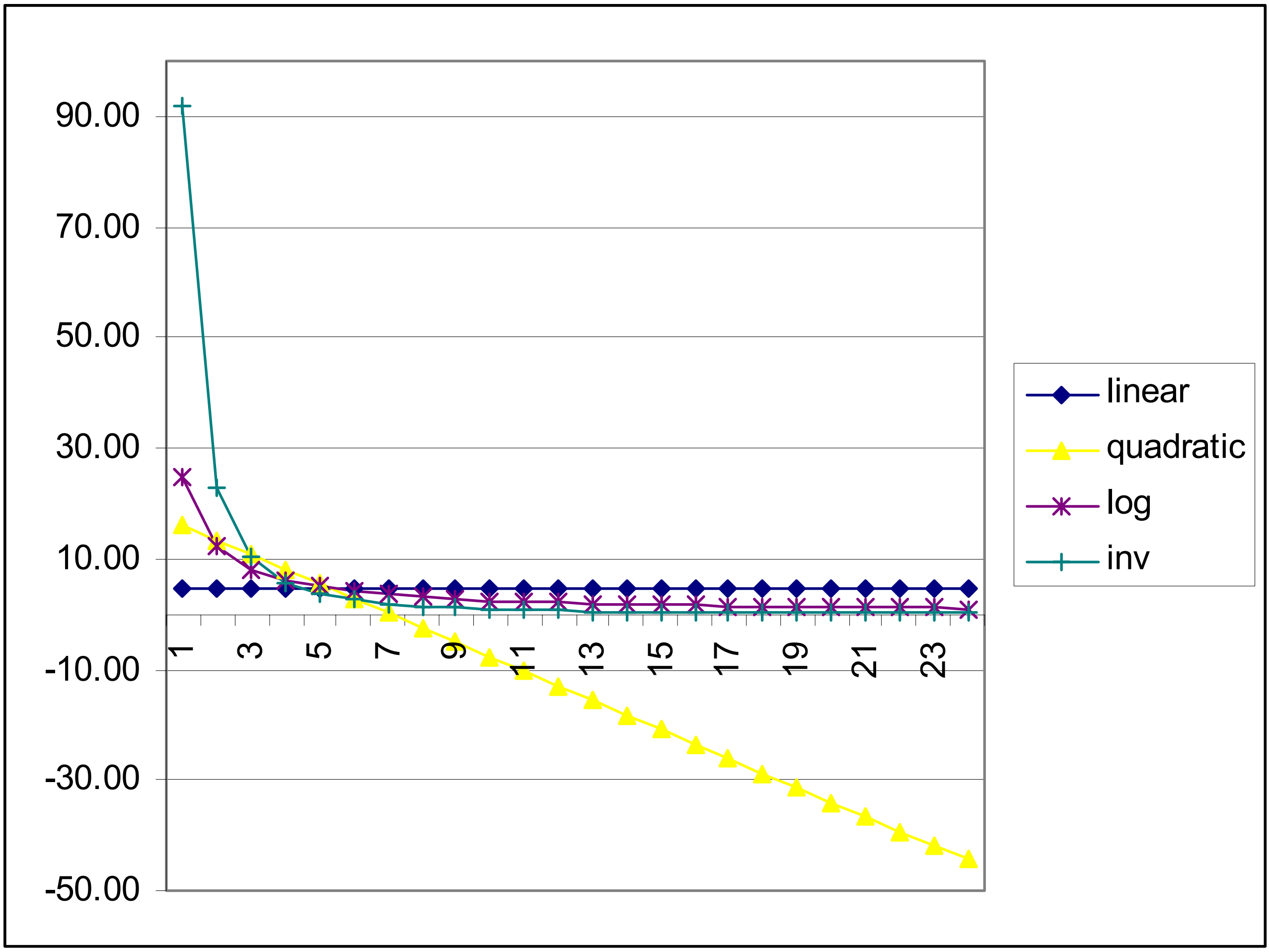

Figure 6: Recreational Fishers Marginal Willingness to Pay to increase daily bag limits under Different Model Specifications

In order to consider these results in terms of the overall allocation model, we need to choose one of the specifications to work with. Based on the statistical results and consistency with economic theory, equation 3 (the log specification) and 4 (the inverse specification) were selected for the purposes of our allocation modeling (see Chapter 4). Essentially the task is to compare the marginal consumer surplus from adding additional abalone to the recreational sector with the marginal value of adding them to the commercial sector.

3.4.4 Interpretation of Scenario B: Estimating the Marginal Willingness to Pay to Avoid Reduced Catch Limits

For scenario B, if the two indirect utility functions are equal, so that Δv in equation (4) above is zero, then the abalone fisher is indifferent between maintaining bag limit with the higher fee and reduced bag limit at the current fee. If the utilities are not equal then the fisher will accept or reject the retained bag limit/higher fee combination offered. That is:

If v (p,0,y) > v (p,q,y-A), then the utility with the reduced bag limit and current price is greater than the utility with the current bag limit and higher price and the respondent will answer NO to the survey question.

If v (p,0,y) < v (p,q,y-A), the respondent will answer YES because the utility with the reduced bag limit and current price is less than the utility from the current bag limit and higher price.

The probability of a YES response takes the form;

Pr (YES) = P ($\tilde{\Delta}$v + ε> 0)

where ε is a random error. If the random error is distributed logistically then the probability can be estimated with logistic regression of the form:

Pr (YES) = (1 + exp (-$\tilde{\Delta}$v))-1

Median willingness to pay can be found by setting the probability of a yes response equal to .5 (indifference in indirect utility) and solving for the increase in total cost that makes the respondent indifferent between having and not having the bag limit increase.
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$\tilde{\Delta}$v or the difference in utility is usually posited to depend on the fee nominated, the quantity-quality available and a range of socio demographic and attitudinal variables. The model is then estimated as a logistic regression with a form:

$$Log[\frac{\Pr ob(yes)}{1-\Pr ob(yes)}] = \alpha_0 - \beta_1 FEE + \beta_2 QTY + \sum \beta_i SOCIO_i$$

The estimated equation can be used to determine average willingness to pay and marginal or “part worth” willingness to pay.

The median willingness to pay is found by finding the fee that would make the probability of a ‘yes’ equal to 0.5 which is the point at which the abalone fisher would be indifferent between having the extra catch or not. This median willingness to pay cannot be generalized to the population. For this a mean willingness to pay is needed and this in turn requires integration to get the area under the logistic curve.

However, it can be shown that using the above specification, the untruncated mean willingness to pay is:

$$\text{Mean Maximum WTP} = \frac{1}{\beta_1}\left[\ln\left(1 + e^{\alpha_0 + \beta_2 QTY + \sum \beta_i SOCIO_i}\right)\right]$$

Where, in the above, FEE is the specified fee; QTY is the specified quantity is SOCIO is set of socio demographic and attitudinal variables. This means estimate can be generalized to the population.

While the above is illustrated as a linear specification, non-linear specifications are allowable. Each equation then implies different marginal willingness to pay. The marginal willingness to pay or part worth is defined in terms of the trade off between quantity and price which is of the form,

Marginal willingness to pay = $(\partial(\Delta V)/\partial QTY)/(\partial \Delta V/\partial Fee)$,

which for the linear case is β_2/β_1

Results: Scenario B

Of the 364 respondents, 171 were presented with Scenario B, that is, their willingness to pay to avoid a reduced daily bag limit. This provided us with a statistically significant data set. The variables used in the analysis and their descriptive statistics are shown in Appendix 8.

For scenario B, the same logistic specifications were investigated as for scenario A. Each specification was subjected to stepwise analysis to test for the effects of excluding/including variables. In every case, the quantity offered was not statistically significant. Using conventional stepwise logistic regression the only variables that were consistently significant were the price (license fee) offered to enable fishers to avoid the bag limit reduction and the number of times the fisher fished in the metropolitan region. The former had the expected negative impact and the latter the expected positive impact. The constant term was not significant.

This outcome means that, in effect, only one equation exists and that the marginal willingness to pay for abalone cannot be inferred from the estimated equations and that the mean aggregate willingness to pay does not depend on the quantity.

The results for the best fitting equations where, for equation 1, quantity is excluded and where for equations 2, 3 and 4 we forced quantity into the equation are shown in Appendix 9.

Using the mean maximum willingness to pay equation as discussed above, yields the estimates given in the Appendix 10.

The estimates vary considerably across the models. At 5 abalone, which is close to the average number offered in the survey, the mean maximum willingness to pay is $65.18 for the linear model, $65.61 for the log model and $64.24 for the inverse specification. This is substantially higher than for scenario A but, as already noted, the lack of statistical significance for the quantity term means that we cannot have great confidence in these estimates.

Using the part worth equation as discussed above yields the marginal willingness to pay results shown in Appendix 11. The willingness to pay is constant at $2.62 in the linear version and starts at 11.10 for log equation and $74.9 for the inverse equation. It falls to $5.00 at just over 2 abalone per day for the log specification and it falls to $5 at just under 4 abalone per day in the case of the inverse model. However, as with the mean maximum willingness to pay, the fact that the quantity term is statistically insignificant means that we have to treat these particular results with caution.

For this reason subsequent analysis relies on the results from Scenario A.

The explanation as to why quantity is not statistically significant appears to be connected to the shortfall in season catch and the amount of the bag limit reduction nominated to respondents. On average, season catch is 51 abalone below the theoretical maximum of 120. The average bag limit reduction nominated was 5.8 (that is, around 35 abalone below the catch limit for the season). When we consider these two facts, we can conclude that for many of the scenario B respondents, the bag limit reduction offered was non binding in the sense that their season catch was already falling short by at least this amount. In these circumstances, it not surprising that the reduced quantity did not have a significant impact. Ideally, to test this scenario, the bag limit reductions nominated need to be large enough to be binding such that failure to pay would result in an actual catch reduction.

Further research to better understand recreational fishers' behaviour in face of reduced bag limits is needed before Scenario B type results could be used in allocation models.

3.4.5 Overview of Survey Results and Interpretation of Rise and Fall Catch Limit Scenario

The recreational fishing survey results turned out to be somewhat contrary to the general expectation about the extent to which fishers were constrained in catch terms.

Contrary to widely held perceptions among interested parties, what we discovered was that the constraints on recreational fishing in the Perth roe's abalone fishery were not universally binding on individual respondents in our recreational survey. Many chose to fish less than the allowed days and caught less than the allowed daily catch. Also, somewhat surprising, individual respondents' were not universally unsatisfied at the existing constraints even when they were pushing against them. The responses to questions about satisfaction with aspects of the fishing experience indicated that the fishers are far from homogeneous.

The following diagram can illustrate our findings.

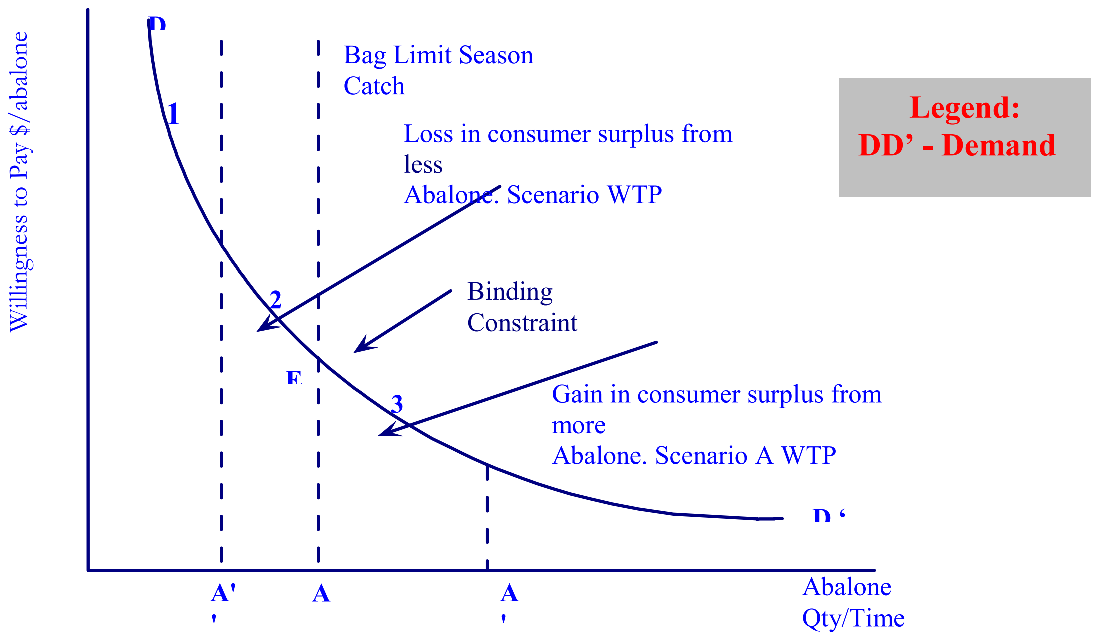

Figure 7: Hypothetical Demand Conditions

The initial expectation was that respondents would effectively be at a point like E, that is they would be on or near the catch limit applied to their fishing. However, the results indicate that a significant number of respondents are not catching at the limit. Indeed, around 40 percent of our survey population had fished less than 4 out of the permitted 6 times with average catches per trip (less than 15 abalone) well below the maximum allowable take (20 abalone). These outcomes were much lower than expected even after allowing for the possibility that poor ocean conditions may have limited fishing opportunities, although 16 per cent of our survey group fished the permitted 6 times and averaged catches per trip at or close to the maximum allowable catches (that is, 18 abalone or more per trip).

We expect this to affect the results on willingness to pay as follows.

- A person at a point like 1 in Figure 7 on the demand function has optimized well short of the bag limit. Such as person was not likely to be impacted by the bag limit changes offered under either Scenario A or B. Such individuals may therefore not be to be willing to pay to achieve the bag limit increase offered under Scenario A or avoid the bag limit reduction offered under Scenario B.

- A person at a point like 2 in Figure 7 has optimized short of, but close to, the current bag limit constraint. Such a person may not be impacted by the proposed bag limit increase under Scenario A but is more likely to be impacted by the proposed bag limit reduction under Scenario B (depending on the size of the reduced bag limit offered relative to just how far short of the current bag limit the individual respondent is). Such an individual is more likely to be willing to pay under Scenario B than Scenario A.

- A person who is bound by the constraint and wishes to be at a point like 3 on Figure 7 would benefit from the increase in catch limit offered under Scenario A and be hurt by the catch limit reduction offered under Scenario B. Such an individual would be expected to be willing to pay under both Scenarios A and B with the willingness to pay being greater under Scenario B, all other things equal.

The expectation was that virtually all abalone fishers were constrained by the current bag limit. This being the case only modest reductions were proffered under Scenario B. It appears that, for a significant number of respondents, the catch reduction offered did not take them below their current catch.

As a consequence, the Scenario B results were considerably different from those for Scenario A. Most noticeably, the size of the reduction offered was not significant in explaining the willingness to pay. Only price was significant.

Nonetheless, these survey results were insightful in their own right. In particular, they show that to properly test reduction scenarios such as Scenario B, the bag limit reductions nominated need to be large enough to be binding such that failure to pay would result in an actual catch reduction and hence a worsening of consumer welfare. Further research would be required in this area before Scenario B type results could be factored into our allocation model.

Scenario A results, on the other hand, yielded a set of statistically significant outcomes and valuation estimates equations (3 and 4) consistent with economic theory. For the demonstration purposes of this project we used Scenario A outcomes from equations 3 and 4 in our optimal allocation modeling (see Chapter 4).

The results from the abalone fishery have also highlighted an intra-allocation issue. The survey responses indicate scope to increase the benefits from recreational use within existing constraints without the necessity to change inter-sectoral allocations. This issue and the policy implication for fisheries management are also discussed in Chapter 4.

4 OPTIMIZING THE NET BENEFITS FROM RESOURCE ALLOCATION BETWEEN COMMERCIAL AND RECREATIONAL USES

In the first report from this study we developed the theoretical framework for considering the optimization of the net benefits of resource sharing between recreational and commercial uses. This theoretical framework, which focused on resource allocation within a sustainable catch and effort, is summarized in Figure 8 below.

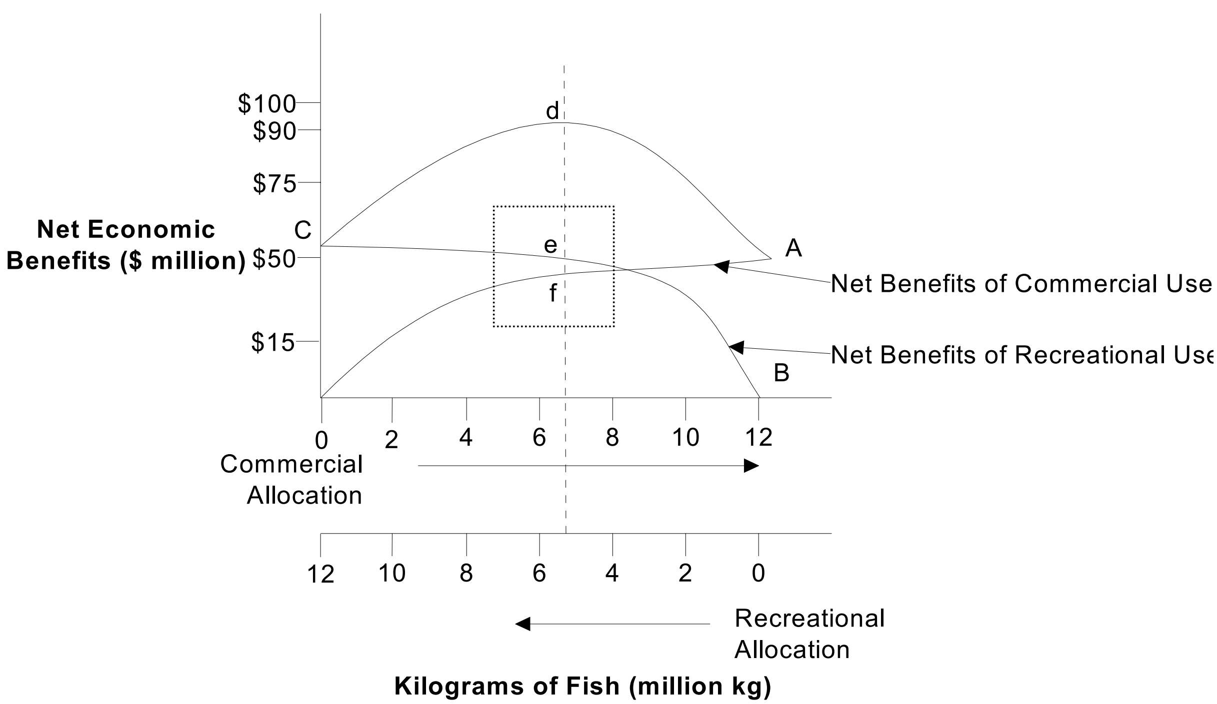

Figure 8: Net Benefits of Resource Allocation: A Theoretical Framework

In Figure 8, curve BC is the net benefits attributable to recreational use, OA is the net benefits attributable to commercial production and local consumption or commercial use, and AC is the total net benefit attributable to the combined commercial and recreational use.

Point ‘d’, which represents the apex of curve AC, is the point at which the overall or aggregate net benefits are optimized from the combined commercial (point f) and recreational (point e) uses. This is the highest point on the aggregate surplus curve AC and at this point the marginal benefit is the same in both competing uses. At no other allocation is the overall net benefit as large. Moving away from this point to an alternative allocation could increase the benefits of one user group but would reduce the benefits to the other user group and would reduce overall benefits because the marginal benefit to the gaining group as we move away from point 'd' would be less than the loss to the losing group.

In economic terms, the overall net benefits from combined commercial and recreational use are maximized at the allocation where the marginal benefits to commercial and recreational use are the same. This is the point where the slope of the net benefit curve for recreational use is the same as the slope of the net benefit curve for commercial use.

In implementing this framework, our analysis therefore set out to focus on the marginal net benefits of the respective uses for the demonstration purposes of this project. That is, we set out to find the point at which the marginal net benefit curves for commercial and recreational use of roe's abalone in the Perth fishery intersect.

4.1 Application of the General Theoretical Framework to the Perth Abalone Fishery

For the demonstration purposes of this case study, our analysis focused on the values recreational fishers attached to increased catch (bag) limits, that is, Scenario A in Section 3.4.3. Essentially, the task is to compare the marginal consumer surplus of adding an additional abalone to the recreational fishers' bag limit with the marginal producer surplus of an equivalent catch by the commercial sector.

As mentioned in Section 3.4.4, the marginal consumer surplus associated with reduced bag limits (that is, Scenario B) was discounted for the purposes of this analysis. As explained previously, for many respondents, the catch reductions offered do not appear to have been large enough to impact negatively on them. Apart from price, there were no other statistically significant explanatory variables in the willingness to pay equations. Further research is required in this area to better understand recreational fishers' behaviour before Scenario B type results could be meaningfully incorporated into our modeling.

One implication of the management regime is that the recreational and commercial products are not identical. The minimum size of roe's abalone that may be taken by recreational fishers in the Perth fishery is 60mm, whereas it is 70mm in the case of the commercial catch. The data available from commercial operators were based on kilograms of whole abalone, whilst those provided by recreational fishers related to more or less abalone in the bag limit. A conversion factor is needed to convert commercial catch data to abalone numbers or recreational abalone numbers to kilograms. For purposes of this analysis, we used conversion factors of 12 roe's abalone to a kilogram of recreational catch in the Perth fishery based on Fisheries Department research. Between 8 to 9 abalone to a kilogram was used for the commercial catches reflecting the catch data reported by commercial operators.

On the recreational side, as mentioned in Section 3.4.3, we have used the log equation and the inverse equation (and discounted the linear and quadratic equations) for analytical purposes. This is because the statistical results from applying these two equations were consistent with the economic theory of diminishing marginal utility, that is, individual's marginal utility declines with each extra abalone consumed. For instance, the utility derived for the first additional abalone will be greater than it is for the second extra abalone and much less for the third and so on. This highlighted the importance of appropriately specifying the marginal benefit (surplus) equations for the optimization model to be used if economically and socially sound allocation estimates are to be derived.

The results of our analysis are shown in Figure 9 below. The diagram is a graphical representation of results already presented previously for the commercial and recreational sectors.

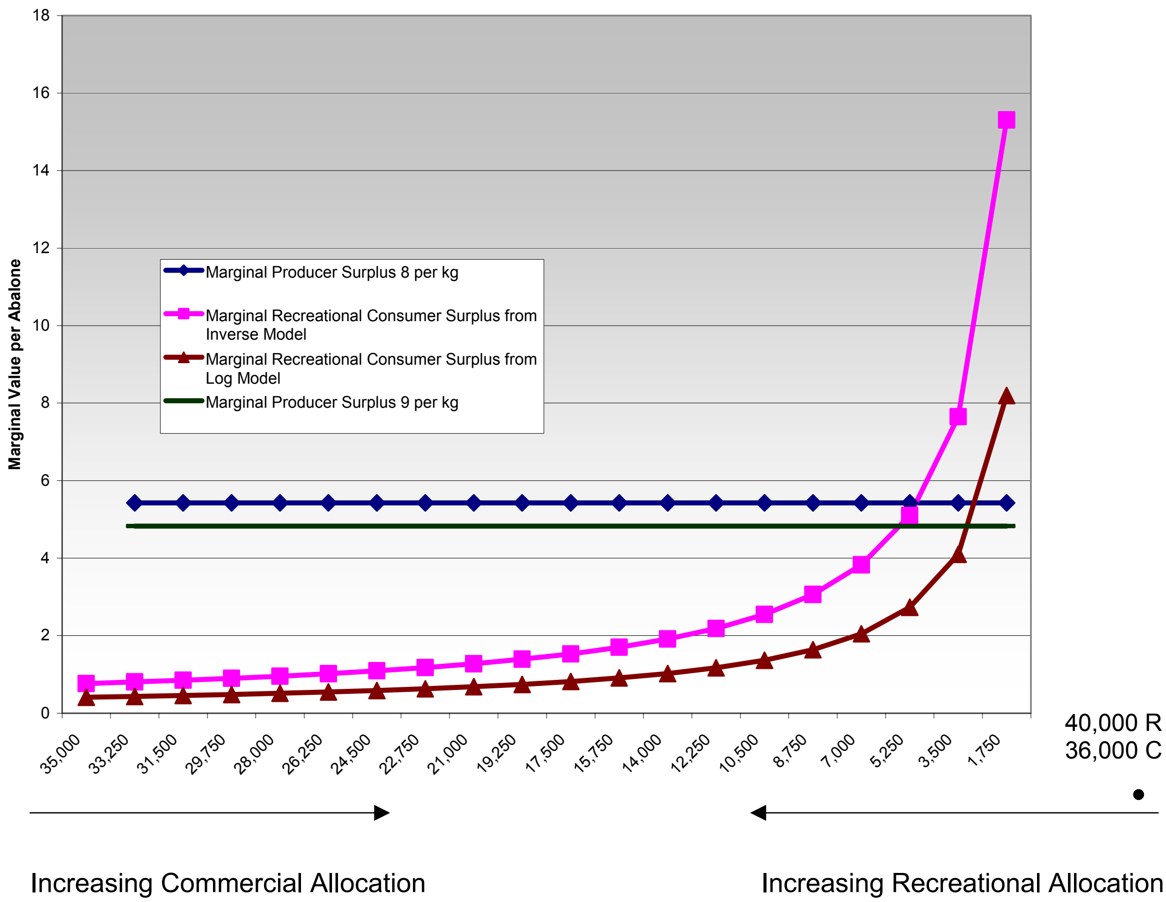

Figure 9: Marginal Net Benefits of Commercial and Recreational Use in the Perth Abalone Fishing

The relationship between the marginal benefits for commercial and recreational use is for a defined volume range. This reflects the underlying supply and demand conditions on the commercial side and the underlying preferences on the recreational side for Perth roe's abalone. The marginal producer surplus for the commercial side is a constant based on the assumption that the Perth roe's abalone industry is a 'price taker' (that is, supply changes will have no impact on price received) and that the marginal costs change little over the volume range.

The right hand origin is the current allocation. Working from right to left the diagram shows additional allocation to the recreational sector. At the existing catch shares of around 40,000 kilograms for recreational and 36,000 kilograms for commercial, the analysis shows that, for the next additional abalone, the marginal benefits to recreational use are estimated to be higher than the marginal benefit from commercial use. If the existing catch levels are accepted as defining the total sustainable catch in the fishery, then a reallocation of up to another 4,500 kilograms of abalone to the recreational sector (based on the inverse equation) is indicated. This would increase the overall benefit to society for the combined commercial and recreational use of the resource. This is because the marginal benefit of an extra abalone allocated to recreational use is greater than the loss in producer surplus at the marginal up to this tonnage. Beyond this extra 4,500 kilograms, the marginal benefit to commercial use exceeds those from recreational use across the remainder of the volume range.

As shown in the Figure 9 above the result does not differ markedly if the commercial conversion factor is based on 8 or 9 abalone to the kilogram of whole abalone. If we used the log equation the corresponding figure is up to 4,000 kilograms. The difference between the two results would be equivalent to an increase in the bag limit of around three compared to four. If the log equation were used instead of the inverse equations for the marginal benefit of recreational use the results would be as low as 2,000 kilogram, which translate into a bag limit increase of less than one.

As mentioned previously, the producer surplus estimates are sensitive to movement in US/Australian dollar exchange rate. Resource allocation decisions should be based on producer surplus derived by using the underlying longer-term rate and not short-term movements.

A critical issue in the successful application of the theoretical framework is the ability to specify the aggregate sustainable catch to be allocated between the competing uses. For the purposes of our analysis, we used the combined actual commercial (36 tonne) and recreational (40 tonnes) catches as being indicative of the sustainable (76 tonnes) catch.

However, the data show that, if the participating recreational abalone fishers had exercised their full entitlement and had fished on all the available fishing days and achieved bag limit catches within the available fishing time, then probably the actual recreational catch would have been closer to 70 tonnes (instead of the actual 40 tonnes) and the combined catch around 106 tonnes (instead of 76 tonnes). Moreover, if all recreational fishers with an entitlement to fish for abalone in the Perth fishery under a specific or umbrella recreational license in 2002 season had exercised and fully used their entitlement, the recreational take would have been around 150 tonne. The aggregate recreational and commercial catch in that case would have been around 186 tonnes. The latent effort implied by the management regime is considerable and there is some doubt as to whether the theoretically possible catches implied by this would in fact be sustainable.

Another major issue relates to the possible need to adjust the allocation over time. The results presented above relate to the determination of the optimal allocation at a point in time, that is, a static analysis. Underlying conditions, including economic and social values, will of course change and the results would need to be reviewed and updated over time. This could be achieved by integrating a formal dynamic element into the analysis that would capture the way that valuations are likely to change over time. How this dynamic element might be incorporate into the analytical model is beyond the scope of this research.

4.2 Underlying Conditions for Applying Inter-Sectoral Allocation Models

The analysis of the abalone fishery was based on the following assumptions:

- The combined existing commercial and recreational catch of 76 tonnes is all that is sustainable and available for inter-sectoral allocation, but this is ambiguous under the existing management regime;
- All recreational participants are subject to binding constraints (bag limits, fishing days and time), that is, there is no unused or spare capacity, but our survey results show that this is not the case for many recreational fishers in the Perth abalone fishery;
- For all commercial operators it is optimal to take the current allowable catch, that is, there is no unused or spare capacity and the survey data tends to support this possibility; and
- All commercial operators are internally structured to maximize producer surpluses from roe's abalone catches in the Perth fishery, and, given the scope to restructure through quota unit transfers among commercial licensees this is most likely the case.

If any of the above assumptions do not hold, the immediate allocation issue may be an intra- rather than an inter- sectoral one. This was clearly the case in our analysis where the survey indicated that not all recreational fishers were using their catch limits. The implications of this are considered in the next section.

4.3 Intra-Sectoral Allocation Issues

For the Perth roe's abalone fishery, the survey results indicate that recreational fishers are not fully exploiting their entitlements (bag limits, fishing days and fishing time) and the existing constraints are non-binding. This implies that there are some recreational fishers who would desire increases in catch and some who have underutilized capacity. In this case, an intra-sectoral reallocation among recreational fishers from low to high marginal value users of the abalone resource may increase the overall benefit from recreational fishing activity without any change to existing aggregate recreational bag limit and fishing days. This increases the combined benefit to society from commercial and recreational use without requiring any immediate inter-sectoral reallocation.

This is illustrated in the hypothetical diagram below.

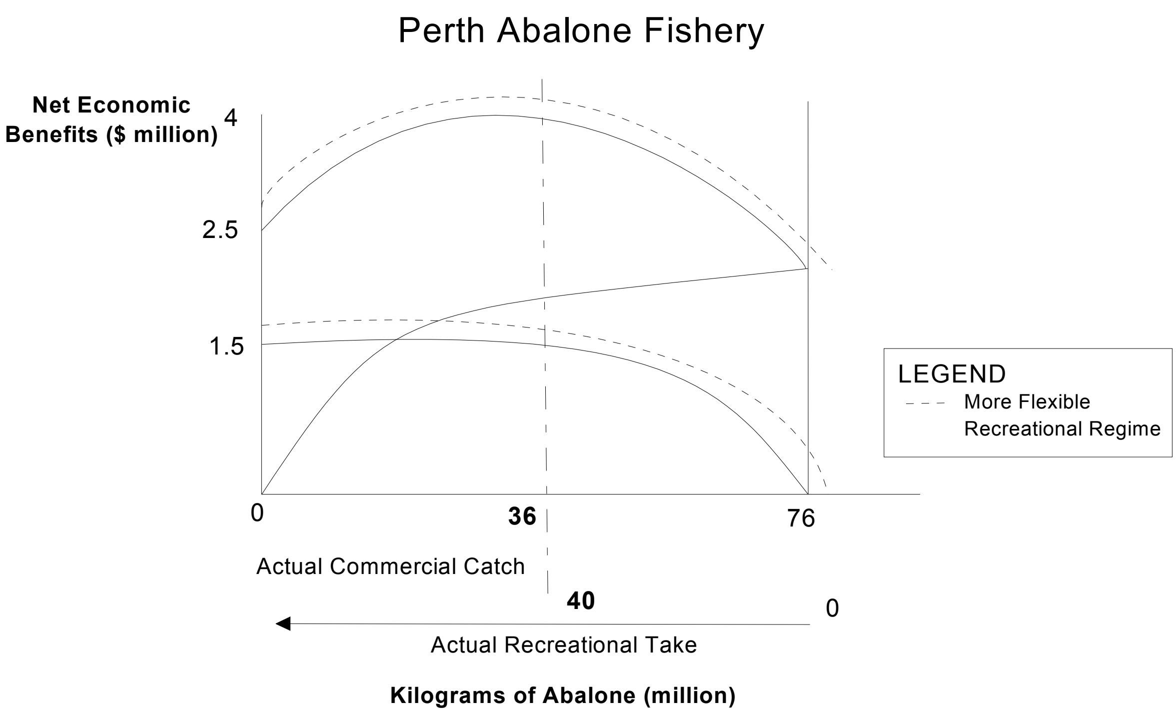

Figure 10: Hypothetical Post Intra-Sectoral (Recreational) Reallocation

The above diagram illustrates the point that efficiency on each side of the allocation needs to be optimised internally to establish the correct starting point for the application of the inter-sectoral principles. By doing this, the starting point is the set of dashed lines not the solid lines and the final solution with combined optimisation in both an intra and inter sectoral sense will deliver greater overall benefits to society from the resource.

In the case of the abalone fishery, the intra-sectoral allocation issue could potentially be addressed by offering recreational fishers more flexibility to better match individual recreational fishers preferences within existing constraints. This could be reflected through a more flexible fee structure, daily catch limits and fishing days so that recreational fishers can exercise choice. This fee structure would be based on a ‘want more, pay more’ principle. A more flexible system would need to be designed in a way that any additional administration and compliance costs did not outweigh the recreational sectors utility gains.

In such circumstances, the immediate allocation issue is an intra- and not an inter-sectoral allocation one. This is because the marginal benefit curve for recreational use would be expected to shift downwards post intra-sectoral reallocation. As the catch of recreational fishers with high marginal values move closer to their individual preferences under a more flexible recreational management regime, the marginal value of an extra abalone post intra-sectoral reallocation is expected to decline, at least in theory, under the conditions of diminishing marginal utility. This assumes that those with lower marginal values will be no worse-off or only marginally worse off due to any utility forgone due to the loss of the option value implicit in the existing bag limit. The hypothetical diagram below illustrates this point.

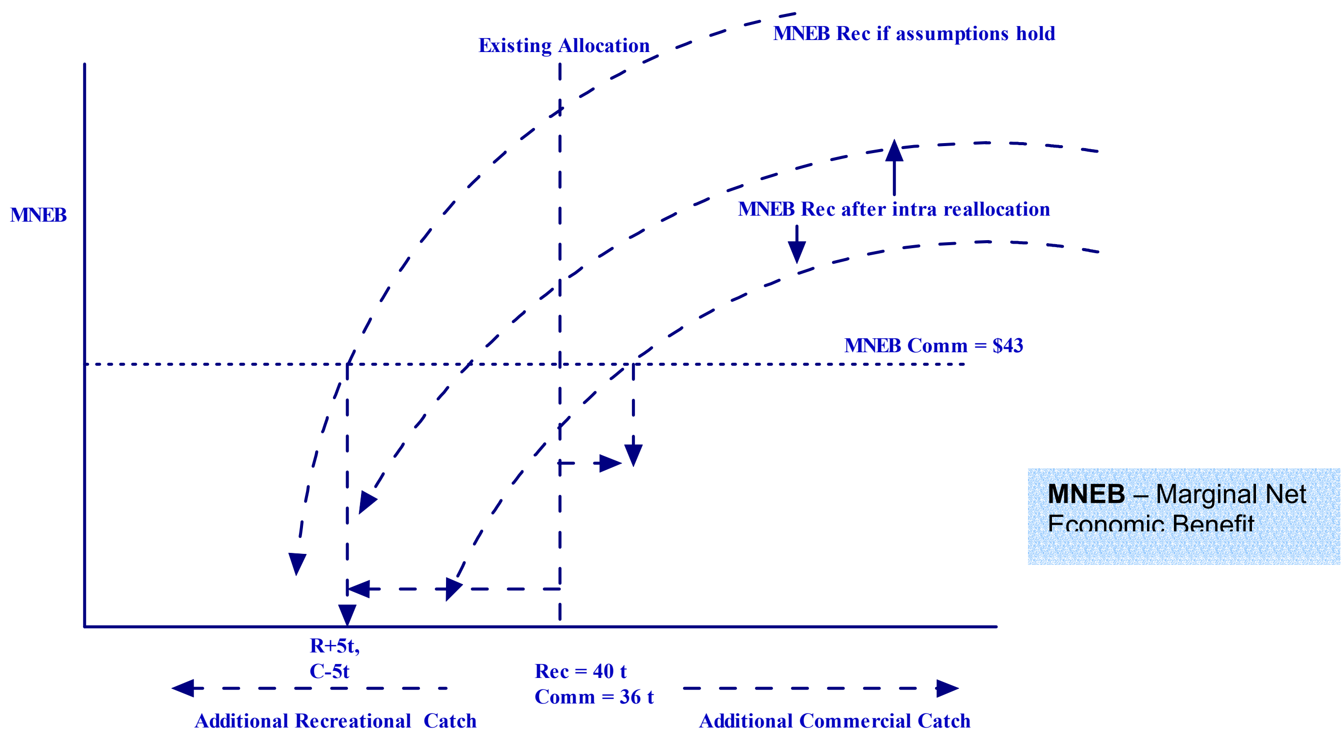

Figure 11: Hypothetical Net Benefits (Recreational) post Intra Sectoral Reallocation

The downward shift in the marginal benefit curve for recreational fishing post intra-sectoral reallocation will impact the extent of any inter-sectoral reallocation necessary to optimize the benefits to society from the combined commercial and recreational use of the resource. The size of any possible inter-sectoral reallocation to the recreational sector would be expected to be less than the 4,500 kilograms from our current modelling results. It is not inconceivable that any such reallocation might ultimately favour the commercial sector under certain conditions.

Once a more flexible recreational management regime has had sufficient opportunity to effect an intra-sectoral reallocation within the recreational sector, the static analysis would need to be reviewed and updated to determine whether an inter-sectoral reallocation remains an issue at that time.

5 GLOSSARY OF TERMS

Average total cost	Average total cost is the sum of all the production costs for a commercial fishing activity divided by the number of units produced.
Choke price	The lowest price at which the quantity demanded is zero. At every price higher than the choke price demand is zero.
Consumer surplus	The benefit consumers gain from being willing to pay more than the equilibrium market price. This is based on the notion that consumers (e.g. recreational fishes or retail consumers)m derive greater benefit from consuming a product or activity (e.g. recreational fishing or retail purchase of fish for consumption) than the cost to them of purchasing it.(e.g. time and money for recreational fishers).
Contingent valuation	The use of structured surveys to estimate the willingness of respondents to pay for public projects or programs. (e.g. access to fish stocks for recreational fishing).
Demand (curve or equation)	It shows the amount of a good that consumers are willing and able to buy at various prices.
Existence value	The benefit derived by an individual (s) from the knowledge that an environmental resource (e.g. fish stocks) exists.
Fixed cost	Costs that do not vary with the level of output. They are therefore constant

	in total as output changes..
Marginal cost	The amount spent on producing one extra unit. The marginal cost is the increase in total cost when one more unit is produced.
Opportunity cost	The decision to produce or consume a product or undertake an activity involves giving up another product. The real cost (opportunity cost) of an action is the next best alternative forgone in order to do it..
Option Value	The benefit derived by and individual(s) from retaining the option to use an environmental resource at some future date (e.g. to fish up to a bag limit in the future). Option value arises from the combination of the individual's uncertainty about future demand for the resource and uncertainty about its future availability.
Optimum allocation	Occurs when resources are allocated between competing uses (e.g. fish between recreational and commercial uses) such that it is not possible to redistribute resources to increase the welfare of any one consumer without reducing the welfare of some other consumer.
Price elasticity of demand	A measure of responsiveness of some other variable to a change in price
Producer surplus	The difference between the minimum price a producer would accept to supply a given quantity of a good and the price actually received. (e.g. the difference between the price received in the market place for commercially caught fish and the minimum price

	which reflects the marginal cost of catching).
Variable cost	Variable costs are costs that vary with the level of output/activity.(e.g. bait for commercial fishing)
Supply (curve or equation)	The relationship between the price of a good and the quantity of the good supplied by producers (firms).

6 APPENDICES

Appendix 1: Perth Abalone Fishery Commercial Use Questionnaire

We are seeking information regarding your business activities associated with the commercial take of roe's abalone in the Perth region. All figures should relate to the 2001/02 financial year.

Your information will be treated in the strictest of confidence. The data will be combined with that provided by other businesses and used by the research team for aggregate statistical analysis only.

Please complete the questionnaire by ticking boxes or providing the requested details where indicated. Please return your completed questionnaire in the enclosed reply paid envelope (addressed to Economic Research Associates, PO Box 3004, Broadway Nedlands, WA, 6009) by Monday 16th December 2002. Completed questionnaires marked for John Nicholls' attention can also be faxed to (08) 9386 3202.

Business Information

Q1 What is your business enterprise structure? (Please tick one only)

Sole Trader	☐.1	Incorporated Company	☐.4
Family Partnership	☐.2	Other (please specify)	☐.5
Other Partnership	☐.3	________________	

Q2 What is business activities are you involved with associated with roe's abalone in the Perth Fishery?

Licence holder/Diver	☐.1	Marketing and Distribution	☐.4
Processor	☐.2	Other (please specify) ________________	☐.5
Exporter	☐.3		

Q3. Please provide the number of employees and total wages and salaries.

Type of Employment	Number of Employees
(a) Full Time Employment	________________
(b) Seasonal	________________
(c) Casual	________________

(d) **Total Number of Employees** ____________________

Q4. What percentage of your employee's time would you attribute to your business activities associated with roe's abalone taken from the Perth region? %

Catch Value

Q5a. Please provide the following details of total volume of roe's abalone taken from the Perth region that was handled by your business during 2001/02.

	(1) **Catching**	(2) **Processing**	(3) **Marketing & Distribution**	(4) **Exporting**	(5) **Other**
(a)	Kg	Kg	Kg	Kg	Kg

Q5b. Please provide the following details of total value (quantity x sale price) for roe's abalone taken from the Perth region that was handled by your business during 2001/02.

	(1) **Catching**	(2) **Processing**	(3) **Marketing & Distribution**	(4) **Exporting**	(5) **Other**
(a)	$	$	$	$	$

	'Whole' Abalone	Chilled Abalone Meat	Canned Abalone Meat
Q6. a) How do you sell your abalone?	☐	☐	☐
b) What percentage of each type do you sell?	.... %	.... %	.... %

Q7. What percentages of the quantities shown in question 5 are sold to the following areas?

	(1) **WA Fish Processors**	(2) **WA Exporters**	(3) **Directly to Overseas Customers**
(a) Roe's Abalone	%	%	%

Expenditure

Q8 Please specify in the table below costs associated with your business activities relating to the volume of roe's abalone shown in question 5 (see question 5 above). (If you do not have exact figures, your best estimates will do).

		Catching	Processing	Distribution & Marketing	Exporting	Total
(a)	Wages and Salaries (owner and operator)	$	$	$	$	$
(b)	Abalone Purchased	$	$	$	$	$
(c)	Fuel	$	$	$	$	$
(d)	Repairs and Maintenance	$	$	$	$	$
(e)	Depreciation	$	$	$	$	$
(f)	Lease Payments	$	$	$	$	$
(g)	Interest Payments	$	$	$	$	$
(h)	Fees and Taxes (including fisheries and Transport fees)	$	$	$	$	$
(i)	Insurance	$	$	$	$	$
(j)	Freight	$	$	$	$	$
(k)	Office Administration	$	$	$	$	$
(l)	Other: ______________________________	$	$	$	$	$
(m)	**TOTAL**	$	$	$	$	$

Q9 What proportion of these costs would you consider to be fixed costs, that is, the level of the cost would not change regardless of volume (e.g. depreciation on diving gear) %

Q10 How will an increase or decrease in the volume of roe's abalone available to be taken in the Perth area by commercial businesses impact on your total costs? (your best estimate will do)

	Increase in volume	Change in Total Costs		Decrease in volume	Change in Total Costs
(a)	15%	%	(e)	-5%	%
(b)	20%	%	(f)	-10%	%
(c)	25%	%	(g)	-15%	%
(d)	30%	%	(h)	-20%	%

Q11 Estimate the capital replacement value of the business assets associated with roe's abalone taken from in the Perth region?

$

Abalone Prices

Q12 If the volume of roe's abalone taken in the Perth region by commercial businesses were to increase or decrease by the percentages shown below, what impact would you expect this change to have on abalone prices you might receive (please estimate a percentage)?

	Increase in volume	Change in prices		Decrease in volume	Change in prices
(a)	15%	%	(e)	-5%	%
(b)	20%	%	(f)	-10%	%
(c)	25%	%	(g)	-15%	%
(d)	30%	%	(h)	-20%	%

Q13 What were the prices you received for abalone or abalone purchased that you sold?

	Type		
(a)	Whole abalone	$	per kg
(b)	Chilled abalone meat	$	per kg (meat)
(c)	Canned abalone meat	$	per kg (export price Aus$)

Q14 Please indicate the roe's abalone prices that you used in Q5b, and what proportion you sell at each price level

Ex Wharf prices?	☐	.... %
Delivered to Customer's door?	☐	.... %
Ex factory?	☐	.... %

Appendix 2: Net Benefits from Commercial Activity

Kgs	Total Cost	Fixed Cost	Average Cost	Marginal Cost	Total Revenue	Producer Surplus	Producer Surplus (unit)
28,000	$440,620	**$255,200**	$15.74		$1,400,778	$960,158	$34.29
29,000	$447,242	**$255,200**	$15.42	$6.62	$1,450,806	$1,003,564	$34.61
30,000	$453,864	**$255,200**	$15.13	$6.62	$1,500,833	$1,046,969	$34.90
31,000	$460,486	**$255,200**	$14.85	$6.62	$1,550,861	$1,090,375	$35.17
32,000	$467,108	**$255,200**	$14.60	$6.62	$1,600,889	$1,133,781	$35.43
33,000	$473,730	**$255,200**	$14.36	$6.62	$1,650,917	$1,177,186	$35.67
34,000	$480,352	**$255,200**	$14.13	$6.62	$1,700,944	$1,220,592	$35.90
35,000	$486,975	**$255,200**	$13.91	$6.62	$1,750,972	$1,263,998	$36.11
36,000	**$493,597**	**$255,200**	**$13.71**	$6.62	**$1,801,000**	**$1,307,403**	**$36.32**
37,000	$500,219	**$255,200**	$13.52	**$6.62**	$1,851,028	$1,350,809	$36.51
38,000	$506,841	**$255,200**	$13.34	$6.62	$1,901,056	$1,394,215	$36.69
39,000	$513,463	**$255,200**	$13.17	$6.62	$1,951,083	$1,437,620	$36.86
40,000	$520,085	**$255,200**	$13.00	$6.62	$2,001,111	$1,481,026	$37.03
41,000	$526,707	**$255,200**	$12.85	$6.62	$2,051,139	$1,524,432	$37.18
42,000	$533,329	**$255,200**	$12.70	$6.62	$2,101,167	$1,567,837	$37.33
43,000	$539,952	**$255,200**	$12.56	$6.62	$2,151,19	$1,611,24	$37.47

					4	3	
44,000	$546,574	**$255,200**	$12.42	$6.62	$2,201,222	$1,654,649	$37.61
45,000	$553,196	**$255,200**	$12.29	$6.62	$2,251,250	$1,698,054	$37.73
46,000	$559,818	**$255,200**	$12.17	$6.62	$2,301,278	$1,741,460	$37.86
47,000	$566,440	**$255,200**	$12.05	$6.62	$2,351,306	$1,784,866	$37.98
48,000	$573,062	**$255,200**	$11.94	$6.62	$2,401,333	$1,828,271	$38.09
49,000	$579,684	**$255,200**	$11.83	$6.62	$2,451,361	$1,871,677	$38.20
50,000	$586,306	**$255,200**	$11.73	$6.62	$2,501,389	$1,915,082	$38.30

Appendix 3: Survey of Abalone Recreational Fishery

Introduction

Hi, I'm ______ from __ and we're researching recreational fishing. Can I please speak to _________?

Yes… (Continue)

No… (Terminate interview)

You would have received a letter about this recently. This survey is about abalone fishing experiences in the Perth Metro Area and should take about 15 minutes. Only the researchers will see your answers. No personal information will be passed on to Fisheries. Nothing in this survey should be taken to be current or intended policy of government or the opposition parties.

Fishing Background

Q 1 To start with, have you gone fishing in the last twelve months?

Yes (Go to Q2) 1

No (Go to Q4) 2

Q 2 Which of these have you fished for in the last twelve months? (Accept multiples) (Read out.)

Abalone 1

Other shellfish (mussels, oysters, clams)2

Crustaceans (crabs, rock lobster, prawns) 3

Fish 4

Other (specify)

___________________________ ( )

Q 3 In the last twelve months, how many times have you fished for abalone:

a) in the Perth metropolitan area ___ times

(If '0' times, Go to Q4)

b) on the South Coast of WA ___ times

c) in other areas along the West Coast ___ times

Q 4 Why didn't you fish for abalone in the Perth Metro area in the 2002 season?

(Do not prompt) (Accept multiples)

Was sick/away/unable to 1

To stop others taking all the abalone 2

To preserve/look after the future of the

abalone fishery 3

Don't fish for abalone 4

Other (specify)

____________________________ ( )

(Terminate Interview)

Q 5 Over the last twelve months, what percentage of your fishing trips were to fish for abalone in the Perth metro area?

_______ %

Perth Abalone Fishing

READ OUT - These next questions are about fishing for abalone in the Perth Metro area between Cape Bouvard and Wedge Island during the 2002 recreational season.

Q 6 How many abalone did you take during the 2002 season in total?

_______ abalone

Q 7 How many times did you go fishing for abalone in the Perth Metro area in the 2002 season?

_______ times

Q 8 How much time on an average fishing day do you spend actually fishing for abalone?

_______ hours

Q 9 On average, for how long are you away from home when you go fishing for abalone in the Perth metro area?

_______ hours

Q 10 For a typical trip during the 2002 Perth Metro abalone season, why did you stop at the number of abalone you caught? (Accept multiples.) (Do not prompt.) (Do not read out.)

Caught the bag limit 1

I only take as many as I can eat or use 2

That's as many as I can get 3

The availability of abalone 4

Poor weather conditions 5

Other (specify)

____________________________ ( )

Q 11 Of the abalone you kept from the Perth metro area during the 2002 recreational season, what proportion would you say was: (Read out)

a) Eaten by your household ____ %

b) Given to another household ____ %

c) Or used some other way ____ %

TOTAL (check) 100 %

Q 12 I am going to read out factors about abalone fishing in the Perth metro area during the 2002 recreational season. As I read out each one, please tell me how important a role it plays in a successful abalone trip, and how satisfied you are with each factor. (Read out each statement.) (One importance rating and one satisfaction rating per statement.)

Not at all Not Quite Very Very Very NA

important very important dissatisfied Neutral
satisfied

a. You take as many abalone as you expect to 1 2 3 4
1 2 3 4 5 9

b. The size of the abalone you take 1 2 3 4 1 2
3 4 5 9

c. The time it takes you to obtain the number of

abalone you want 1 2 3 4 1 2 3 4 5 9

d. You take enough abalone for a decent feed 1 2 3 4 1 2 3 4 5 9

e. Having a good time trying to take abalone

regardless of how many you end up with 1 2 3 4 1 2 3 4 5 9

f. The social aspects of abalone fishing with

family and friends 1 2 3 4 1 2 3 4 5 9

Most Recent Abalone Fishing Trip in the Perth Metro Area

(Read out) The next questions are about your most recent abalone fishing trip in the Perth Metro area.

Q 13 When was the last time you fished for abalone in the Perth Metro area?

_______________ (date/month or # weeks ago)

Q 14 Was fishing for abalone the main reason for going to that Perth beach that day?

Yes (SKIP to Q16) 1

No 2

Q 15 If not, what was your main reason for going to that Perth beach that day?

To catch up with friends or family 1

To go to the beach 2

To fish for something else 3

Other (specify)

_____________________________ ( )

Q 16 Why did you choose that particular beach that day? (Accept multiples.) (Do not prompt.)

It is local / convenient 1

Not crowded 2

Always go there 3

Lots of abalone there 4

Good sized abalone available 5

Easy to get to abalone 6

Safe to fish for abalone there 7

Other (specify)

____________________________ ( )

Q 17 How many abalone did you take that day?

_______ abalone

Q 18 Why did you stop fishing for abalone that day? (Accept multiples.) (Do not prompt.)

Caught the bag limit 1

Ran out of time 2

Poor weather conditions 3

Other (specify)

____________________________ ( )

Q 19 Were you happy with the number of abalone you personally kept that day? (One only)

Yes 1

No 2

Q 20 Were you happy with the size of the abalone you personally kept that day? (One only)

Yes 1

No 2

Q 21 Did you take as many abalone as you thought you would? (One only) (If no, ask if they thought they'd take more or less)

No, thought I'd take more 1

No, thought I'd take less 2

Yes, got as many as I thought I would 3

Q 22 How far did you travel to the beach and back to fish for abalone that day? (Include any side trips related to abalone fishing, eg picking up mates, etc.)

________ kms

Q 23 How long did it take you to travel that distance?

________ hours

Cost of Abalone Fishing

Q 24 (SCENARIO A – Sample Group A only)

A fishery management strategy could be introduced in the Perth abalone fishery, which could increase the number of abalone available to be taken by recreational fishers in the Perth Metro area. This means that you could take more abalone over the same one and a half hour period on each Sunday morning over a six week period in November and December.

The strategy would funded by an increase to the existing $35 seasonal recreational abalone licence fee. The money collected would be used to look after the future of the abalone fishery in the Perth Metro area.

The alternative to the strategy is to leave things as they are. That means that the daily bag limit is not increased and the seasonal licence fee you pay to fish for abalone in the Perth metro area stays at $35.

Are you willing to pay $* on top of the current $35 seasonal abalone licence fee to increase your daily bag limit by ** abalone over one and a half hours on six consecutive Sundays?

Yes, willing to pay 1 (Go to Q25)

No, not willing to pay 2 (Go to Q26)

These will be randomly assigned to Sample Group A respondents.

*Alternative extra start fees are $20, $40 and $60.

**Alternative increases in the daily bag limit are 3, 6 and 9 abalone.

Q 25 (If 'yes' to Q24) For the same increase in the daily bag limit, are you willing to pay $*

(Starting at the price offered in Q24, increase the start price by $5 intervals and ask if they are willing to pay until a 'no' response is received. Record the price given for the last amount the respondent said 'yes' to.)

$25 $30 $35 $40 $45 $50 $55 $60 $65 $70 $75 $80 $85 $90 $95 $100 $105…

Last 'Yes' Price $________

Q 26 (If 'no' to Q24) For the same increase in bag limit, are you willing to pay $*

(Start at the price that is $5 below the price offered in Q24, decrease the start price by $5 intervals and ask until a 'yes' response is received. Record the price the respondent said 'yes' to.)

$55 $50 $45 $40 $35 $30 $25 $20 $15 $10 $5 $0

'Yes' Price $________

GO TO Q30

Q 27 (SCENARIO B – Sample Group B only)

More and more people are fishing for abalone in the Perth Metro area, which is putting more pressure on the future availability of abalones in the Perth Metro Area. To maintain the existing daily bag limit of 20 abalone over the same one and a half hour period for six consecutive Sundays in November and December, a revised recreational fisheries management strategy will need to be introduced.

This strategy could involve protecting the habitat, increased enforcement of daily bag and size limits, more education and expanded marine research. This will cost money and will need to be in place for at least five years to be effective.

To cover the cost of this strategy, the $35 seasonal recreational abalone license fee for the Perth fishery will be increased. The extra money collected will go into a dedicated recreational abalone fishing fund to support this revised strategy.

The number of fishing days and time would not change. However, without funding support or any change, daily bag limits will could be reduced by ** abalone.

Are you willing to pay an extra $* on top of the current $35 seasonal abalone license fee to stop the daily bag limit dropping by ** abalone?

Yes, willing to pay 1 (Go to Q28)

No, not willing to pay 2 (Go to Q29)

These will be randomly assigned to Sample Group B respondents

*Alternative extra start fees are $35, $80 and $200.

**Alternative reductions in the daily bag limit are 2, 5 and 10 abalone.

Q 28 (If 'yes' to Q27) To stop the bag limit dropping by ** abalone, are you willing to pay $*?

(Increase the start price by using the intervals below and ask until a 'no' response is received. Record the price given for the last 'yes' response below.)

$40 $50 $60 $70 $80 $90 $100 $110 $120 $130 $140 $150 $160
$170 $180 $190 $200 $210 $220 $230 $240 $250 …

Last 'Yes' Price $________

Q 29 (If 'no' to Q27) To stop the bag limit dropping by ** abalone, are you willing to pay $*?

(Decrease the start price by using the intervals below and ask until a 'yes' response is received. Record the price given for the 'yes' response below.)

$190 $180 $170 $160 $150 $140 $130 $120 $110 $100 $90 $80 $70
$60 $50 $40 $30 $20 $10 $0

'Yes' Price $________

Demographics

Q 30 Gender (record automatically)

Male 1

Female 2

Q 31 Which of these age categories do you belong to? (One only.) (Read out.)

15 to 19 years 1

20 to 29 years 2

30 to 39 years 3

40 to 49 years 4

50 to 59 years 5

60 to 69 years 6

70 years or older	7
(Refused)	99

Q 32 Which of the following best describes your employment situation? (One only.) (Read out.)

Full time paid employment	1
Part time or casual paid employment	2
Unemployed, looking for work	3
Unemployed, not looking for work	4
Full-time student (not in paid employmt)	5
Home duties	6
Retired	7
Pensioner (disability, illness, age, etc)	8
Other (specify)	
______________________________	( )
(Don't know)	98
(Refused)	99

Q 33 What is your personal weekly income before tax? (annual income indicated in brackets) (One only.) (Read out.)

Negative income	01
Nil income	02
\$1–\$79 (\$1–\$4,159)	03
\$80–\$159 (\$4,160–\$8,319)	04
\$160–\$299 (\$8,320–\$15,599)	05
\$300–\$499 (\$15,600–\$25,999)	06
\$500–\$699 (\$26,000–\$36,399)	07

$700–$999 ($36,400–$51,999)	08
$1,000–$1,499 ($52,000–$77,999)	09
$1,500 or more ($78,000 or more)	10
(Don’t know)	98
(Refused)	99

That concludes the interview. Thank you for your time.

(Standard Interview Closing Spiel.)

Appendix 4: Contingent Valuation Survey Recreational Abalone Fishers: Descriptive Statistics for Scenario A (Increased Daily Bag Limit)

		N	Range	Minimum	Maximum	Mean	Std. Deviation
DEPENDENT VARIABLE = RESPONSE	1 = Yes, 0 = No	188	1	0	1	.40	.491
AGGLIM	Season Limit = maximum season limit minus actual season catch	188	120.00	.00	120.00	46.3457	32.67164
PRICE	Price offered	188	95	5	100	32.66	20.116
Q24ABALO	Scenario A. Extra abalone offered (number of abalone).	188	6.00	3.00	9.00	5.8883	2.41060
Q6	Number of abalone caught in 2002 season in total	188	120	0	120	73.65	32.672
Q22.	Distance travelled to reach abalone fishing.	140	124.70	.30	125.00	27.9807	24.84951
Q3a	Number of times fished for abalone in metro area.	188	11	1	12	4.87	1.809
Q3b	Number of times fished for abalone on south coast	188	6	0	6	.15	.738
Q24SQ	Square of Quantity of abalone offered.	188	72.00	9.00	81.00	40.4521	29.10010
Q24LN	Log of Quantity of abalone offered.	188	1.10	1.10	2.20	1.6787	.44911
Q24INV	Inverse of Quantity of abalone offered.	188	.22	.11	.33	.2066	.09406
Valid N (listwise)		140					

Appendix 5: Contingent Valuation Survey of Recreational Abalone Fisheries Scenario A (Increase Bag Limit) Logistic Regression Results

Variable	Equation 1		Equation 2		Equation 3		Equation 4	
	Linear		**Quadratic**		**Log^2**		**Inverse**	
	Coefficient	Wald	Coefficient	Wald	Coefficient	Wald	Coefficient	Wald
AGGLIM	-.007	1.699	-.014*	3.778	-.010*	2.728	-.014*	3.028
PRICE	-.030*	8.588	-.035*	10.345	-.032*	9.420	-.035*	9.820
Q24ABALO	.133*	2.940	.651*	3.731				
Q22	.019*	5.452	.016*	3.858	.017*	4.440	.016*	3.822
Q3A	-.155*	3.307	-.282*	5.380	-.213*	4.527	-.278*	3.917
Q3B	.559	2.112	.635	1.999	.590	2.070	.626	1.972
Q24SQ			-.046*	2.516				
Q24LN					.787*	4.168		
Q24INV							-3.214*	2.086
Constant							2.573	4.621
% Correct	72.1		70.1		70.1		72.1	

-2logλ								
-2logλ								
Pseudo R2	.240		.255		.248		.188	

Appendix 6: Mean Willingness to Pay for Increased Recreational Catch Limits under Different Model Specifications

	Linear Equation 1	Quadratic Equation 2	Log Equation 3	Inverse Equation 4
Daily Increase in Limit. Abalone	$	$	$	$
1	18.05	9.66	9.45	3.29
2	19.97	14.28	14.76	13.60
3	22.04	19.12	18.79	20.39
4	24.26	23.51	22.10	24.55
5	26.63	26.88	24.91	27.28
6	29.14	28.81	27.36	29.21
7	31.79	29.12	29.55	30.62
8	34.59	27.77	31.52	31.71
9	37.52	24.90	33.31	32.57
10	40.58	20.83	34.97	33.27

Appendix 7: Recreational Abalone Fishers Marginal Willingness to Pay to Increase Daily Bag Limits under Different Model Specifications (Scenario A)

	Linear Equation 1	Quadratic Equation 2	Log Equation 3	Inverse Equation 4
Daily Increase in Limit. Abalone	$ Per abalone	$ Per abalone	$ Per abalone	$ Per abalone
1	4.43	15.97	24.59	91.83
2	4.43	13.34	12.30	22.96
3	4.43	10.71	8.20	10.20
4	4.43	8.09	6.15	5.74
5	4.43	5.46	4.92	3.67
6	4.43	2.83	4.10	2.55
7	4.43	0.20	3.51	1.87
8	4.43	-2.43	3.07	1.43
9	4.43	-5.06	2.73	1.13
10	4.43	-7.69	2.46	0.92
11	4.43	-10.31	2.24	0.76
12	4.43	-12.94	2.05	0.64
13	4.43	-15.57	1.89	0.54
14	4.43	-18.20	1.76	0.47
15	4.43	-20.83	1.64	0.41
16	4.43	-23.46	1.54	0.36
17	4.43	-26.09	1.45	0.32
18	4.43	-28.71	1.37	0.28
19	4.43	-31.34	1.29	0.25
20	4.43	-33.97	1.23	0.23
21	4.43	-36.60	1.17	0.21
22	4.43	-39.23	1.12	0.19
23	4.43	-41.86	1.07	0.17
24	4.43	-44.49	1.02	0.16

Appendix 8: Contingent Valuation Survey of Recreational Abalone Fishers: Descriptive Statistics for Scenario B (Reduced Daily Bag Limit)

		N	Range	Minimum	Maximum	Mean	Std. Deviation
Willingness to Pay	1 = Yes, 0 = No	166	1	0	1	.40	.491
Season Limit	Season Limit = maximum season limit minus actual season catch	166	120.00	.00	120.00	51.3675	31.80743
Price offered	Price offered	166	220	10	230	78.80	68.062
Scenario 2	Scenario B. Abalone reduction (number of abalone).	166	8.00	2.00	10.00	5.8012	3.35247
Q6.	Number of abalone caught in 2002 season in total	166	120	0	120	68.63	31.807
Q8.	Time spend actually fishing for abalone	163	29.50	.50	30.00	1.2000	2.30900
Q22.	Distance travelled to reach abalone fishing.	120	209.90	.10	210.00	36.9675	34.81771
Q3a	Number of times fished for abalone in metro area.	166	5	1	6	4.47	1.639
Q3b.	.Number of times fished for abalone on south coast	166	5	0	5	.11	.627
Q27SQ	Square of Quantity of abalone offered.	166	96.00	4.00	100.00	44.8253	41.95553
Q27LN	Log of Quantity of abalone offered.	166	1.61	.69	2.30	1.5577	.66625
Q27INV	Inverse of Quantity of abalone offered.	166	.40	.10	.50	.2620	.17075

Valid N (listwise)		119					

Appendix 9: Contingent Valuations Survey of Recreational Abalone Fishing Logistic Regression Results: Scenario B (Reduced Bag Limit)

Variable	Equation 1		Equation 2		Equation 3		Equation 4	
	Linear		Quadratic		Log		Inverse	
	Coefficient	Wald	Coefficient	Wald	Coefficient	Wald	Coefficient	Wald
AGGLIM								
PRICE	-.020*	17.839	-.021*	17.659	-.021*	17.443	-.022*	17.554
Q27ABALO			.055	.850				
Q22								
Q3A	.232*	11.314	.179	4.091	.171	2.992	.305*	11.877
Q3B								
Q24SQ								
Q24LN					.233*	.696		
Q24INV							-1.573	1.916
Constant								
% Correct	77.9		75.2		77.0		71.7	
-2logλ								
-2logλ								
Pseudo R2	.250		.256		.235		.264	

Appendix 10: Recreational Abalone Fishers Mean Willingness to Pay to avoid Reduced Daily Catch Limits under Different Model Specifications: Scenario B

	Linear Equation 1	Log Equation 3	Inverse Equation 4
Daily Increase in Limit. Abalone	$	$	$
1	57.59	54.60	28.28
2	59.45	59.98	48.70
3	61.33	63.25	57.06
4	63.24	65.61	61.50
5	65.18	67.48	64.24
6	67.14	69.02	66.11
7	69.14	70.33	67.45
8	71.16	71.48	68.47
9	73.20	72.50	69.26
10	75.27	73.41	69.90

Appendix 11: Recreational Abalone Fishers Marginal Willingness to Pay to avoid Reduced Catch Limits under Different Model Specifications

	Linear Equation 1	Log Equation 3	Inverse Equation 4
Daily Increase in Limit. Abalone	$ Per abalone	$ Per abalone	$ Per abalone
1	2.62	11.10	74.90
2	2.62	5.55	18.73
3	2.62	3.70	8.32
4	2.62	2.77	4.68
5	2.62	2.22	3.00
6	2.62	1.85	2.08
7	2.62	1.59	1.53
8	2.62	1.39	1.17
9	2.62	1.23	0.92
10	2.62	1.11	0.75
11	2.62	1.01	0.62
12	2.62	0.92	0.52
13	2.62	0.85	0.44
14	2.62	0.79	0.38
15	2.62	0.74	0.33
16	2.62	0.69	0.29
17	2.62	0.65	0.26
18	2.62	0.62	0.23
19	2.62	0.58	0.21
20	2.62	0.55	0.19

A Socio-Economic Valuation of Resource Allocation Options between Commercial and Recreational Use

FRDC Project No. 2001/065

PART FOUR
THE WEST COAST WETLINE FISHERY CASE STUDY

Dr P McLeod and J Nicholls

Economic Research Associates

Australian Government

Fisheries Research and Development Corporation

A Socio-Economic Valuation of Resource Allocation Options between Recreational and Commercial Sectors

Dr P. McLeod[1] and J. Nicholls[2]

The Fisheries Research and Development Corporation plans, invests in and manages fisheries research and development throughout Australia. It is a federal statutory authority jointly funded by the Australian Government and the fishing industry.

Key Words: Fisheries Economics; resource allocation; evaluation framework; socially optimal allocations

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SOCIO-ECONOMIC VALUATION OF RESOURCE ALLOCATION OPTIONS BETWEEN COMMERCIAL AND RECREATIONAL USE

THE REPORT

The report relating to this research project will be presented in four parts. These parts are as follows:

Part One: The General Theoretical Framework;
Part Two: The Western Australian Cockburn Sound Crab Fishery Case Study;
Part Three: The Perth Abalone Fishery Case Study; and
Part Four: The West Coast Wetline Fishery Case Study.

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- The assistance of the Department of Fisheries and the Department of Infrastructure and Planning in supporting and facilitating this research through their data bases;
- The cooperation of recreational fishers as well as commercial fishers and post harvest operators in our endeavours to discover the required socio-economic data;
- Our associates at Data Analysis Australia, Dr John Henstridge, Jodie Thompson, Rebecca Gordon and Sarah Barnes, for their practical guidance in survey design and the evaluation and choice of data collection methods, assistance with survey data collection and analysis, and their perseverance with our supplementary data demands as we developed the analysis; and
- Carole Lefort and Terri Burgess who provided typing and secretarial support to this project.

The achievements that have been made in this case study are in no small way attributable to the contribution and support they have provided. For this support and assistance we are most grateful.

FOREWORD

This case study is part of a wider project focused on 'socio-economic' valuation methodologies for evaluating resource allocation options between commercial and recreational use of fish resources. It is the last of three case studies to demonstrate the practical application of socio-economic valuation methodologies within a general theoretical framework. The framework was developed as the first stage of the project.

The general theoretical framework was formulated in terms of use values associated with fishing activity. These values focus on the uses of the fish resource by commercial or recreational fishers. The framework identifies appropriate values needed to enable meaningful comparisons between these uses that can be the basis for optimising net benefits to society from alternative allocations of fish resources between such uses.

The overall objective of the project, as explained above, is methodological. The case studies are designed to test aspects of the theoretical framework. Therefore, the empirical outcomes for this case study are primarily illustrative of the application of the framework. These applications occur at a point in time, and, therefore, provide only a snapshot of the circumstances in the fishery. This case study is not designed to be the basis for actual allocation decisions.

If ultimately there is a desire to adopt the proposed framework and associated valuation methods as input into any future resource allocation considerations in this fishery (either within existing or under any revised catch and effort controls adopted for sustainability reasons), there will be a need for:

- Further research to obtain up-to-date and more exact information which might help to more exactly identify contemporary supply and demand equations associated with commercial and recreational use; and

- A 'due diligence' process to independently validate the robustness of this or any further research and its outcomes relative to the net benefits to society from these extractive uses.

In addition, the approach to illustrate the framework is static. Therefore, there would also be a need to inject a dynamic component into these models to capture underlying changes, which can be expected to impact on social and economic values of commercial and recreational use over time. How best to include a dynamic component was beyond the scope of this project

The volumes of dhufish, baldchin groper, and pink snapper taken from the West Coast Wetline fishery (in terms of both commercial and recreational use) are not insubstantial. Whilst the size of the net benefits to society (under existing or alternative allocation options) is small when considered in the wider fisheries context in Western Australia, the case study is nevertheless important from two perspectives.

First, the outcomes of this study show the general framework is sound and the results are consistent with economic theory and the proposed framework.

Second, this fishery is typical of many fisheries where allocation issues will arise now and in future. Although relatively small, catches of the case study species from the West Coast Wetline fishery are valued by both commercial and recreational sectors and contributes significantly to the well being of numerous commercial harvest and post harvest businesses as well as many recreational fishers and their respective families. The take of the case study species from the West Coast Wetline fishery is the subject of ongoing debate over resource shares.

The focus of this case study has been on use values. However, as it turned out, these as well as options (in the form of an entitlement to hunt case study species) and experiential values (such as catch and release) are dominant values in this fishery. This is not to say other social values (for example, other non-consumptive values, including conservation and preservation uses, as well as inter-generational values and the like) may not be important. Where there are '*a priori'* grounds to believe such values are likely to be significant in a particular fishery, they can be handled within the general theoretical framework outlined in the first phase of this project.

Consistent with the objective for the overall project, this case study report is a 'warts and all' presentation as a learning experience in the application of socio-economic valuation methodologies within the general theoretical framework outlined in the earlier part of this project. It is hoped that others may benefit from the experience.

TABLE OF CONTENTS

TABLE OF FIGURES

EXECUTIVE SUMMARY

This study is one of three case studies to demonstrate the application of socio-economic valuation methodologies for evaluating resource allocation options and of a general theoretical framework for considering the optimisation of social and economic benefits from resource use. The methodology was outlined in the first phase of this project.

The general framework focuses on values associated with commercial and recreational activities. As such it provides a basis for making sound, consistent, and 'like-with-like' comparisons between commercial and recreational uses of fish resources.

Consistent with the objectives of the overall project, this application to the West Coast Wetline Fishery emphasizes methodological and practical issues in the application of the general theoretical framework rather than the actual results.

The Focus of this Case Study

The West Coast Wetline fishery in Western Australia corresponds to the West Coast bioregion and stretches 1100 kilometres from Augusta in the South West to Kalbarri in the North of the State.

The fishery is multi species but this study concentrates on commercial and recreational line fishing for dhufish, pink snapper and baldchin groper. These three species are most sought after by both commercial and recreational fishers.

The catching of these species is the subject of intensifying pressure on the resource and competition between these two sectors.

The Resource Allocation Dimensions

The 'Wetline' fishery raises some complex issues in the application of the general theoretical framework.

The fishery is effectively 'open access' as the license limitations on commercial fishing units and the daily bag limit restrictions on recreational fishers are non-binding. Also, the absolute sustainable take by commercial and/or recreational fishers is not defined. The potential catch, as measured by retained recreational bag limits and commercial license limits, is many times the estimated aggregate catch. Consequently, there is no fixed aggregate or individual species catch to be shared.

As the existing restrictions in this fishery are effectively non-binding, both commercial and recreational fishers can easily increase effort (eg more commercial fishing units exercising entitlements to participate in the fishery, increased fishing trips by commercial and recreational fishers and increased time spent on each fishing trip) with the result that they can seek more catch without any commensurate change in explicitly defined allocations. In the circumstances, there is no simple way to reallocate fish between commercial and recreational fishers in the Wetline fishery.

If commercial fishers reduced actual (not latent) effort in the fishery, commercial catches may fall. These fish would be available to be hunted by recreational fishers. However, unlike the confined Perth abalone fishery that was analysed in Case Study Two of this project, the nature of the 'wetline' fishery means that there is no guarantee that all or any of a reduced commercial catch would be caught by recreational fishers.

On the other hand, if recreational fishers' daily bag limits were reduced, in circumstances where actual catch experience is well below the bag limits, there may be little (if any) change in actual recreational catches. Hence, there may be little change in the availability of additional fish for commercial fishers to catch.

For the demonstration purposes of this case study, we assumed the combined commercial (504 tonnes) and recreational (300-350 tonnes) catches of the case study species to be the total sustainable catch (800-850 tonnes) and the resource allocation options between the two sectors were analysed within this total catch scenario. We also assumed any explicit reduction in either commercial or recreational catch would result in an immediate and commensurate catch increase by the other unaffected sector. While neither of them may be exactly the case, these assumptions represent reasonable starting points for thinking about allocation issues in the fishery.

Availability of Socio-Economic Data

The two previous case studies have illustrated the lack of comprehensive and relevant socio-economic data relating to commercial and recreational fishing. The same is true for the case study species in the West Coast Wetline fishery. Hence, it is not possible to undertake detail benefit-cost analyses of resource allocation options in this fishery with the publicly available data. The data sets, which were available for the fishery, were in various ways incomplete.

The lack of relevant socio-economic data is, with hindsight, not surprising. The sort of evaluation framework proposed in this project is not currently applied in the resource allocation decision-making processes and neither is broad benefit-cost analysis. Hence, managers and agencies have not had any particular need to routinely collect this sort of data.

Discovery of Relevant Socio-Economic Data

The lack of data meant that original data collection was required for virtually all aspects of the case study. Relevant economic data were required for harvest and post-harvest businesses as well as recreational fishers associated with the case study species caught in the West Coast Wetline fishery. These data were collected through surveys of businesses and recreational fishers. The survey implementation, including survey design, evaluation and selection of survey method (telephone, mail, or face-to-face surveys) and associated original data collection, is discussed in the main body of the report.

For the recreational survey, during the design phase, considerable attention was given to the survey content and the choice of survey method and we called on experiences gained during the first two case studies. On this occasion, we trailed three pilot recreational fishers' surveys before we designed one that would produce analysable information.

There are different benefits and costs associated with different survey methods as well as different statistical and sampling issues. The choice of the most cost-effective method involves trade-offs between data quality and collection costs. Given the demonstration purposes of this project, methods were adopted that kept overall collection costs to a minimum. As a general rule, it is often better to have a few, quality observations than many poor ones.

A number of unexpected gaps and inconsistencies were identified in the commercial data sets during the analysis of the commercial survey results. In these instances, supplementary surveys of, and discussions with, industry were undertaken to bridge these gaps as best we could. Ultimately, the commercial data set was adequate for the demonstration purposes of this project.

However, if the methodologies and framework were to be used as input into a process considering future allocations in this fishery, further work to refine the supply and demand functions for commercial and recreational use of the case study species taken from the 'Wetline' fishery would be worthwhile.

Valuing Recreational Use

Our survey of recreational fishers for the case study species in the West Coast 'Wetline' fishery was developed and implemented against a widely held public and interested parties belief that, at the existing constraints (bag limits, etc), there was universally unsatisfied demand for extra catches of these preferred case study species among recreational fishers. Logically, this would mean that fishers were expected to be limited by the 'official' bag limits. Ultimately, the survey results challenged the validity of this belief.

The recreational survey asked respondents to indicate a willingness to pay (in the form of an annual license fee) across a range of 'offered' daily catch limits. These were total daily catch limits for a bundle of case study species where the range offered went above and below the existing 'official' daily bag limit.

The responses received allowed an assessment of:

- the aggregate willingness to pay for various daily catch limits; and
- the marginal willingness to pay for a higher daily catch limit within the range offered in the survey

These marginal values included elements of experiential, retained catch (use) and option values. The option value reflects an entitlement to hunt and to retain catch that exceeds proscribed minimum sizes. In addition to values ascribed to retained catch, experiential, including catch and release and options values appear to play a significant role for recreational fishers, and, therefore, are reflected in the values that the recreational fishers ascribe to fishing trips in this 'Wetline' fishery.

The analysis of recreational values relied on the use of the stated preference approach and contingent valuation surveys.

The contingent valuation modelling indicates that most survey respondents were currently optimising 'well being' within existing constraints. That is, they were choosing to cease fishing activity with retained catches less then the 'official' daily bag limit. Some fishers were bound by the current bag limit, and we assume that they would prefer to have higher bag limits.

A majority turned out to be satisfied with their fishing experience, even though case study species catch entitlements (as reflected in daily bag limits, and sizes) were not fully exercised contrary to wider community perceptions. This appears to be due in part to all, but a very small proportion (1.1 per cent) of the survey respondents, having achieved an actual catch (whether retained or not) during their fishing trips, even though this may not have included any of the case study species. There was a much smaller group (less than one per cent of the sample) who fully exercised their entitlements (catch limits) and were dissatisfied.

In economic terms, this means that most recreational fishers were optimising utility (satisfaction or well being) within their current preferences, existing budget (money and time) constraints and catch limits, whilst a smaller group were not. Consequently, we expected to find recreational fishers who place high value on extra-retained catch limits and others who do not. This distribution of recreational values was confirmed by the survey data.

The data showed that, using the model specifications that were most consistent with economic theory, the marginal willingness to pay for the option to retain fish in 'offered' daily catch limits for case study species in the West Coast 'Wetline' fishery. For the option of one fish, the mean marginal willingness to pay was greater than $84, falling to around $9-10 for three fish (which corresponded to average catch per trip experience of our survey respondents), dropping to about $5 for 4 or 5 fish, and little (if any) above 9 fish.

The aggregate willingness to pay for a daily catch limit of 5 fish is estimated to be around $1.9 to $2.1 million. The results are sensitivity to the estimate of the average weight of the basket of case study species and the number of participating by recreational fishers.

Valuing Commercial Use

The commercial take of case study species from the West Coast 'Wetline' fishery is predominantly sold for consumption in Western Australia. Exports (overseas and inter-State) are around 10 to 15 per cent of the catch of each of the case study species.

Consequently, the net benefits from commercial use reflect:

- the aggregate 'producer surpluses' of harvest and post harvest activities in Western Australia associated with the local and export market disposals of the case study species taken from the West Coast 'Wetline' fishery; plus
- the local 'consumer surpluses' associated with local market disposals of the case study species taken from the fishery.

The net benefit from commercial use (that is, the aggregate producer surpluses for harvest and post-harvest activities in Western Australia plus the local retail consumer surpluses) in aggregate for all three case study species was estimated to be around $4.603 million or $9.15 per kilogram of whole fish. This corresponds to an annual recorded commercial catch of 504 tonnes of the case study species from the West Coast 'Wetline' fishery.

The marginal net benefit from commercial use of the case study species caught in the West Coast 'Wetline' fishery was estimated to range (for the existing catch ± 20 per cent) from around $4.95 per kilogram to $6.52 per kilogram of whole fish. For the defined catch volumes, the estimated benefits ranged from $6.30 to $8.14 for dhufish, $3.90 to $5.20 per kilogram for pink snapper, and around $3.40 to $4.40 for baldchin groper.

The marginal benefit from commercial use varies with changes in the volume and timing of commercial catches. In general, as the catch available for local consumption rises, the prices will fall all other things being equal, and producer surpluses will decline given the marginal (harvest and post harvest) costs were constant across our defined catch volumes. On the other hand, the consumer surpluses will rise with an increased volume consumed at a lower price. The data shows that, in aggregate the net effects on the marginal benefit from commercial use declined. This is attributable to the price elasticity of supply being higher than the price elasticity of local demand, that is the increase in consumer surpluses did not outweigh the fall in producers surpluses for a given increase in catch volume of the case study species.

Likewise, a fall in catch volume will result in a local price rise. This will increase the marginal producer surpluses but reduced the local consumer surpluses. The data shows the gain in producer surpluses outweighed the loss in consumers surpluses and consequently the overall net benefits from commercial use increased for a given volume reduction.

Optimising Net Benefits from Commercial and Recreational Use

The aggregate net benefits from commercial use were estimated to be around $4.603 million or $9.15 per kilogram of whole fresh fish for the 504 tonnes of total commercial catch of the case study species from the West Coast 'Wetline' fishery during the 2001-2002 year. The aggregate surpluses in recreational fishing of 300-350 tonnes of the case study species taken from the fishery was estimated to be around $1.9-2.1 million or around $6-6.50 per kilogram of fish. However, as the framework paper makes clear, comparing two aggregate net values does not explain what should happen to resource allocation at the margin.

The important values in a benefit-cost analysis of resource allocation options are not the aggregate but marginal net benefits for the respective uses. The optimum allocation occurs where the marginal net benefits from each of the resource uses are the same. Our modelling focused on the marginal benefits.

Assuming the existing combined commercial and retained recreational catch (850 tonne) is sustainable and represents the defined total allowable catch, then the theoretically optimal shares would be around 310 tonnes retained recreational catch and 540 tonnes commercial take in aggregate for the three case study species at the present time. At this point, the marginal benefit from commercial and recreational use is the same that is around $5.50 per kilogram of whole fish. This would mean a reduced recreational share of up to 40 tonnes of fish from the recreational sector. The results are highly sensitive to the assumptions made about the number of recreational participants in the West Coast 'Wetline' fishery.

The modelling shows that this reduced level of retained recreational take of around 2.3 fish per person of the case study species (assuming 45,000 recreational participants in the fishery and 3 kg average weight for the basket of retained case study species catch). This is marginally less then the existing average recreational take of 2.66 fish during 2001-2002.

In practical terms the analysis suggests that the gains in attempting to 'fine tune' the actual retained recreational catch from 2.66 to 2.3 fish per person would be problematic in the current fisheries management environment.

The gain in the overall benefits from the combined commercial and recreational use would be up to $76,000 (assuming no transaction costs) to the estimated $6.6 million for the existing catch shares. In reality, the net gains are likely to be less than this given transaction costs of enforcing reduced recreational catch limits. In consequence, there is unlikely to be any material net gain in reallocating existing actual catch shares at the present time.

We suspect that the values that recreational fishers would ascribe an extra retained catch of the case study species where there was a greater degree of certainty may be higher than these outcomes. However, in this fishery, the reallocation may need to be quite 'lumpy' if there were to be any significant lowering in the probability of an increased recreational catch of the case study species.

The species and size composition of the recreational basket that might optimise the marginal net benefits could not be determined from the recreational data available. However, there may be net benefit gains in differentiating the size of the fish that can be retained by commercial and recreational fishers if the existing management rules remain.

Underlying Assumptions for Applying Inter-Sectoral Allocation Models

This analysis is based on certain assumptions. It assumes that:

- The combined existing commercial and recreational catch is all that is sustainable and available for inter-sectoral allocation,

- All recreational participants are subject to binding constraints (catch limits), that is, there is no unused or spare capacity,

- For all commercial operators it is optimal to take the total sustainable catch, that is, there is no spare capacity, and

- All commercial operators are internally structured to maximize producer surpluses from catches of the case study species in the West Coast' Wetline' fishery

There is currently ambiguity around the total sustainable catch in this fishery. Also, the results of our analysis indicate that the assumptions relating to the commercial and recreational activity do not hold.

In what is effectively and 'open access' fishery, the immediate issue is a sustainable catch not resource allocation. Both commercial and recreational fishers can increase effort to achieve increase catch without any commensurate and explicit change in catches allocations.

Reality Checking of Model Outcomes

The results of the modelling are illustrative only and a 'snapshot' in time. The outcomes are dependent on the robustness of the assumptions behind the models. Nevertheless, we did undertake a series of 'reality checks' of the data sets and statistical outputs in the course of the assessment to ensure the results appeared consistent with what was happening in the industry. This focused on whether the results appeared sensible and rational in economic terms, made sense in terms of the actual operation of the market and was consistent with the overall circumstances in the fishery.

Injection of a Dynamic Component

As already noted, for any actual implementation, the analysis would need to be updated (and recalibrated) once the sustainable catches are addressed and explicitly determined and as the underlying conditions behind economic and social values change over time.

While the development of a dynamic element would be required to ensure that the analysis approximates more closely contemporary circumstances as they change over time, it is beyond the scope of the current study.

Overview

The case study demonstrates that the general theoretical framework based on economic principles can be applied. The results are broadly consistent with economic theory and can be the basis for developing allocation policy.

1. Background

This case study applies the theoretical economic framework for evaluating the net benefits to society of resource allocation options developed in Part One of this project to The West Coast Wetline Fishery[3]. It is one of three case studies that demonstrate the application of the framework to resource sharing options in fisheries management.

Consistent with the objectives of the overall project, this application to the West Coast Wetline Fishery emphasizes methodological and practical issues in the application of the framework as much as actual results.

Lessons for the practical application of the valuation methodologies that form part of this project are considered. In particular, the principles incorporated into data collection for commercial and recreational activities along with survey design, analytical models, statistical analyses, together with survey and analytical lessons learned, form the basis of this case study and the overall report.

1.1 Management Framework

The West Coast Wetline Fishery, for the purposes of this report, comprises commercial and recreational line fishing for dhufish, baldchin groper, and pink snapper off the West Coast of Australia between Augusta in the South West and Kalbarri in the Mid West. This fishery covers 1100 kilometres of coastline that corresponds to the West Coast marine bioregion.

These three demersal species are most sought after by both commercial and recreational fishers. The catches of these species on the West Coast between Augusta and Kalbarri are the subject of intensifying resource-sharing pressures between these two sectors, particularly in the off shore fishing locations close to the more populated Perth-Fremantle-Mandurah area.

Under the Western Australian *Fish Resources Management Act 1994,* there are a number of controls in place that impact on commercial and recreational fishing in this fishery. However, a formalised management plan has not been introduced. An explicit harvest level covering commercial and recreational take of the case study species from this West Coast fishery has not been determined. Based on data available, our best estimate of the combined commercial and recreational catches of these species in the West Coast bioregion is of the order of 850 tonnes.

This is often referred to as an ‘open access’ fishery. There is considerable latent effort in the commercial fishery with the potential for increasing recreational participation from population and tourism growth. Technological

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3 P.McLeod and J Nicholls “A Socio-Economic Valuation of Resource Allocaton Option between Commercial and Recreational Use: Part One-A General Theoretical Framework” (March 2002) FRDC Project 2001/065

advancement over the past 10 years in the form of GPS and sounders are likely to have had a significant impact on efficiency of both sectors.

1.2 Commercial Fishing

1.2.1 Access Controls

There are about 1350 licensed commercial fishing units eligible to access the West Coast Wetline fishery. This number will not increase whilst the existing fisheries management policy of not issuing any further ‘Wetline’ entitlements continues. ‘Wetliners’ held around 26 per cent of these units only. Commercial fishermen held the remainder with entitlements to other fisheries.

In any given year, typically around 240 units exercise this entitlement, although not necessarily the same units operate in the fishery in any year. Over the past decade, 500 units have reported West Coast Wetline catches according to the Western Australian Fisheries Department. This means there is considerable latent commercial fishing effort in this fishery.

1.2.2 Vessel Sizes and Gear Used

The case study species are generally found in fishing locations off shore that typically require boats of 6.5 metres or greater. Wetline fishing methods for the target species are restricted to hand and drop lines.

These fishing methods resulted in catches of fish species besides the case study species.

1.2.3 Size Limitation

A legal minimum fish size applies to each of the case study species. These are 500mm for dhufish, 400mm for baldchin groper and 410mm for pink snapper.

1.2.4 Seasonal Restriction

Fishing for pink snapper in Cockburn Sound is closed from the 15 September to the 31 October. Also, future restrictions on commercial fishing for baldchin groper off the Abrolhos Islands were being considered at the time of the case study.

1.2.5 Commercial Catch

According to data available, the recorded commercial catches of the case study species from the West Coast fishery were estimated to be 504 tonnes during 2001-2002 year. Catches of each of these species over the past four years are shown in Table 1 below.

Table 1: The West Coast Wetline Fishery: Dhufish, Baldchin Groper and Pink Snapper Commercial Catch Estimates: 1998-1999 to 2001-2002 (tonnes)

Species	1998-1999	1999-2000	2000-2001	2001-2002
Dhufish	179	173	192	220
Baldchin Groper	32	33	33	34
Pink Snapper	135	158	210	250
Total	346	364	435	504

Source: Western Australian Department of Fisheries

1.3 Recreational Fishing

There is no restriction on recreational fisher participation in the West Coast ‘ wetline’ fishery. The location of these bottom dwelling fish species typically requires access by boat with jetty or shore-based recreational catches of these species being insignificant.

Registered pleasure craft data at the Department of Infrastructure and Planning (Marine Transport Division) suggest there are around 70,000 craft that are potentially capable of being used to fish for these species. According to the Department, the number of pleasure craft registrations is growing at a rate of around 3 to 4 per cent annually.

In addition, there are charter vessel operations licensed by the Western Australian Fisheries Department located at ports that take recreational fishers fishing for the case study species in the West Coast ‘Wetline’ fishery.

1.3.1 Daily Bag Limits[4]

Under fishing regulations applying at the time of the recreational survey each recreational fisher is limited to a maximum daily take of:

- 4, dhufish, and
- a mixed bag limit of 8 reef fish, including pink snapper and baldchin groper.

[4] The ‘official’ daily bag limit should not be confused with the range of daily catch limit offered to surveyed recreational fishers. The number of fish in the ‘offered’ range varied and went above and below the official bag limit.

These catch limits were under review with the Fisheries Department of Western Australia releasing for public comment the possibility of halving the daily bag limit at the time of this case study.

1.3.2 Size Limitations

A legal minimum fish size applies to each of these species that recreational fishers wish to retain. These sizes are the same as those for commercial catches see (Section 1.2.3 above).

1.3.3 Recreational Catch

According to the Western Australian Fisheries Department's 1996/1997 survey data, the recreational catch of the targeted case study species from the West Coast Wetline fishery was estimated to be around 182 tonnes. This is the most recent, statically reliable, data available on recreational catches of these species from this fishery. These data are shown in Table 2 below.

Table 2: The West Coast Wetline Fishery: Recreational Dhufish, Baldchin Groper and Pink Snapper Catches (a): 1996-1997 Recreational Fishing Survey

Species	Retained Catch (tonnes)	High Catch Locations	High Seasonal Catches	Catch Rate
Dhufish	132	Jurien Bay, Lancelin, Geraldton	Summer	0.42/angler trip
Baldchin Groper	23	Jurien Bay	Summer/Autumn	NA
Pink Snapper	27	Mandurah	Spring	0.27/angler trip
Total	182			

(a)Excludes recreational catches from commercially operated recreational charter vessels.

Source: Western Australian Department of Fisheries

However, the magnitude of this catch may have changed since that time. The number of pleasure craft registrations has been growing at 3 to 4 per cent annually since 1995/1996. On this basis and assuming participation and angler catch rates remained unchanged from those observed during the 1996/1997 recreational survey, the recreational catch of these species might now be at least 16 per cent higher or around 220 tonnes.

This estimate is likely to be conservative. First, the benchmark year was apparently considered a poor year for recreational catches of dhufish and pink snapper. Second, the participation rate in the West Coast fishery by recreational boat owners may have increased, on average, with more leisure time among an increasing proportion of retirees.

Based on recent statistically incomplete national recreational survey results and reported catches on recreational charter fishing operations in the bioregion, we estimate the recreational take of these species in 2001-2002 from the West Coast Wetline fishery to be around 350 tonnes. These estimates are shown in Table 3 below. Our recreational survey results showed a similar proportional pattern of retained catch among our respondents.

Table 3: Best Estimates of the Recreational Catch of Dhufish, Baldchin Groper and Pink Snapper in the West Coast Wetline Fishery (a)- 2001-2002

Species	**Low Estimate**	**High Estimate**
Dhufish	193	228
Baldchin Groper	47	53
Pink Snapper	60	69
Total	**300**	**350**

(a) Includes recreational catches on charter operations

1.4 Resource Sharing Setting

This study considers the marginal net benefit from commercial and recreational use on the assumption that existing effort and catch in the West Coast Wetline fishery are sustainable. It focuses on values of commercial and recreational fishing.

1.5 Underlying Settings

The study was carried out within the fisheries management arrangements and the social and economic climate prevailing at the time of the study. The study is based on choices implicit in the commercial and recreational fishers' intentions to fish for the case study species in the West Coast Wetline fishery.

The general theoretical framework for evaluating the net benefits to society of fish resource allocations is built around a defined aggregate total sustainable catch for the various resource uses. In this context, the theoretical framework provides a basis for evaluating the changes to the overall net benefit to society of varying the catch shares between the using sectors within this total sustainable catch to determine the socially optimal allocation at that point in time.

As mentioned above, this case study fishery does not have an explicit total allowable harvest level for either commercial or recreational sectors, nor a well-defined total sustainable catch for the case study species in the West Coast 'Wetline' fishery. This means any reallocation of fish resource shares through a reductions in actual (not latent) fishing effort for one sector may possibly impact on fish abundance and improve the chances of an increased catches by other user groups. Consequently, such tighter input and effort controls in commercial sector may not be manifested necessarily in actual increased catches in the other use sector(s) commensurate with any reduced catch experienced by the commercial sector as a result of changes to the input and effort controls. In these circumstances, any attempted fish resource reallocation through changes to input and effort controls will be uncertain in terms of the size and timing around the realization of any fish resource re-allocation.

Similarly, if the 'official' daily bag limit were reduced for recreational fishers, given the current position where retained catches are well below this limit, there may be little (if any) reduction in recreational catch and hence little change in the availability of additional fish for commercial fishers to catch.

In a fishery that covers such a broad expanse of coastline, there is biological uncertainty as to whether the pink snapper and dhufish stocks to be shared are the same. For instance, a reduced catch of these species in the ocean off Geraldton (at the Northern end of this fishery) may not necessarily result in increased abundance for commercial and recreational fishers further South in the fishery (such as the waters off Fremantle).

Of particular significance is the non-existence of a single, discrete and realizable total allowable catch within which to analyse the net benefits of changes in share allocations between commercial and recreational use. The combined aggregate total catches for these uses in uncertain.

For the methodological demonstration purposes of this case study, we applied the general theoretical framework outlined in Part One of this project based on the following assumptions:

- the existing commercial catch (504 tonnes) and retained recreational catch (350 tonnes) of case study species is sustainable;
- the combined commercial and recreational take (850 tonnes) is the defined total allowable catch;
- the fish to be shared is the same stock across the fishery, that is, a fish not caught in one area within the fishery will become available to be caught elsewhere in the fishery;
- an explicit reduced catch share for one sector is reflected in an immediate and commensurate increase in the catch share taken by the other user group; and

- a 'zero-sum' resource allocation game can be played within the assumed total allowable catch.

Whilst none of these assumptions may be exactly the case, we saw them as representing a reasonable starting point for thinking about resource allocation issues in this fishery.

In circumstances where the combined catch level and shares were uncertain, this case study considered values and allocations at the margin for commercial and recreational use. In this context, the size of the overall recreational catch became less significant. The important values were the marginal benefits of commercial and recreational use and the way they varied at different potential catch levels.

1.6 Case Study Presentation

The net benefits from commercial use in this fishery consist of:

- The net benefits attributable to production (Chapter 2); plus
- The net benefits attributable to local consumption (Chapter 3); resulting in
- The net benefits from commercial use (Chapter 4).

The net benefits from recreational use are discussed in Chapter 5, whilst the optimisations of the net benefits from the combined commercial and recreational use are dealt with in Chapter 6.

2. Valuing 'Producer Surpluses' From Commercial Use

Whilst the paucity of information on recreational fishing values is generally recognized in fisheries management, there is often little recognition given to the data issues in respect of commercial activities. The resource-sharing framework requires that marginal values for recreational and commercial activities be compared on a 'like-with-like' basis. As the Part One, General Theoretical Framework paper makes clear, this requires a 'producer surplus' calculation for commercial activities.

Contrary to generally held perceptions that the information needed to estimate 'producer surpluses' would be readily available from official databases, we discovered that the required socio-economic information is not generally available.

In respect of the West Coast Wetline Fishery, there was no suitable database that had any "official" status. Hence, the required estimation of the relevant 'producer surpluses' for both the commercial catching sector and the associated post-harvest processing, distribution, exporting and local retailing activities had to be based on data collected specifically for this study.

The required price and cost data (including the sensitivity of prices and costs to changes in volume) as well as certain social information (such as business structures and employment) had to be collected directly from the seafood industry, including a survey of commercial operators.

2.1 Data Collection

A survey questionnaire was developed with input from the Interested Parties Consultative Group, using experiences gained from the previous two case studies, the Cockburn Sound Crab fishery and the Perth Abalone Fishery. This process helped to ensure the questionnaire was unambiguous and the proposed questions were couched in a way that would be easily understood and consistently interpreted by commercial fishermen (and others).

The survey questionnaire used is shown in Appendix 1.

Where surveys seek disclosure of private and commercially confidential business information, there is a natural and understandable predisposition towards non-disclosure. In such circumstances, voluntary disclosure should not be readily expected.

Such circumstances usually necessitate a process that attempts to gain the confidence of the potential respondents. For our case study, this process occurred at two levels.

First, our correspondence that accompanied the survey questionnaire to potential commercial harvest and post harvest respondents:

- explained the objectives of the research project;
- outlined the particular data which we needed to complete the study and how the data would be used for aggregate statistical analysis purposes only;
- provided assurances that individual enterprise data would be used for the purposes of this project only and treated in the strictest of confidence; and
- sought their cooperation in the provision of survey information.

Second, the peak industry body, under separate correspondence to the potential respondents, indicated its support for this research, encouraged them to complete the questionnaire, and extended a testimonial as to our credentials and the integrity of our ‘confidentiality assurances’.

The survey questions did not easily lend themselves to telephone collection methods. Also, with 250 commercial fishing units actively utilizing West Coast ‘wetline’ fishery endorsements and with as many post harvest enterprises with an interest in the processing, distribution, exporting and retailing of the three case study species, ‘face-to-face’ survey methods were not a cost effective data collection method in these circumstances. Mail survey and subsequent telephone contact was seen as the least cost method, despite the low expected response rates typically associated with such data collection methods.

2.2 Data Submitted

Survey returns combined with supplementary information provided us with adequate data for the harvest and post-harvest activities to meet the demonstration objectives of this project. These data covered prices and costs for harvest and post-harvest activities associated with the case study species caught in the West Coast 'Wetline' fishery. For reasons of commercial confidentiality, individual and aggregated returns for each of the harvest and post-harvest activities could not be published.

The surveys produced data across a range of enterprises with varying degrees of dependency on catches of the case study species in the West Coast Wetline fishery. In aggregate, the survey returns for each of the fishing, wholesaling/distribution, and retailing activities represented between 10 per cent and 15 per cent of the commercial catches of the case study species from the West Coast 'Wetline' fishery. These were a reasonable sample sizes for the demonstration purposes of this case study.

2.2.1 Markets for Commercial West Coast Wetline Fishery Catches of the Case Study Species

The data initially obtained from respondents on the operation of the markets for commercial catches were incomplete. The important gaps were 'plugged' as best we could through supplementary information obtained from the Western Australian Department of Fisheries and industry contacts, including seafood wholesalers/distributors and retailers. However, obtaining information which is objective and reliable may be much more difficult (and costly) where there are many buyers and sellers as was the case in this study.

With this supplementary information, we pieced together our best estimates of where commercial catch of the case study species went and of the significance of each of these outlets relative to the most recent catch year. In the main, survey returns from fishermen covered catches of all three species, although a few related to commercial catches of pink snapper only.

According to the data submitted by commercial fishermen, 90 per cent of the commercial catch of the case study species is sold as fresh whole fish with 9 per cent sold as whole, chilled or frozen fish. Case study species sold by fishermen as chilled or frozen filleted fish represented only 1 per cent.

The survey returns from commercial fishermen also show that, in aggregate, commercial catches were sent to wholesalers (70 per cent) or directly to retail outlets (25 per cent), including restaurants. The remaining 5 per cent went to fish processors with no direct exports by the fishermen that responded to our survey. These data are shown in Table 4 below.

Table 4: Disposals of Case Study Species by Commercial Fishermen

Outlets	Dhufish	Pink Snapper	Baldchin Groper	Aggregate
Processors	3%	6%	10%	5%
Wholesale/Distribution:				
Perth Fish Market	46%	14%	40%	26%
Other	20%	60%	14%	44%
Sub-Total	66%	74%	54%	70%
Retailers	**31%**	**20%**	**36%**	**25%**

The information available also suggests that:

- 85-90% of the local commercial catch finds its way to local 'seafood' markets[5]; and
- 10-15% is exported, mostly by wholesalers and mainly to interstate markets[6].

Filleting of the fish for local markets was generally undertaken by processors and retailers, and, to a much lesser extent, by enterprises involved in wholesaling, and distribution. According to disposals on the Sydney Fish Market, inter-State exports were chilled or frozen, cleaned, whole fish, and, to a lesser degree, filleted.

In general, prices received for the case study species appeared to follow the daily 'clearing' prices at the Perth Fish Market. These prices fluctuated daily depending on the catches available on the day and seasonal demands.

2.3 Industry Costs and Revenues

2.3.1 Cost Apportionment

Cost data submitted related to aggregate information for all three case study species and involved cost apportionment in all cases. This was the case across both the harvest and post-harvest activities.

The survey questionnaire did not seek information on the basis of the cost appointments used. The submitted data was taken at face value and being indicative of the basis on which business decisions were made.

Information on individual operators fishing intentions for each fishing trip could be used as a basis for cost apportionment. This basis could change depending on whether the catches of the case study species were primary or

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5 Includes sales made directly to WA retail outlets (seafood retailers, restaurants, etc) and to seafood wholesaler/distributors

6 Exports were chilled or frozen, whole or filleted, fish.

incidental to the individual operators fishing intentions on the trips when these species were caught. That is, whether an operator of an individual vessel that reported catches of the case study species actually went fishing with the intention of specifically targeting that fish specie or species caught (i.e. the sand dwelling pink snapper and/or the reef dwelling dhufish and baldchin groper) or whether the reported catches of the case study species were simply incidental to the primary fishing intention such as the catching of rock lobster.

If the catches of the case study species on a commercial fishing trip were incidental to the primary fishing intention, then the catches of these species could be viewed as a 'by-product' of that commercial fishing activity. In such circumstances, the costs attributable to catches of the case study species could be viewed as only those directly associated with the actual catching (that is, the direct labour costs in managing the hand and drop lines and the bait plus any additional fuel costs in relocating to any incidental fishing site), handling and disposal of the case study species caught.

Alternatively, if the primary intention of the fishing trip was to specifically target the case study specie(s), then the costs attributable to the catches of the specie(s) could be the total costs associated with that fishing trip. Where the primary intended catches relate to more than one species, then cost could be apportioned on either the expected 'net' returns (prices expected to be received less any associated freight i.e. outward freight costs) to the operator from the sales of each of the species caught on that trip or the volume of the each of the species caught. The former basis has the attraction of attributing costs on the premise that costs are incurred on the basis of prospective returns

In situations where cost apportionment issues arise, it is important to ensure that there is a sound and consistent treatment of cost apportionments. We were unable to verify this in the case of data returns received during this case study.

2.3.2 Resource (Opportunity) Cost Adjustments

In economic terms, the costs of particular interest in a resource sharing context is the resource (or opportunity) cost of inputs used (that is, the value in alternative uses) in commercial catch and its subsequent processing, distribution, exporting and retailing to consumers. As is standard in economic studies, this often requires some adjustments to collected data so that they better approximate the underlying resource costs from society's viewpoint.

To achieve this, adjustments were made to the returned cost data in order:

- To remove transfer payments such as interest, lease payments, and taxes (like diesel fuel excise) as well as those included in insurance premiums (where the real service cost included in paid premiums is typically around 8 per cent);

- To ensure as far as possible consistency in the treatment of capital items in terms of replacement values, expected life, and depreciation method; and

- To reflect as best we could the opportunity (or resource) cost of inputs used, particularly labour where average weekly earnings were taken arguably as indicative of the cost of labour in alternative uses (that is the opportunity cost) from society's viewpoint.

The adjusted cost data enabled an estimate of the total (resource) cost for commercial activity based on the submitted returns. These estimates were 'scaled-up' to derive 'ball park' estimates of the total resource costs for the harvest and post-harvest activities based on the 2001-2002 catch and costs associated with the case study species. The 'scaling-up' factors were based on the proportion by volume that the aggregate catch of each of the case study species by respondents represented of the harvest. These 'scaled-up' estimates are shown in Table 5.

2.3.3 Prices and Revenue Data

Price data were also available for harvest and post-harvest sector for the 2001-2002 commercial catches of the case study species taken from the West Coast Wetline Fishery. These data enabled us to estimate the aggregate revenue for the harvest and post-harvest returns. These estimates were then 'scaled-up' (in a similar manner to that used on the cost side) to estimate the aggregate 'industry' revenue for the harvest and post-harvest activities. These estimates are also shown in Table 5.

2.3.4 Aggregate Revenue, Resource Costs and Surpluses

The estimates in Table 5 suggest that, in aggregate across all three case study species taken from the West Coast 'Wetline' fishery for the year 2001-2002:

- the catching sector's average cost was about $5.56 per kg and average revenue were around $7.68 per kg;
- the post harvest (processing, exporting, distribution and retailing) sector's average revenue was $13.08 per kg with an average cost of $11.41 per kg;
- the combined harvest and post harvest surpluses (which is not profit in the accounting sense as certain costs are excluded or adjusted but what in economic terms is the value added by industry) amounted to $1.913 million or $3.80 per kilogram; and
- the harvest sector accounted for $2.12 per kg, whilst the post- harvest activities accounted for the remaining $1.68, of this combined harvest and post-harvest surpluses.

The harvest and post-harvest 'surpluses' shown in Table 5 represent the difference between the aggregate industry revenue and costs associated with the catching, processing, distribution, exporting and local retailing of all three case study species. These estimates are not measures of the 'producer surpluses' used in benefit-cost assessments of resource allocation options from society's viewpoint.

Producer surplus estimates are based on the difference between the marginal revenue (that is, the price for an extra unit of commercial catch) and the combined marginal cost of the harvest and post harvest activities associated with the production of that extra unit whether it is destined for local or export sale. This requites an understanding of the industry's cost structure and how production costs and prices (local and export) behave with changes in catch volumes. These aspects are discussed in Section 2.4 (Industry Cost Structure), and Section 2.5 (Marginal Costs and Revenue) below. This lays the foundations for estimating the 'producer surpluses' (Section 2.6) or the net benefits to society from commercial use of the case study species.

Table 5: Commercial Catches of Dhufish, Pink Snapper and Baldchin Groper from the West Coast Wetline Fishery: 2001 to 2002[7]

	Total Kgs	Revenues & Costs Scaled
Catching Sector		
Dhufish (catching)		$2,383,839
Pink Snapper (catching)		$1,484,140
Baldchin Groper (catching)		$179,206
Total Revenue (catching)		*$3,868,240*
Wages and Salaries		$1,284,766
Fuel		$762,910
Repairs and Maintenance		$288,996
Depreciation		$109,601
Bait		$135,675
Insurance		$15,114
Freight		$105,597
Office Administration		$36,326
Other		$59,737
Total Cost (catching)		*$2,798,722*
Surpluses		$1,069,518
Surpluses per unit of catch		**$2.12**
Post Harvest Sector		
Wholesale and Retail Sector Local Sales		$6,085,935
Export Sales		$501,366
Total Sales		*$6,587,302*
Wholesale and Retail Fixed Costs		$407,900
Wholesale and Retail Variable Costs		$1,427,649
Export Fixed Costs		$7,554
Export Variable Costs		$32,733
Input Cost (Total Revenue Catching)		$3,868,240
Total Costs		*$5,744,076*
Surpluses		$843,226
Surpluses per unit of catch		**$1.67**
Combined Commercial Harvest and Post Harvest Sectors		
Surpluses		$1,912,744
Aggregate Surpluses per unit of catch		**$3.80**

[7] Based on Dhufish catch of 219,065kg, Pink Snapper catch of 250,077kg, Baldchin Groper catch of 33,898kg representing an overall take of 503,040kg

2.4 Industry Cost Structures

Returned survey data provided information on cost items that remain fixed over a volume range and those that are variable over that range for both the harvest and post harvest activities. This allowed us to estimate the way total costs vary with volume of catch (or throughput).

On the assumption that there are no significant scale economies associated with harvesting due to changes in vessel sizes across range of catch volumes and that the pattern of the commercial catches, effort and disposals of all three case study species remained proportionately unchanged across our specified volume ranges, we estimated the aggregate cost structures of the combined harvest and post-harvest activities based on the 2001-2002 catch and cost data for the case study species. These estimates are shown diagrammatically in Figures 1 and 2 below.

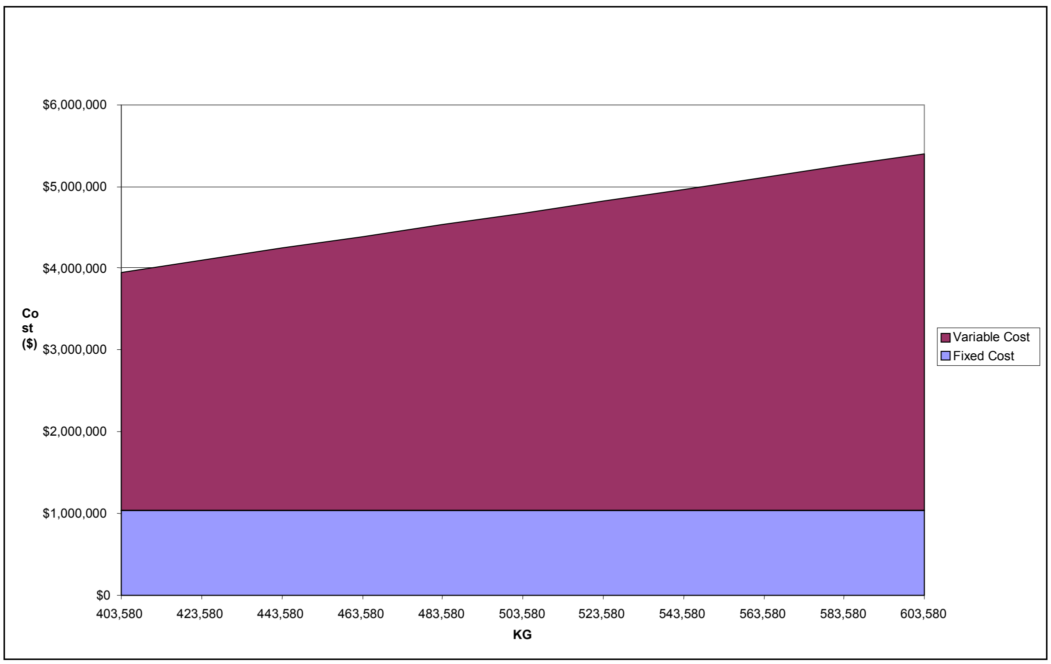

Figure 1: West Coast Wetline Fishery Commercial Total Cost Curve

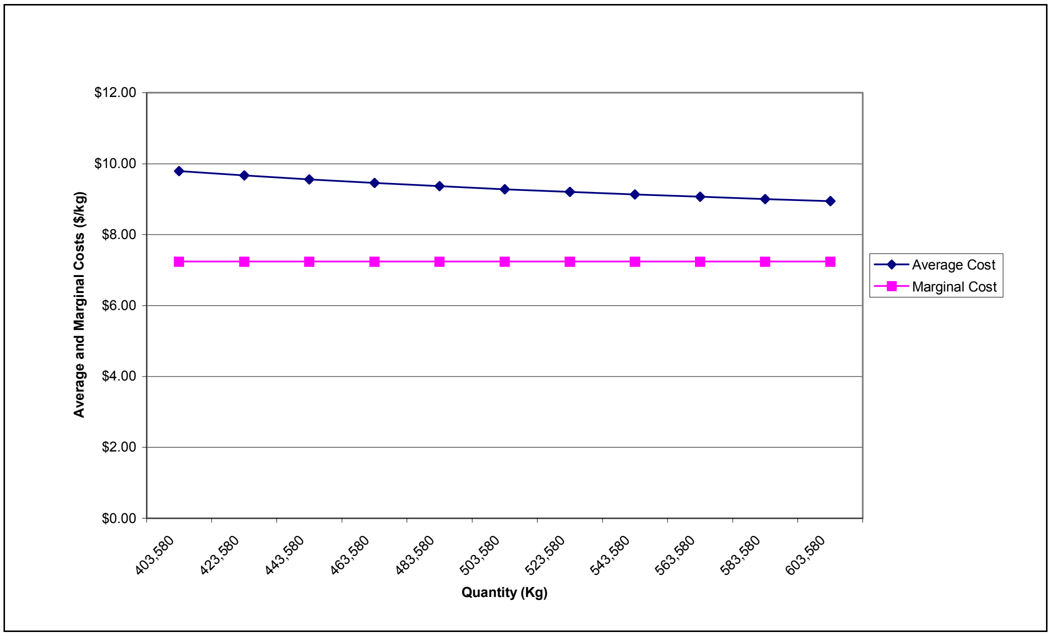

Figure 2: West Coast Wetline Fishery Average and Marginal Cost Curve

Cost data provided by fishermen enabled estimates of the marginal costs for commercial fishing operations that reported predominately pink snapper catches and those which reported predominately dhufish and baldchin groper catches. The marginal costs of commercial fishing operations that were predominately dhufish and baldchin groper catches were higher than the pink snapper operators. These enterprise level marginal cost estimates are shown in Table 6 below.

Table 6: Marginal Costs Estimates for Commercial Fishing Enterprises Harvesting Case Study Species from the West Coast Wetline Fishery.

Nature of Fishing Operation	Marginal Cost ($/kg)	Range ($/kg)
Predominately Pink Snapper	4.15	3.10 to 5.10
Predominately Dhufish/Baldchin Groper	6.20	5.20 to 7.60

Note: The word 'predominately' means these particular species represented more than 70 per cent by volume of the reported catch of the case study species.

The variability in marginal cost estimates is not unusual for the type of enterprises that operate in the West Coast Wetline fishery. These range from those enterprise where the Wetline endorsement is incidental to their primary fishing activity (for instance, Western Rock lobster fishing) to those where it represents their primary fishing activity. For instance, rock lobster fishermen with a 'Wetline' endorsement can throw a line out as part of the lobster-fishing trip to compliment the catch with case study species. The marginal cost for this type of operation in catching the case study species will be lower than a specialist Wetline fishing operation that steams out and back for the primary purpose of a Wetline catch. Also, the individual fishing enterprises are typically family based where the choices between profit maximization and leisure can be traded off. In these instances, the basis of cost allocations will vary among and between these categories of fishing operations.

2.5 Marginal Costs and Revenue

The resource-sharing framework requires that the marginal values for commercial and recreational use be compared on a 'like-with-like' basis. As the Part One, General Theoretical Framework paper makes clear, this requires a 'producer' surplus calculation for commercial activities at the margin for each of the case study species. To do this, we need to estimate the marginal costs and revenue for each of the case study species across a volume range.

2.5.1 Marginal Costs

The 'scaled-up' industry data in Table 5 above indicates that, in aggregate, the combined harvest and post- harvest marginal costs across all domestic and export disposals of the 2001-2002 commercial catch of all three case study form the West Coast 'Wetline' fishery is around $7.14/kg.

The marginal cost estimates shown in Figure 2 above represent an aggregate for a proportionally similar catch of case study species across our specified volume range. These would be indicative of the marginal cost for each of the case study species only if the catch per unit of effort were the same for all three species. Catch and effort data provided by the Fisheries Department for case study species taken from the West Coast Wetline fishery indicates that this is not the case.

The returned survey data from fishermen that caught all three species were not adequate to specify a more complex total cost model (see Appendix 2) that could be used to derive estimates of the marginal costs for each of the case study species for these multi-species 'Wetline' fishing operations.

Using returned survey data from industry and catch and effort data supplied by the Western Australian Department of Fisheries, we derived marginal harvest cost estimates for each of the case study species. These aggregate industry level marginal cost estimates, which are shown in Table 7 below, are at best indicative only. If these estimates were intended to be used for actual decision purposes, further research may be appropriate to validate them.

The post- harvest marginal costs are estimated to be around $3.16/kg for locally sold catch and about $0.65/kg for export sales. The data suggests that the marginal post-harvest cost estimates are likely to be much the same over the volume range specified in this case study. The marginal costs are considered to be not materially different among the case study species. These estimates are used in estimation of the net economic benefits (i.e. ‘producer surpluses’) from commercial use

‘Within-Year’ Marginal Harvest Cost Movements

The marginal costs will vary within a year depending on the ease of obtaining a commercial catch. In typical high catch periods the marginal costs will be lower than in low seasonal catch periods. This can be reflected in a fewer number of fishing days and/ or fishing trips to obtain an equivalent catch quantity.

If the catch per unit of effort data provided by the Western Australian Fisheries Department were taken as a guide of the likely probability of a catch, the range of aggregate ‘within-year’ marginal harvest cost estimates were made. These estimates are shown in Table 7 below.

Marginal Harvest Cost Differences between Locations

The catch and effort data also suggests the marginal costs can vary between location. For example, commercial pink snapper fishing operators based in Geraldton achieved, in aggregate, markedly better catches per unit of effort than their counterparts operating from Fremantle. This was also the case for those that reported catches of both pink snapper and dhufish; a result largely due to the pink snapper catches per unit of effort because the differences in the catch per unit of effort for dhufish between the two locations were in aggregate broadly similar. These estimates are also shown in Table 7 below.

In the absence of any other more reliable ‘official’ marginal harvest cost estimates for each of the case study species, we have relied on those shown in Table 7, despite their limitations, as a basis for the estimation of marginal producer surpluses for the demonstration purposes of this case study. If these estimates were intended as a basis for resource allocation decisions further research may be worthwhile to validate them.

Table 7: 'Within-Year' Marginal Harvest Cost Movements by Location ($/kg of whole fish caught)

Pink Snapper					Dhufish					Baldchin Groper		
Availability	**Period**	**Fremantle**	**Geraldton**	**Industry**	**Availability**	**Period**	**Fremantle**	**Geraldton**	**Industry**	**Availability**	**Period**	**Industry**
High	4	8	1.85	2.85	**High**	4	8.8	4.1	5.1	**High**	4	10.2
	5	11.75	2	4.1		5	7.4	4.7	5.55	**Moderate**	2	11.2
	2	10.3	1.85	3.2		11	5.65	6.1	6		3	11.15
	3	14	1.75	3.2	**Moderate**	3	6.7	6.3	6.3		5	7.62
Moderate	1	6.45	1.25	2.4		12	4.55	12.95	8.6		6	5.15
	6	10	2.05	4		8	3.4	6.7	6.25		7	5.65
	8	6.7	2	2.2		1	9	5.7	7.45		8	11.9
	12	5.8	1.8	2.95		6	4.3	5.3	5.1		9	7.8
	9	8.25	2.85	3		7	4.15	5.6	5.1		12	2.8
Low	11	11.4	2.85	3.85	**Low**	9	7.25	7.7	7.65	**Low**	11	5.65
	7	6.6	2.25	2.8		2	12.6	8.9	10.4		1	2.95
	10	7.25	3.2	3.45		10	N/A	6.9	6.9		10	7.1
Industry Aggregate		**8.9**	**2**	**3.1**			**6.7**	**6**	**6.2**			**6.2**

Notes: (1) Availability refers to aggregate local market supplies for the particular species. (2) The underlined period corresponds to shift in product availability on local markets from high to moderate and moderate to low (3) All numbers have been rounded to the nearest whole or half dollar amount (4) Baldchin groper relates to Geraldton only.

2.5.2 Marginal Revenue

Using the domestic demand functions for each of the case study species (specified in Section 3 on Consumer Demand and Surpluses Section), we estimated movements in the annual and monthly average returns for a 20 per cent rise or fall in catch volumes. These estimates are shown in Table 10 below.

The estimates were based on the assumption that

- the monthly supply patterns for each of the species remained proportionally similar to that observed for the 2001-2002 year;
- the volume changes for each specie were not contemporaneous and occurred whilst all other things remained unchanged; and
- the portion (10 per cent) of the catch exported remained the same over the defined volume ranges for all case study species.

Table 8: Domestic Price Responsiveness to Product Availability Changes

Species	Observed Prices [1] ($/kg)	Product Availability Change			
		20% Fall		20% Rise	
		Annual ($/kg)	Monthly ($/kg)	Annual ($/kg)	Monthly ($/kg)
Dhufish	16.43	18.60	15.60 to 21.35	14.90	11.85 to 17.60
Pink Snapper	**10.81**	12.65	9.00 to 16.75	9.30	5.70 to 13.45
Groper	13.31	14.65	11.35 to 17.80	12.20	9.00 to 15.40

Notes: (1) Annual average 2001-2002 prices

The annualised marginal results are shown in Figures 3 and 4 below.

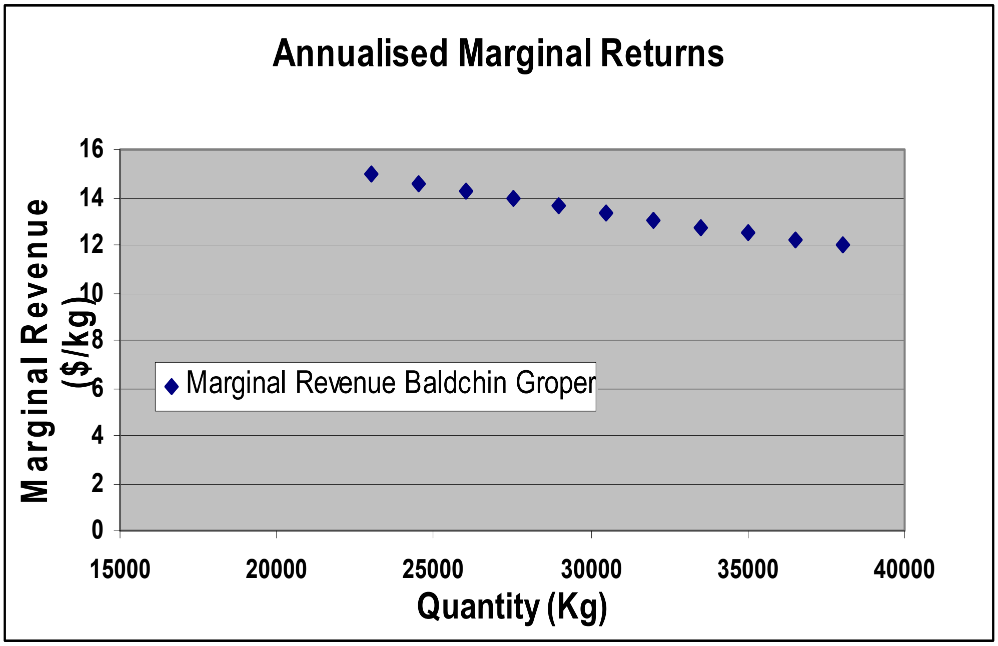

Figure 3: Marginal Returns for Baldchin Groper

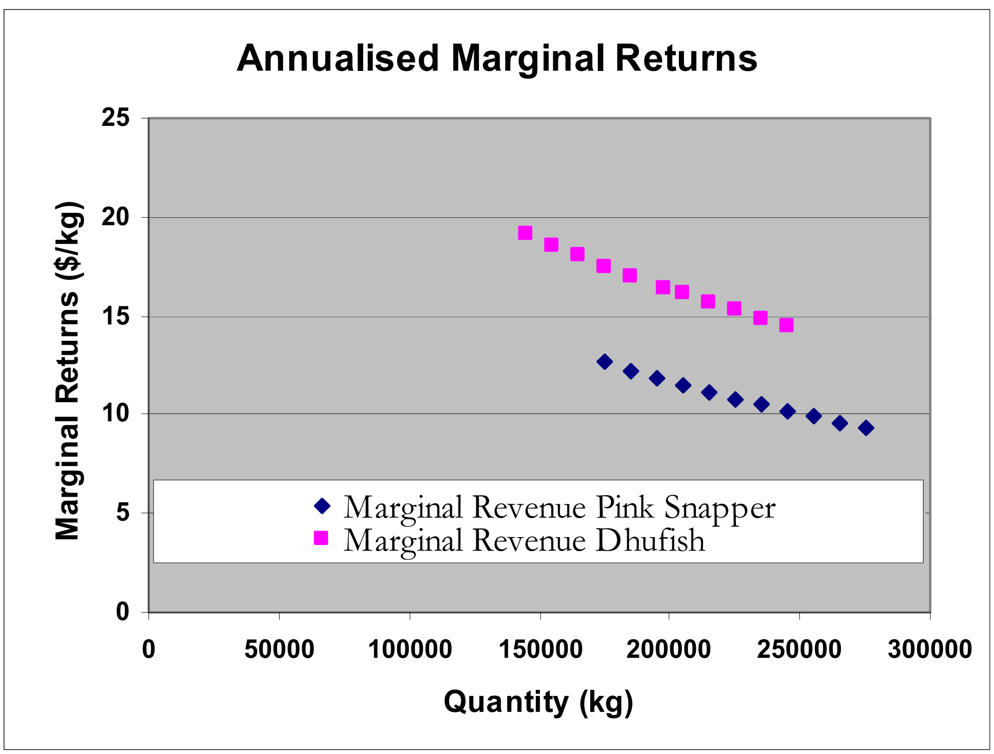

Figure 4: Marginal Returns for Pink Snapper and Dhufish

We tested these results against the aggregate estimates derived from the 'scaled-up' industry cost and revenue data shown in Table 5 above for the 2001-2002 commercial catches of the case study species. The annualised marginal return estimates derived from the application of the demand functions (combined with the assumptions relative to the quantity of domestic and export disposals of the commercial catches and to export returns) turned out to be similar, that is, around $13/kg. This suggested our marginal return estimates are likely to be soundly based.

Marginal returns from commercial use will vary on a daily basis depending on the volumes of catch available to the local markets, as well as seasonal demand (and other) factors. Based on the monthly data used to derive the above estimated marginal returns across the specified volume ranges used in our analysis and underlying assumptions that the monthly supply was similar to the 2001-2002 data, we have shown in Table 9 below estimated species prices over the course of a year for a 10 per cent rise or fall in annual availability of each of the case study species for local consumption. This provides a benchmark indication of the possible movements in domestic prices during the course of a year based on a particular pattern of monthly supplies within the specified volume changes.

Table 9: 'Within-Year' Movements in Marginal Revenue from Local Markets for the Case Study Species ($/kg whole fish)

Species	2001-2002 Data			Product Availability					
				10% Rise			10% Fall		
	Low	Moderate	High	Low	Moderate	High	Low	Moderate	High
Snapper	13-14	10.5-11.5	8-9	12.5-13.5	10-11	6.5-9	14-15.5	12-13	9-10
Dhufish	18-20	16-17	14-15	17-18	15-16	12-13	19-21	17-18	14-15
Groper	16-17	13-14	10.5-12	15-16	12-13	9.5-11	16.5-17.5	14-15	10.5-12.5

Notes: (1) ±20,000kg of whole pink snapper
(2) +17,500kg and –22,500kg of whole dhufish
(3) ±3,000kg of whole baldchin groper
(4) All price estimates were rounded to the nearest half or whole dollar.

The monthly data indicates that annualised marginal returns across the specified volume ranges used in this analysis depends on the period of the year when the rise or falls in product availability occurs. For instance, if a rise in the volume of catches available for domestic consumption occurred in a high product availability period, the annual average returns would be higher than if that rise occurred during a low product availability period. This is because the steep slope of the demand curve at the period of low product availability will produce a proportionately larger fall in prices than an increase in product availability at the larger volume end where the slope of the demand curve is flattening out.

Monthly data obviously masks the price and quantity variability that can occur on a daily basis. Daily price data available were incomplete.

In the absence of any better 'official' data set on marginal returns to the commercial use, we have used these estimates as best proxy estimates of the marginal producer returns and are adequate for the demonstration purposes of this case study. While they may be helpful in providing a broad level guide to direction of resource allocation changes that may result in a shift towards sociably optimal outcomes at an aggregate level, further research may be worthwhile to more clearly specify the marginal return estimates as a basis for actual decisions.

2.6 Producer Surpluses for Case Study Species

On the basis of the aggregate marginal cost and revenue estimates for each of the case study species across the specified volume ranges for domestic market sale, we could derive estimates of the combined harvest and post harvest aggregate producer surpluses for commercial use. These estimates are shown in aggregate in Appendix 3 and for each of the case study species in Appendices 5 to 8. These results are shown in Figure 5 (aggregate), Figure 6 (dhufish), Figure 7 (pink snapper) and Figure 8 (Baldchin Groper) below.

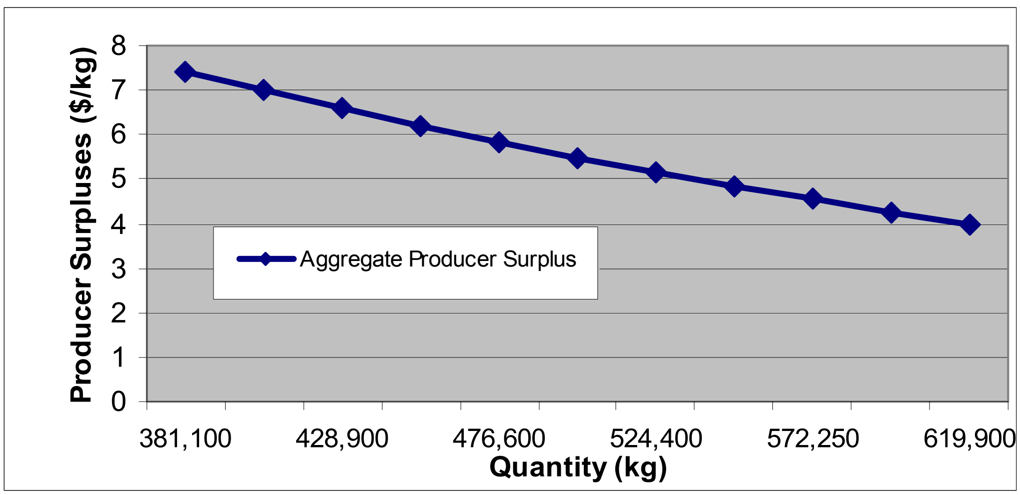

Figure 5: Aggregate Producer Surpluses: All Three Case Study Species

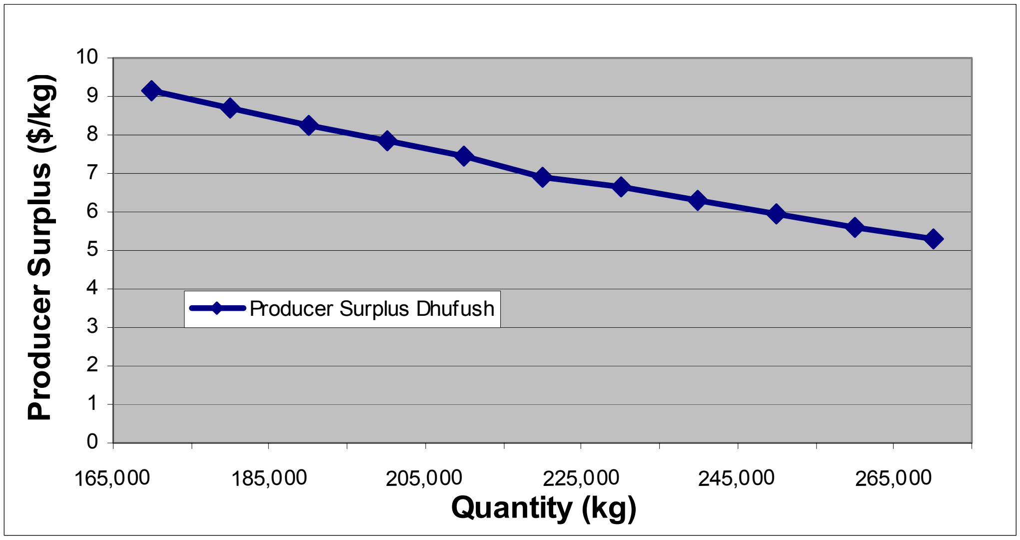

Figure 6: Producer Surpluses: Dhufish

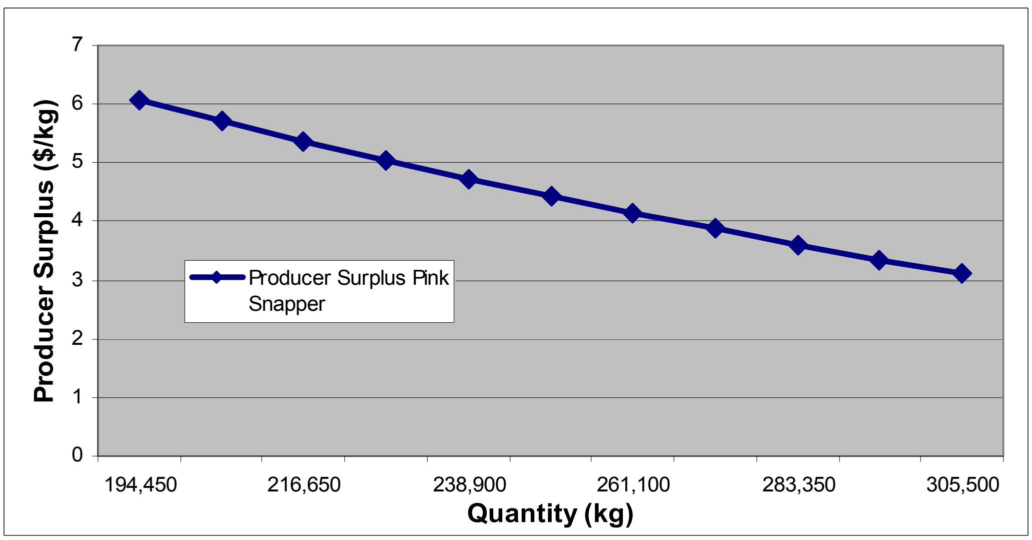

Figure 7: Producer Surpluses: Pink Snapper

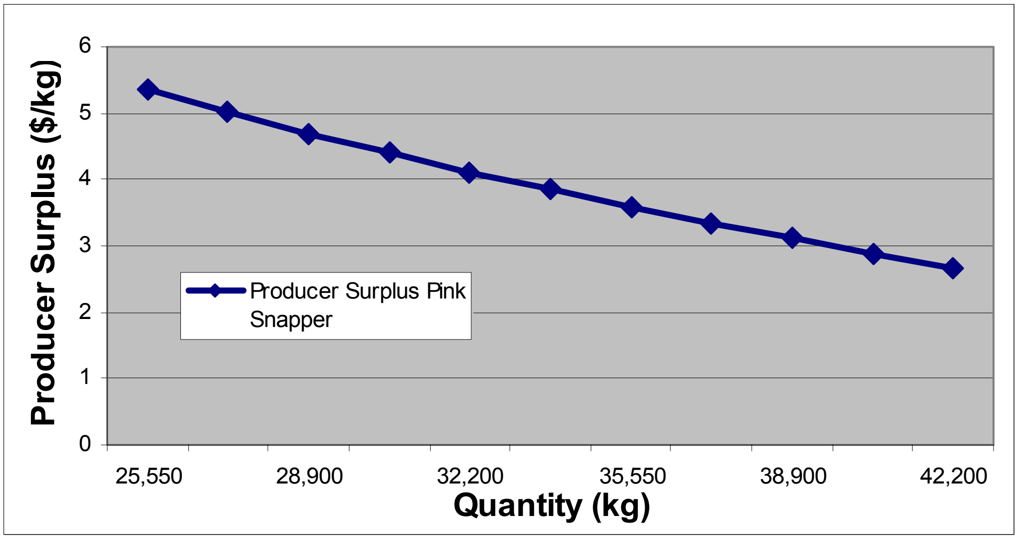

Figure 8: Producer Surpluses: Baldchin Groper

In aggregate, the producer surpluses estimates above for the combined 2001-2002 commercial catches of all three case study species, which were derived from the data sets constructed from survey returns and catch and effort data provided by the Western Australian Department of Fisheries, amounted to $2.751 million or about $5.47/kg.

These aggregate industry surpluses can vary over the course of the year for each of the species, depending on product availability, seasonal demand factors and effort required to obtain a catch. Using 2001-2002 monthly catch and effort data provided by the Western Australian Department of Fisheries, we estimated the producer surpluses for the volume of catch that was available for local market sale. These results are shown in Table 10 below.

Table 10: Aggregate Producer Surpluses for 2001-2002 Catch of Case Study Species Sold on Local Markets

Product Availability	Species		
Local Markets	Pink Snapper	Dhufish	Baldchin Groper
	($/kg)	($/kg)	($/kg)
High	1.80 to 2.90	4.65 to 5.65	1.15 to 2.65
Moderate	4.20 to 5.30	6.00 to 7.70	3.65 to 4.65
Low	6.00 to 7.75	8.65 to 10.50	6.20 to 7.65

The data available also indicates these marginal producer surpluses can vary between location of the fishing operation and among the individual enterprises. For instance, the catch and effort data for pink snapper catches out of Fremantle and Geraldton suggests, in aggregate, the producer surpluses are different. These estimates are shown in Table 11 below.

Table 11: Producer Surpluses by Location for 2001-2001 Catch of Case Study Species Sold on Local Markets ($/kg)

Product	Pink Snapper		Dhufish		Baldchin Groper
Availability	Fremantle	Geraldton	Fremantle	Geraldton	Geraldton
High	-3.65 to-7.90	3.00 to 4.35	2.00 to 6.70	6.25 to 6.75	-2.00 to -2.90
Moderate	2.65 to 4.00	5.30 to 8.00	4.35 to 10.20	0 to 9.00	-2.40 to 9.30
Low	0 to 4.25	7.50 to 8.60	3.25 to 7.60	6.95 to 10.00	6.70 to 10.40

Assuming the catch per unit of effort is a reasonable indicator of the chances of obtaining a catch, the differences were explained by:

- the catch per unit of effort was generally higher, on average, in Geraldton than Fremantle, that is the chances of a catch were better out of Geraldton than Fremantle;
- the Fremantle catches generally coincided with periods of high product availability and lower local prices; and
- the commercial catches in Fremantle tended to correspond with low catch per unit of effort periods and where the marginal cost were higher.

This may be a reflection of the differences in stock abundance and in the combined commercial and recreational fishing effort between the two locations. Fremantle is located on the doorstep of a more populated centre (Perth) with a larger user group accessing the resource. Nonetheless, there are aspects of commercial fishing behaviour that did not appear to be profit maximizing and that other factors may be driving this behaviour. The data available could not explain what these other behavioural-influencing factors might be. Further research would be need to better explain this behaviour and to more precisely specify the supply equations if the outcomes from this demonstration case study were to be used as a basis for actual resource allocation decisions.

The dhufish data did not highlight, in aggregate, any major differences between the locations

3. Local Consumer Demand and Surpluses

Retail volumes and prices for each of the case study species were provided by a number of local ‘seafood’ outlets. The available data represented around 15 per cent of the local catch of each of the case study species from the West Coast bioregion sold on local markets. This was a reasonable sized sample for the demonstration purposes of this case study.

Both daily and weekly average retail prices and quantities were provided for ‘high’, ‘moderate’ and ‘low’ product availability periods. The data sets were not as complete as we would have liked. Nevertheless, they provided us with information on seasonal retail prices and supplies in relation to each of the case study species that was sufficiently insightful for the demonstration purposes of this case study. If this analysis were to be used for actual resource allocation decisions, further research would be required to more exactly identify supply and demand functions.

Assuming 10 per cent of the local catches of each of the case study species from the West Coast 'Wetline' fishery were exported, the available data suggests the local 'seafood' markets typically absorb around 190 tonnes of the dhufish, about 225 tonnes of the pink snapper, and in the vicinity of 30 tonnes of the baldchin groper from the annual take of these species from the West Coast bioregion depending on product availability and retail prices, over recent years.

Retail prices fluctuate throughout the year with seafood demand and supply patterns. Christmas/New Year is typically a period of high seasonal demand with moderate availability of commercial catches of the sought after case study species and consequently retail prices can be higher than what they might be otherwise. Easter period is also a period of relatively high local 'seafood' demand, but, as this corresponds with seasonally high commercial catches for each of the case study species in the West Coast Wetline fishery, retail prices can be lower than what they might be otherwise.

Seasonally low commercial catch periods for the case study species in the West Coast bioregion typically occur in the July to November period. These low supply periods can correspond to higher local retail prices than what they might be otherwise.

The available seasonal prices and supply data were used as a basis for estimating average monthly prices associated with a recorded monthly commercial catches for each of the case study species. The daily price data were also related to estimated daily catches derived from monthly-recorded commercial catches. The statistical parameters of the resulting data sets are summarized in Table 12 below.

Table 12: Local Retail Prices for Case Study Species, ($/kg Whole, chilled fish).

Species	**Mean**		**Range**	**Standard Deviation**
	Monthly Data Set	**Daily Data Set**		
Dhufish	16.43	16.35	14.00 to 20.00	1.76
Pink Snapper	10.81	10.63	8.00 to 14.50	2.24
Baldchin Groper	13.31	13.29	10.50 to 17.00	1.97

3.1 Determining Appropriate Demand Functions

These data sets were used to derive demand functions for each of the case study species. Three forms of these demand equations were then tested to determine the 'best fit' functions. Both data sets produced plausible demand curves consistent with economic theory and with fairly strong R-squared values. In general, the monthly data sets provided 'best fit' demand functions. The R-squared results are summarized in Table 13 below.

Table 13: Demand Functions for Case Study Species- R-Square Results

Species	Monthly Data Set			Daily Data Set		
	Linear	**Expon-ential**	**Log**	**Linear**	**Expon-ential**	**Log**
Dhufish	0.8463	0.8801	0.9054	0.8225	0.8481	0.8776
Pink Snapper	0.8903	0.9200	0.9480	0.8836	0.9109	0.9463
Groper	0.907	0.9432	0.9707	0.9041	0.9400	0.9752

These monthly-based demand functions, which are shown graphically in Figure 9, reflect the pattern of demand within a twelve-month period. For the demonstration purposes of this case study, we assumed that, whilst the demand would move up or down the demand curve, depending on the catch quantities available to the local markets, the slope of the demand functions for each of the case study species would remain unchanged. Further research may be required to test the validity of this assumption, if this analysis of 'consumer surpluses' were to be used as a basis for actual resource allocation decisions.

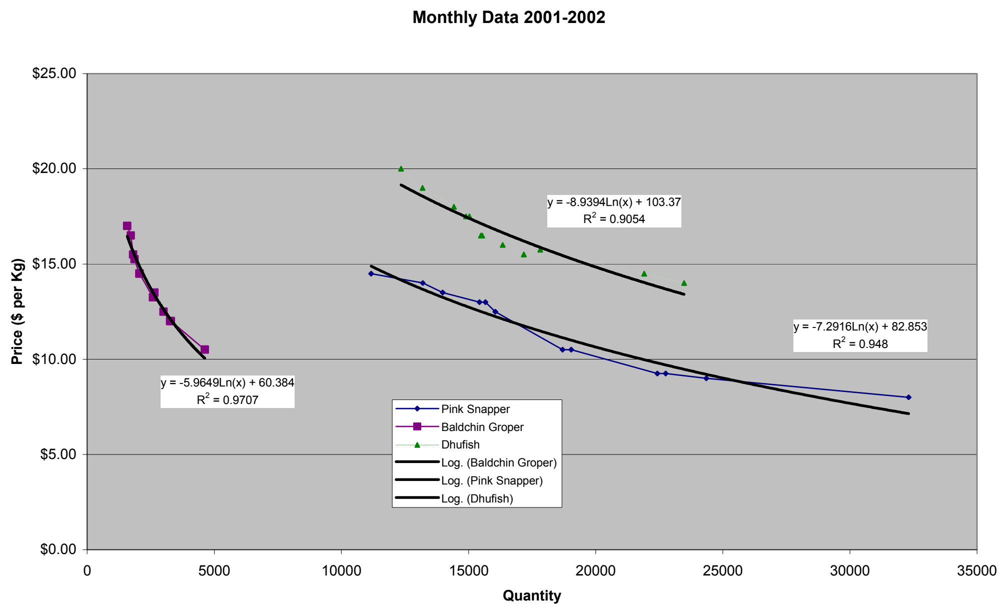

Figure 9: Demand Curves Derived From Seasonal Price and Quantity Data for Case Study Caught in the West Coast 'Wetline' Fishery During 2001-2002

These demand functions were then used to estimate the local prices over the specified range of annual catch volume changes. The estimates are based on the assumption that, for each catch volume within the specified range, the export disposals would remain at 10 per cent and the pattern of monthly local market disposals would be the same as the 2001-2002 data set. From this data set, we could derive the average monthly and annual 'clearing' price for each of the species and in aggregate over the specified volume range using the demand functions shown in Figure 9 above. The aggregate and species specific annualised demand functions, which are shown in Figure 10 to 13 below, are used to estimate the 'consumer surpluses' in aggregate and for each of the case study species across the specified catch volume changes.

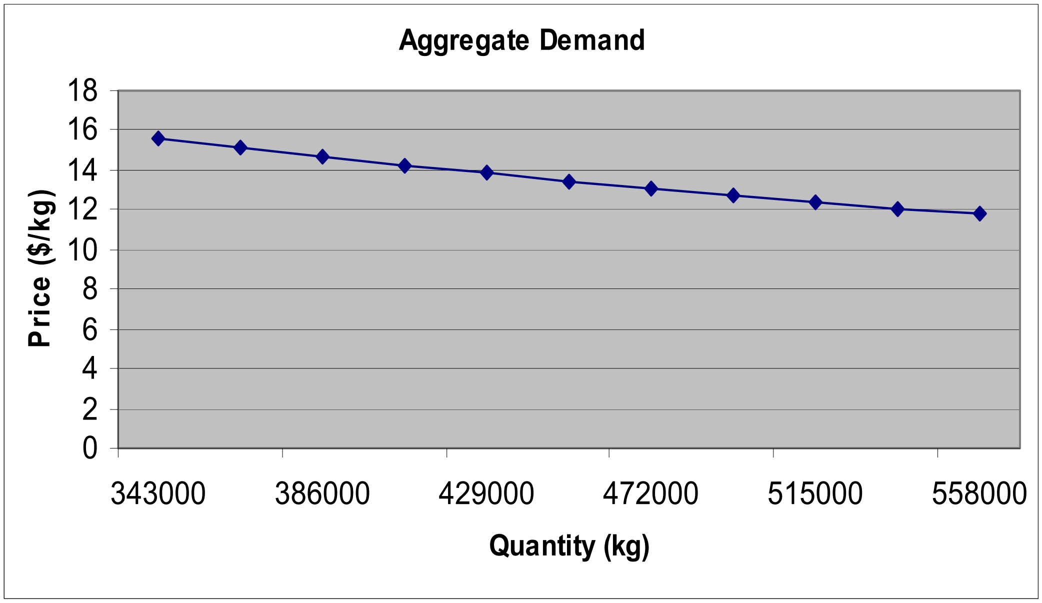

Figure 10: Aggregate Consumer Demand: All Three Case Study Species

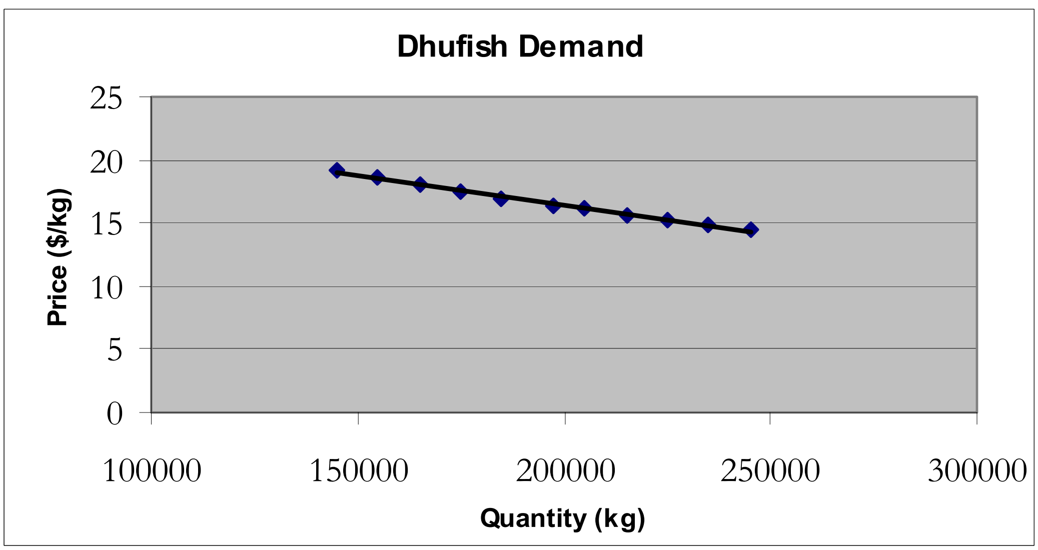

Figure 11: Dhufish Demand

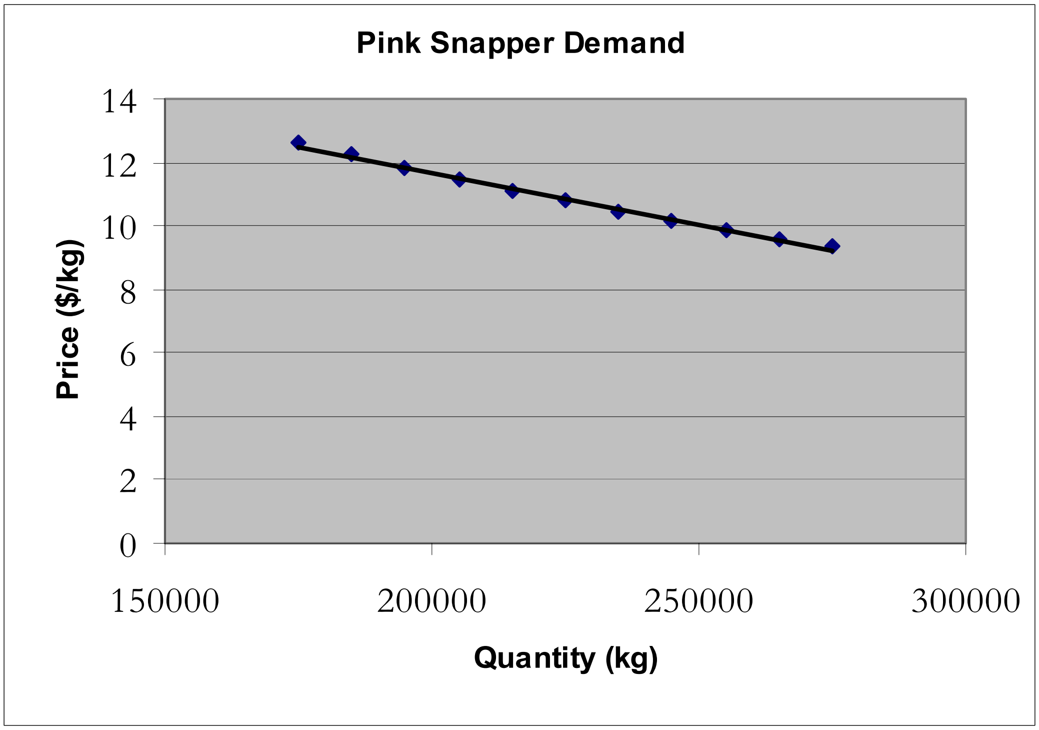

Figure 12: Pink Snapper Demand

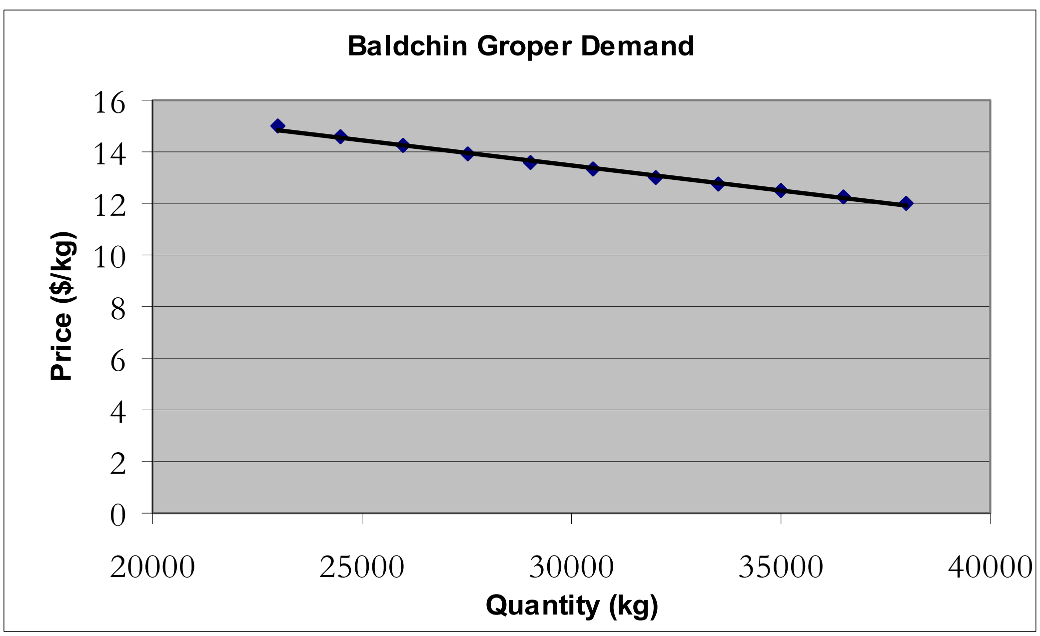

Figure 13: Baldchin Groper Demand

3.2 Elasticity of Demand for the Case Study Species

The price elasticity varies over the observed range of prices and quantities for each of the case study species. These 'own' price elasticities, which are summarized in Table 14 below, are consistent with standard demand theory.

Table 14: Own Price Elasticities of Demand for Case Study Species

Species	Product Availability		
	Low	**Moderate**	**High**
Dhufish	-2.034	-1.83	-1.465
Pink Snapper	-1.69	-1.41	-0.90
Baldchin Groper	-2.607	-1.89	-1.631

These estimates reflect for a particular species the responsive of quantity demanded to changes in retail prices assuming all other things remain unchanged. For example, in the case of dhufish, at a price of $16.50 and a local monthly quantity of around 17 tonne, the price elasticity is estimated to be –1.83. This implies that, if retail prices for whole chilled dhufish fell by 10 per cent, the quantity demanded will increase by around 18.3 per cent.

The price elasticity estimates suggest a fairly elastic demand for each of the case study species. These estimates turned out to be far more elastic than the price elasticity of demand estimates for other competitive foodstuffs. For example, the medium to long-term elasticity estimates for beef is estimated to be in the range -0.54 to -0.56 and poultry is in the range -0.55 to -0.74. This could have been the result of our 'thin' data set. Alternatively, a possible economic explanation could be that, if aggregate fish demand were fairly constant, consumers may substitute among and between the case study and other species. That is, individual consumers may satisfy their aggregate fish demand from the available fish species. In that event, the price elasticity of demand for individual fish species would be much more elastic than that for aggregate fish demand.

As already noted, the above estimates were based on incomplete data. To develop a more definitive estimate of the price elasticity would require simultaneous estimation of both the demand and supply curves based on more extensive data collection and analysis..

3.3 Estimating the 'Choke Price'

The 'best fit' demand equation can be used to derive estimates of the 'choke price', that is the price at which there is unlikely to be any demand for case study species. The 'choke price' estimates are the basis for estimating the 'consumer surpluses'. This is the satisfaction derived by the consumer beyond their expenditure on consumed dhufish, pink snapper and baldchin groper.

Where demand equations are derived from a 'thin' data set, which was the case in this study, there is less confidence in the 'choke price' estimates. In the absence of any other objective and reliable data set, we have used the 'choke price' estimates derived from our limited data set for the demonstration purposes of this study.

From the demand equations depicted in Figures 11 to 13 above, we estimated the 'choke prices for each of the case study species. This is the price that would result in the quantity demanded locally falling to zero. These prices, which were estimated to be $18.25/kg for whole, fresh pink snapper, $19.45/kg for baldchin groper and $25.75/kg for dhufish, were used as the 'choke prices' for the purposes of estimating the of consumer surpluses. The resulting 'consumer surpluses' estimates from using such 'choke prices' must be interpreted in the context of the assumptions we outlined above.

3.4 Estimating Retail Consumer Surpluses

We used the demand curve to generate the price-quantity relationships. These were then used to estimate the retail 'consumer surpluses' from local consumption of dhufish, pink snapper and baldchin groper from the 2001-2002 commercial catches. These estimates are shown in Table 15 below.

This suggests that, for the quantum of the 2001-2002 commercial catch of dhufish, pink snapper and baldchin groper in the West Coast 'wetline' fishery consumed locally, the aggregate 'consumer surpluses' across all three species were estimated to be around $1.852 million, or around $4.09/kg whole, chilled, fish.

Table 15: Local Consumer Surpluses for Case Study Species in the West Coast 'Wetline' Fishery During 2001-2002 Year

Consumer Surpluses		
Species	**Total (**$'000)	**Average (**$/kg)
Dhufish	921	4.66
Pink Snapper	873	3.72
Baldchin Groper	94	3.06
Total Consumer Surpluses	**1852**	**4.09**

As mentioned above, these functions were used to generate price-quantity relationships for the case study species across specified catch volume changes. These data provided annual average 'clearing' prices across the specified volume changes. The determined 'bulked-up' price-quantity relationships were used to generate aggregate demand curve for each of the case study species. The functions were the basis for determining the movement in consumer surpluses in response to volume changes. These results are shown in Appendix 7 and shown in Figures 14 to 17 below.

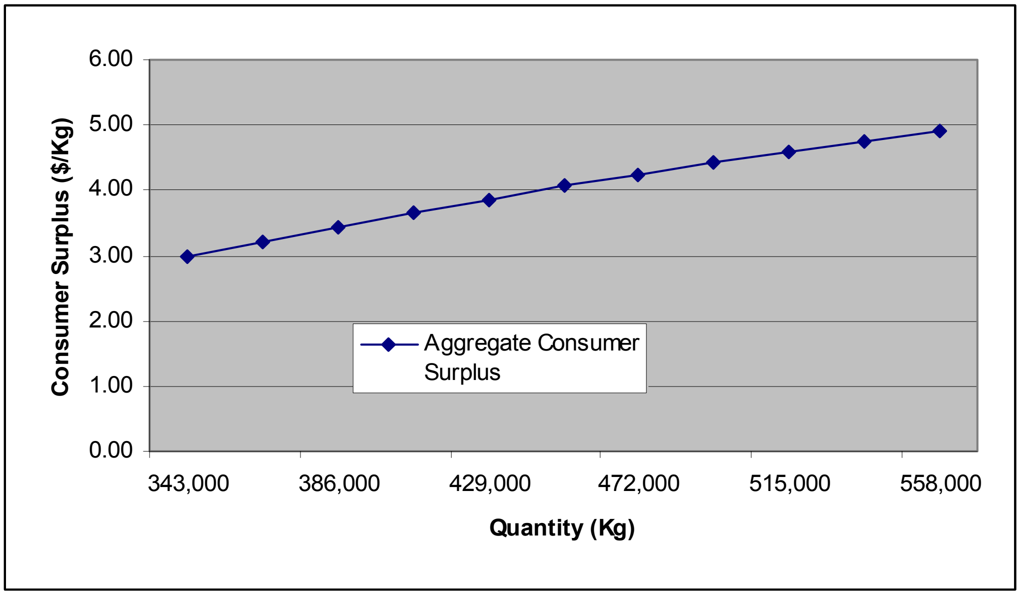

Figure 14: Local Consumer Surpluses: All Three Case Study Species

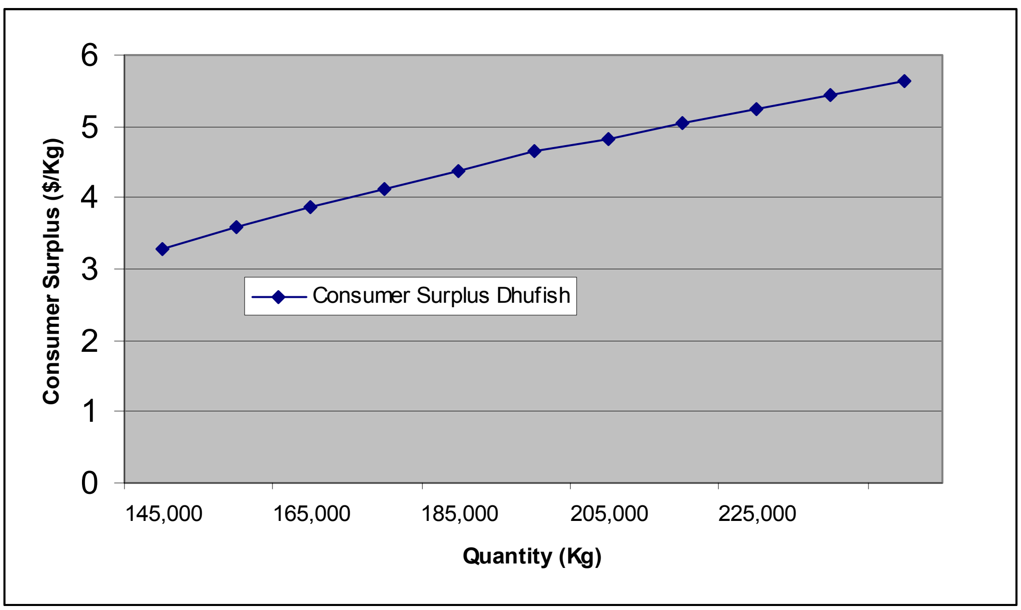

Figure 15: Local Consumer Surpluses: Dhufish

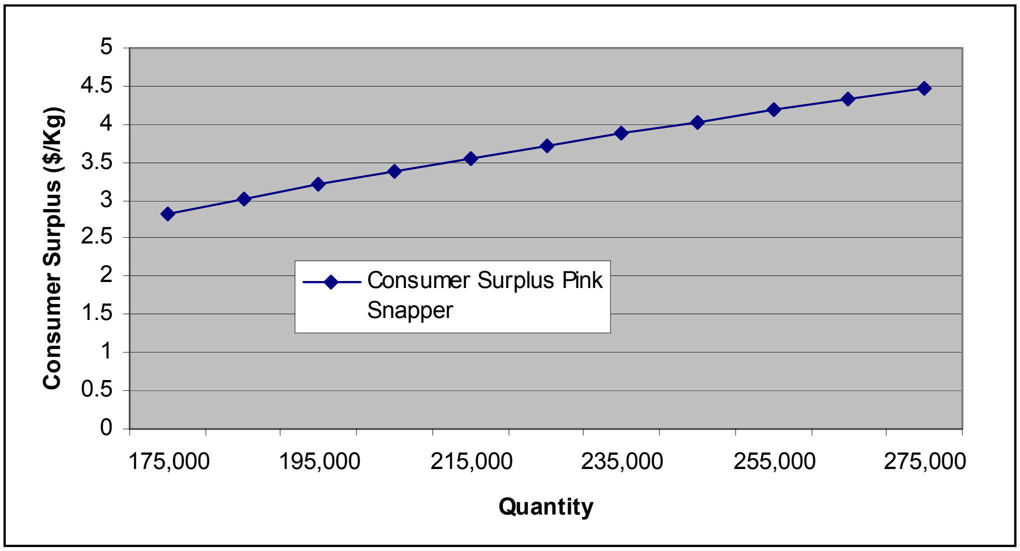

Figure 16: Local Consumer Surpluses: Pink Snapper

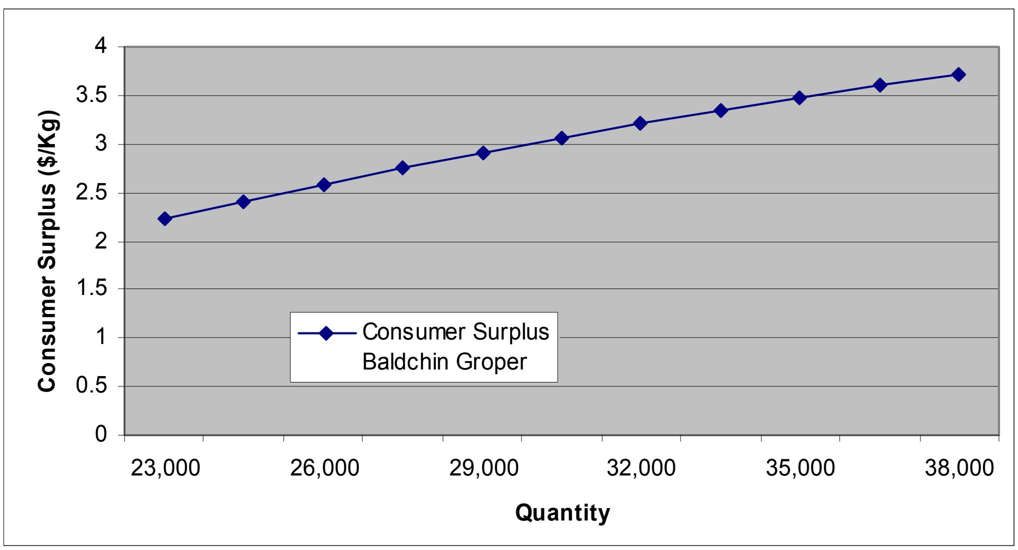

Figure 17: Local Consumer Surpluses: Baldchin Groper

For the purposes of this analysis the focus is on the State and the associated net benefits from allocation to consumers in Western Australia. We have ignored any 'consumer surpluses' accruing to Eastern States consumers of the case study species caught in the West Coast 'Wetline' fishery. If a national perspective were to be taken in considering resource allocation options in this fishery, the surpluses obtained by these Eastern States consumers would need to be factored into this model.

The consumer surpluses estimates were combined with the producer surplus estimates (Chapter 2 above) to derive estimates of the net benefits from commercial use (Chapter 4).

4. Valuing Net Benefits from Commercial Use

From the ‘scaled-up’ industry cost and revenue data in Chapter 2, the aggregate producer surpluses are estimated to be around $2.751 million or about $5.47/kg of whole, fresh fish for the 2001-2002 commercial catches of all three case study species caught in the West Coast ‘Wetline’ fishery. These estimates include both local and export disposals of the commercial catch and cover both harvest and post harvest activities. They represent the net benefit attributable to production.

The local ‘consumers surpluses’ are estimated to be, in aggregate, for the volumes of local catches of the case study species sold locally, to be around $1.852 million. This represents about $4.09/kg of whole, fresh fish and the net benefits attributable to local consumption of the case study species taken from the fishery.

4.1 Aggregate Net Benefits

The total net benefits from commercial use across all three case study amounts to $4.603 million for commercial catches from the West Coast ‘Wetline’ fishery during the 2001-2002 year or around $9.15/kg of whole, chilled fish. This estimate is broadly similar to the estimates derived from cost functions based on survey returns and catch and effort data provided by the Fisheries Department of Western Australia. These later estimates provide more extensive information and are used as the marginal benefits from commercial use.

The estimated net benefits from commercial use in aggregate and for each of the case study species are given in Appendices 5 to 8 and shown in Figures 18 to 21 below.

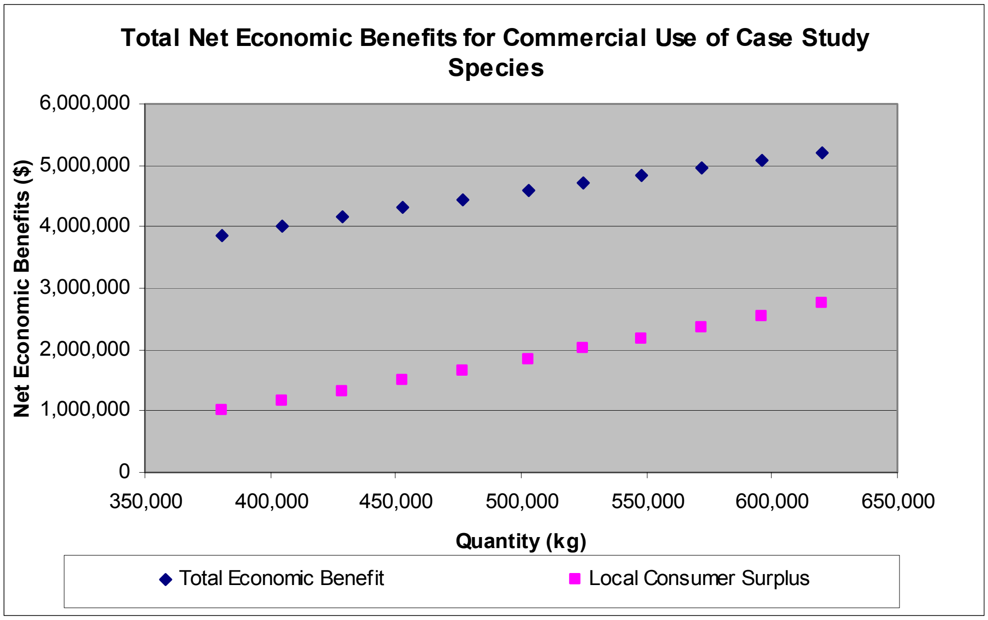

Figure 18: Total Net Economic Benefits from Commercial Use of Case Study Species

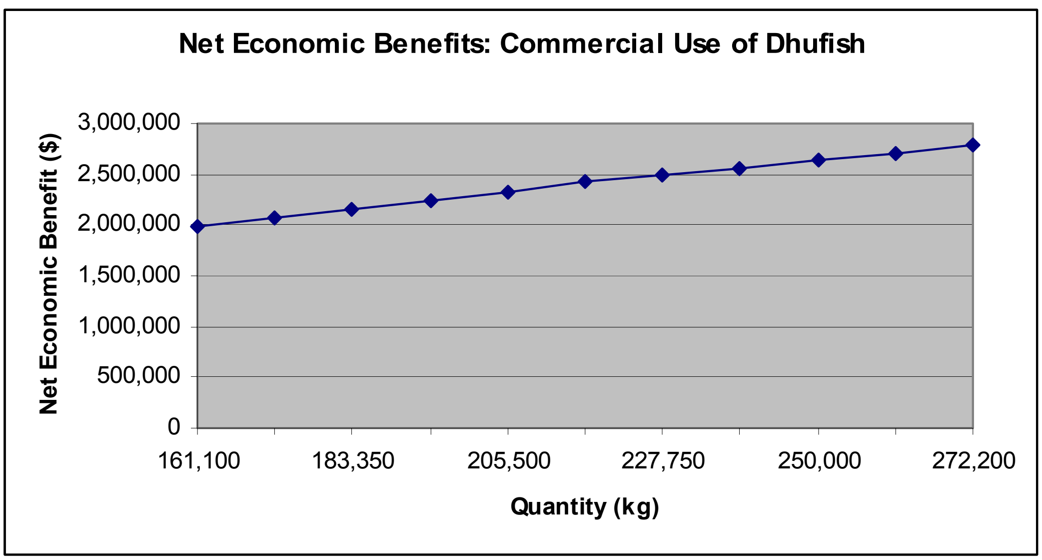

Figure 19: Net Economic Benefits Commercial Use of Dhufish

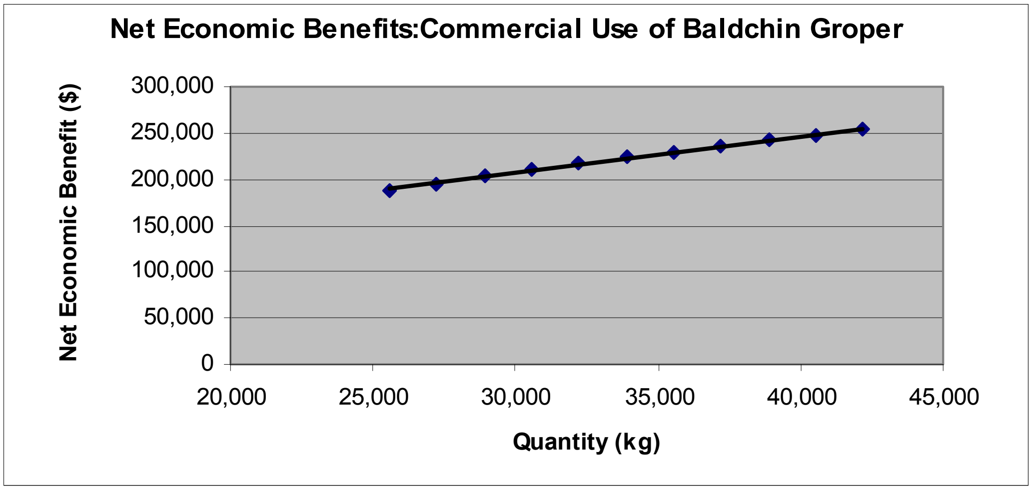

Figure 20: Net Economic Benefits Commercial Use of Pink Snapper

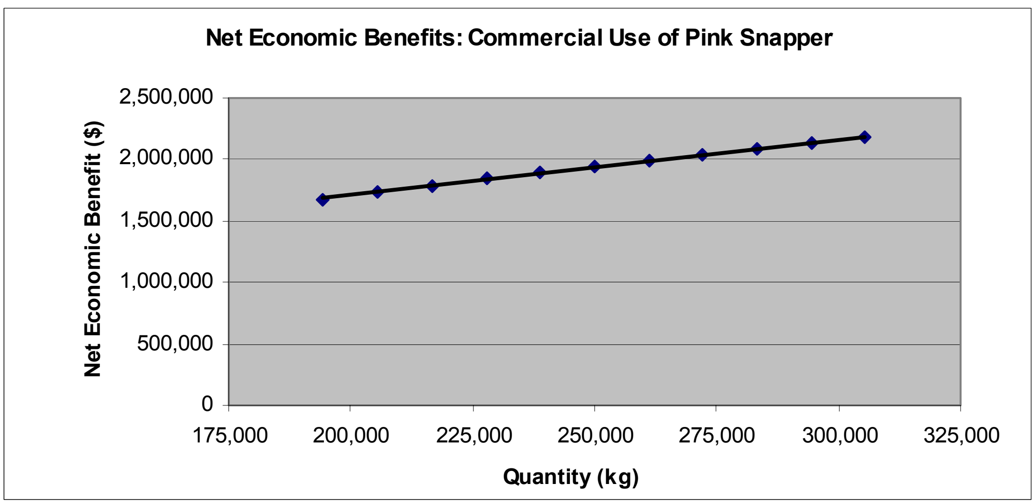

Figure 21: Net Economic Benefits Commercial Use of Baldchin Groper

4.2 Marginal Net Benefits

The resource-sharing framework requires that the marginal not aggregate values from commercial and recreational use be compared on a 'like-with-like' basis. As the framework makes clear, this requires estimates of the marginal net benefits from commercial use. These can be derived from the aggregate net benefits shown in Section 4.1 above.

The marginal net benefit estimates can be derived from the aggregate net benefit shown in Appendices 5 to 8. These results are illustrated in Figure 20 (All Three Species), Figure 21 (Dhufish), Figure 22 (Pink Snapper) and Figure 23 (Baldchin Groper).

These marginal net benefit estimates from commercial use are used as the basis comparison with the marginal values from recreational use shown in Chapter 5 to determine the catch shares that optimise the overall net benefits from the combined commercial and recreational use of the case study species.

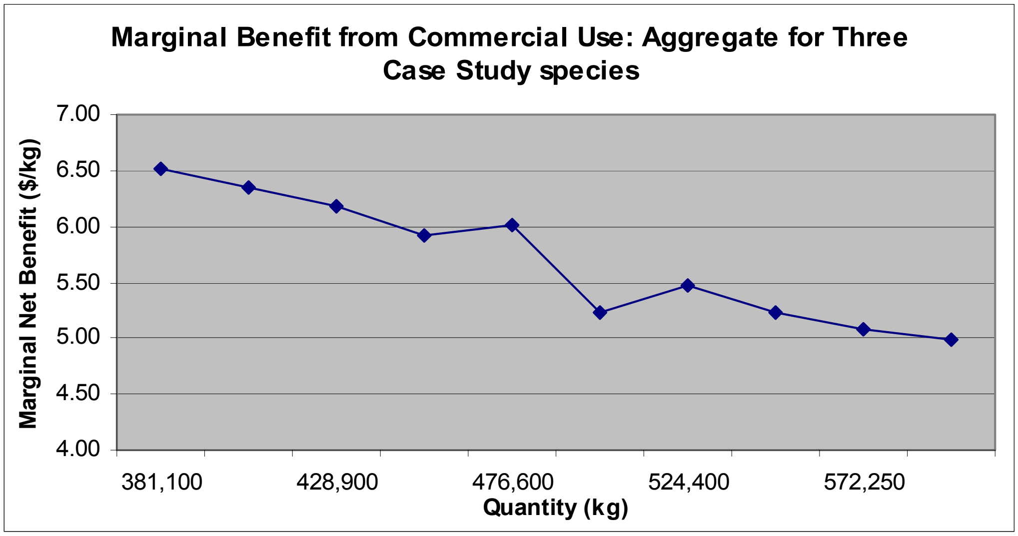

Figure 22: Marginal Net Benefit from Commercial Use: Aggregate

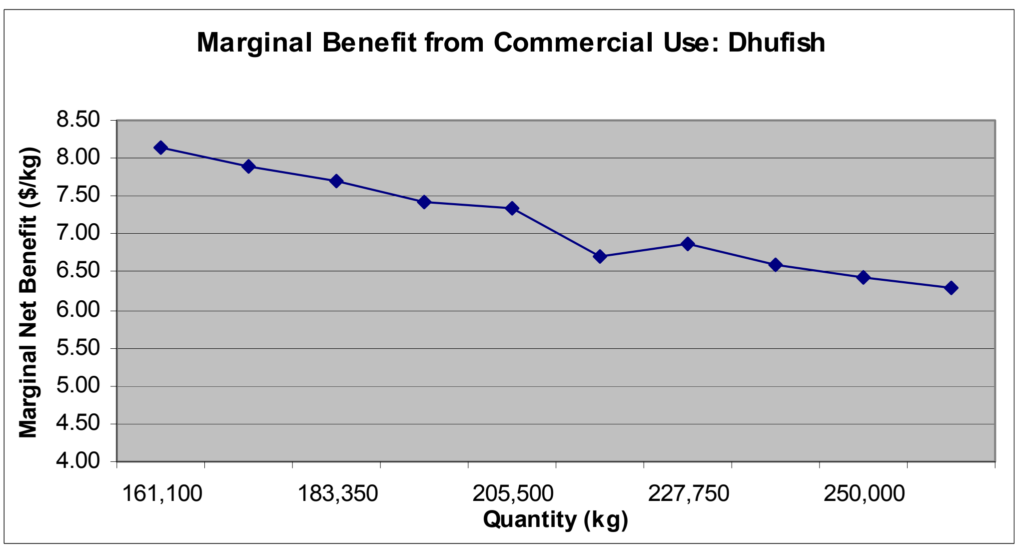

Figure 23: Marginal Net Benefit from Commercial Use: Dhufish

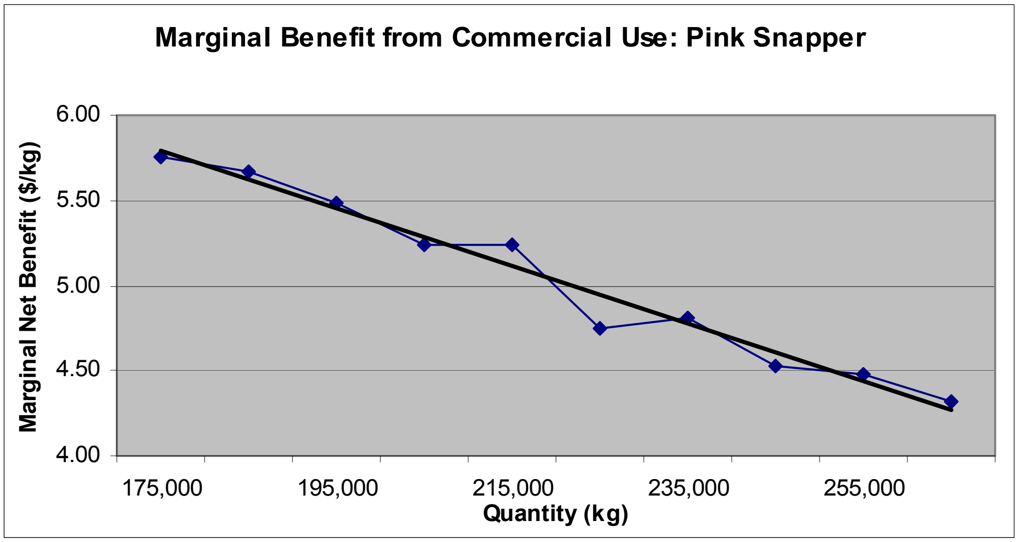

Figure 24: Marginal Net Benefit from Commercial Use: Pink Snapper

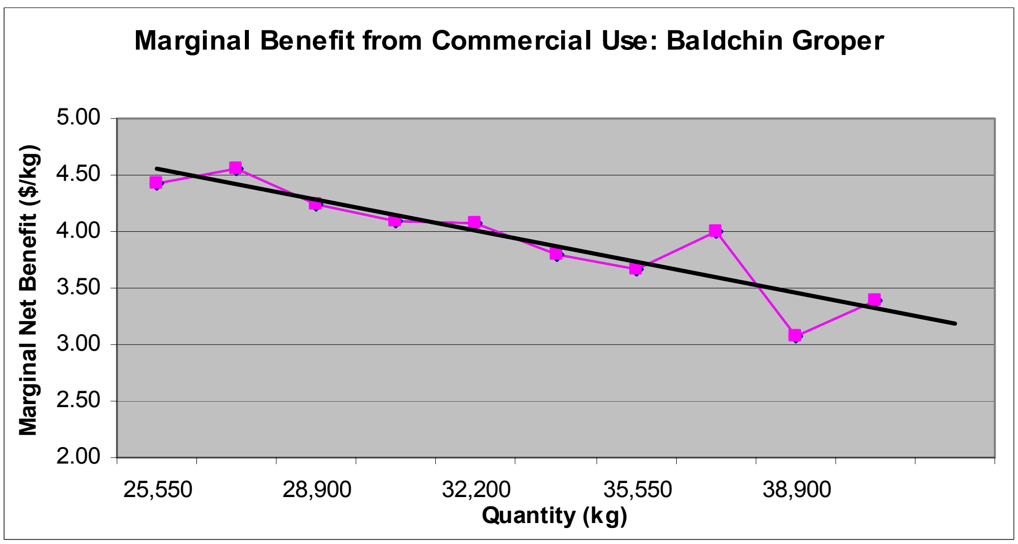

Figure 25: Marginal Net Benefit from Commercial Use: Baldchin Groper

5. Valuing Recreational Use

As with many recreational fishing activities, there is no well-established market where values that recreational fishers place on catches of dhufish, baldchin groper and pink snapper in the West Coast Wetline fishery may be observed. Whilst past surveys have collected data on recreational effort and catches in the West Coast Wetline Fishery, there is no appropriate data set available which would enable an estimation of the values placed on recreational catches of dhufish, baldchin groper, and pink snapper. Hence, to develop estimates of recreational fishing values for these sought after species, original data collection was required. As explained later in this Section, a contingent valuation survey was used to estimate the marginal valuation of the targeted case study species.

Dhufish, pink snapper and baldchin groper are prized species and are targeted by many fishers. Bag and size limits apply to retained catches of dhufish, pink snapper and baldchin groper.

5.1 Data Collection

Essentially valuing recreational catches of dhufish, snapper and groper is an application of the theory of non-market goods valuation. This requires careful consideration of what data are needed and how to collect the required valuation data in a theoretically valid and cost effective way.

Also, the required data needed to reflect the objectives of the project, which were to demonstrate the application of valuation methodologies, based on revealed and stated preferences using surrogate and simulated market approaches.

5.1.1 Survey Questionnaire

The survey questionnaire was developed with the assistance of an Interested Parties Consultative Group, which comprised people with a sound knowledge of fisheries and with the insights gained from our two previous case study fisheries. 'Test runs', using a recreational fisher who had fished in the West Coast Wetline fishery for the case study species, provided valuable feedback. This process helped to ensure that, as far as possible, the proposed questions were clear and unambiguous, and, in particular, the contingent valuation question posed a believable and realistic scenario that would yield analyzable results.

In this case study, there was a widely held perception among interested parties that, besides the values that they placed on retained catch of the case study species, recreational fishers' place considerable value on the fishing experience for these species. We tailored the contingent valuation question in a way that attempted to separate of experiential values from those associated with the retained catches of the case study species.

The contingent valuation question was initially structured in two parts. First, respondents were asked about their ‘willingness-to-pay’ an annual ‘entry’ recreational license fee to access the West Coast Wetline fishery, regardless of catches. This was designed to provide a proxy experiential value. Second, the respondents were asked about the ‘willingness-to-pay’ for non-refundable, colour-coded, fish tags of one week (Appendix 7) and subsequently twelve months (Appendix 8) duration for each of the case study species that they caught and retained. This was designed to determine the use values attributed to each of the case study species.

The tags could be purchased in any combination of species numbers but within the existing daily bag and size limits. The ‘willingness-to-pay’ for fish tags were to be teased out to determine individual respondents actual preferences. This was achieved by raising or lowering the tag prices where a ‘yes’ or ‘no’ response was given to the ‘initial randomly assigned price until a ‘no’ or ‘yes’ response (respectively) was forthcoming.

The annual ‘entry’ fee and tag prices were varied and randomly assigned to respondents.

‘Pilot testing’ the survey questionnaires established a ‘willingness-to-pay’ an annual ‘entry’ fee but an unwillingness-to-pay for non-refundable fish tags, regardless of whether they were of one or twelve months duration. This highlighted the value of testing surveys before adoption and implementation. If we had proceeded with a full-blown survey without first testing the questionnaire, the survey would have been costly and would not have yielded analysable data on recreational values.

Analysis of the retained catch data showed that, contrary to wider community perceptions, individual recreational catches, in aggregate or individually, of the targeted case study species did not come close to the ‘official’ daily bag limits. They did have significant released catches of the case study species. Hence, it appears that, for most recreational fishers, the ‘official’ bag limit is not binding.

Indeed, the evidence from an analysis of the catch data, is that for most fishers the retained daily catch was less than three in aggregate of the case study species, whilst catching six, which is well below the bag limit, was exceptional. For the individual species, retained catches were often not achieved. This meant individual recreational fishers were not confident of a successful retained catch of any of the case study species, that is, their expectation of achieving a retainable catch was probably low.

The contingent valuation question was redesigned and ‘tested’ using annual West Coast Wetline recreational licensing fee for various, endorsed, daily catch limits (See Appendix 9). The recreational survey asked respondents to indicate a willingness to pay across a range of daily catch limits. These were total daily catch limits for a bundle of case study species and the range offered went above and below the existing ‘official’ daily bag limit.

There were 77 different 'offered' daily catch limits used, ranging from 'nil' for each of the targeted case study species up to one of a maximum of 4 dhufish, and 8 of both baldchin groper and pink snapper. The annual license fee and daily catch limit for each of the case study species were randomly assigned to respondents.

A 'test run' of the redesigned contingent valuation scenario yielded analysable results and became the basis of our recreational survey. The survey was expected to produce data that would enable the estimation of experiential values distinct from those placed on retained catches of the targeted case study species. The later values were expected to include an element of use and option values. Given retained catch experiences of individual recreational fishers in this fishery for the case study species are well below the existing daily bag limits these values were expected to include a significant element of option values.

The 'test runs' and the subsequent 'full blown' survey occurred against the background of report released by the Fisheries Department of Western Australia that proposed reduced bag limits for the case study species. This may have influenced individual responses to the contingent valuation question.

5.1.2 Survey Population and Sample Size

In the absence of recreational licenses applying in this fishery, surveys would normally sample a cross section of the general population in regions judged to be the likely 'draw areas' of recreational fishers or perform a 'face-to-face' survey at most frequented boat ramps by recreational fishers accessing the West Coast Wetline fishery. In this case study, as catches of the targeted case study species occur off shore from a boat, we were able to draw from a pool of 70,000 pleasure craft registrations held by the Marine Section of the Department of Planning and Infrastructure in Western Australia.

A stratified, random sample based on postcode locations of 2,000 pleasure craft owners were contacted (in writing) by the Marine Section asking them to advise the Department if they were not agreeable to their contact details being released for possible participation in our recreational survey. The Department made a sample of 1,734 contacts available.

This sample was used for the testing of the survey questionnaires (50 contacts) and the remainder became the basis for our telephone survey of 500 contacts.

5.1.3 Survey Method

The survey data were collected by telephone interviews using Computer Assisted Telephone Interviewing techniques. This was judged to be the most cost effective data collection method for this demonstration project.

Mail out survey methods typically achieve to few observations where 30 per cent or less response rates tend to be the norm. ‘ Face-to-face’ interview methods were clearly too costly for the purposes of this project.

5.2 Data Analysis

The key outcomes are outlined below:

The Sample Group and Response Rate

- Out of the contact list of 500 pleasure craft owners randomly selected from the 1734 contacts provided by the Marine Section of the Western Australian Department of Planning and Infrastructure, 380 (or 76 per cent) completed the telephone survey. This response rate is typical of telephone surveys.

- The remaining 120 contacts consisted of those who could not be contacted by telephone after five attempts, those with incorrect or disconnected telephone numbers, those who declined to participate in the survey, and those who had not fished in the West Coast ‘Wetline’ fishery over the past twelve months.

- Respondents were predominately male (96 per cent) and were mostly in the 30 to 60 years age group (75 per cent). Retirees and pensioners were around 17 per cent of the sample. The majority were engaged in full time employment.

- Disclosed annual incomes (before tax) of respondents were oriented towards the higher income groups with 35 per cent earning above $51,999 annually. These data are summarized below:

Annual Incomes	**Percentage of Respondents**
Less than $8,319	6
$8,320 to $15,599	7
$15,600 to $25,999	11
$26,000 to $36,399	17
$36,400 to $51,999	24
$52,000 to$77,999	20
$78,000 or more	15

Respondents Fishing Background

- On average, respondents' recreational fishing in the West Coast Wetline fishery for the case study species accounted for 53 per cent of the usage of their boats over the past twelve months. These boat usage data are shown below.

Percentage of Boat Use Spent fishing offshore in the West Coast Wetline Fishery for the Targeted Case Study Species

Percentage of Boat Use	Frequency (%)
10 per cent or less	24
11 per cent to 30 per cent	15
31 per cent to 50 per cent	18
51 per cent to 70 per cent	5
71 per cent to 90 per cent	6
91 per cent to 100 per cent	32

- On average, respondents went 'bottom fishing' 12.8 times in the West Coast Wetline fishery over the past twelve months. Around 30 per cent fished 5 times or less, whilst 94 per cent fished 30 times or less. Two fished around every third day over the past twelve months. These data are shown below.

Number of Fishing Trips in the West Coast Wetline Fishery for the Targeted Case Study Species

Number of	Trips Frequency (%)
10 trips or less	58
11 to 20 trips	28
21 to 30 trips	8
31 or more trips	6

- Fishing trips typically involved two or three people, representing three quarters of the survey responses; although as many as 6 persons was not unusual. Most were either friends or family.

- For almost all (97 per cent) of the sample group, fishing trips in the West Coast Wetline fishery for the case study species were of one day's duration or less. The mean fishing trip was 4.7 hours duration with the range from less than 2 hours to 20 days. These data are shown below.

Length of Time, on average per trip, spent fishing in the West Coast Wetline fishery by Respondents who spent less than one day

Hours	Frequency (%)
Less than 2 hours	3
2 to 3 hours	27
4 to 5 hours	40
6 to 7 hours	17
8 to 9 hours	8
10 hours or over	5

- In the past twelve months, 81 per cent of the respondents specifically targeted dhufish when they went fishing in the West Coast Wetline fishery, whilst 64 per cent targeted pink snapper and 44 per cent baldchin groper. This affirmed strong preferences attaching to dhufish among recreational West Coast Wetline fishers. Sixty three per cent of the respondents also targeted other species besides the case study species.

- Over the past twelve months, on average per trip, over 90 per cent had not achieved daily bag limit catches, in aggregate or individually, of the case study species whilst fishing in the West Coast Wetline fishery, contrary to wider community perceptions. Indeed, for each of the case study species, most respondents had not caught and kept any of the case study species. These data are shown below.

Distribution of Respondents by Retained Catch in the West Coast Wetline Fishery for the Case Study Species

	Percentage of Respondents		
Number of Fish	**Dhufish**	**Baldchin Groper**	**Pink Snapper**
0	37	71	55
1	35	17	23
2	18	7	14
3	6	1	3
4	2	2	2
Over 4	2	2	2

- The retained catch data shows that, over the past twelve months, the mean:
  - dhufish catch was just over one, with a range from 0 to 12 on average per trip,
  - pink snapper catch was just under one, with a range from 0 to 20 on average per trip, and
  - baldchin groper catch was just 0.56, with a range from 0 to 20 on average per trip, whilst
  - other species catch dominated at 5.95 and only 16 per cent of respondents had zero retained catches of other species.

- Over the past twelve months, on average per trip, most respondents had not caught and released any of the case study species whilst fishing in the West coast Wetline fishery. These data are shown below.

Distribution of Respondents by Released Catch in the West Coast Wetline Fishery for the Case Study Species

Number of Fish	Percentage of Respondents		
	Dhufish	Baldchin Groper	Pink Snapper
0	37	86	52
1	22	6	12
2	17	4	13
3	11	1	5
4	5	2	4
Over 4	6	1	15

- The released catch data shows that, over the past twelve months, the mean released catch of:
    - dhufish was 3.7, with a range from 0 to 40,
    - pink snapper was 5, with a range from 0 to 40, and
    - baldchin groper was just 1.25, with a range from 0 to 15, whilst
    - other species was 7.3, with 30 per cent of the respondents had zero released catches of other species.
- The retained and released catch data are correlated but not perfectly correlated. To get a feel for the extent of catching activity we need to combine them. The following table shows the combined data for dhufish, pink snapper and baldchin groper. The mean combined retained and released catch was 7 fish. Only 15 percent of respondents had neither retained nor released catches over the past 12 months for the case study species.

Aggregate Retained and Released Catches by Respondents in the West Coast Wetline Fishery for the Case Study Species Over Past 12 Months

	N	Min.	Max.	Mean	Std. Dev.n
Aggregate retained and released of catch dhufish, pink snapper, baldchin groper.	379	0	107	7.05	10.51
Aggregate retained catch of dhufish, pink snapper, baldchin groper.	380	0	52	2.65	3.88
Aggregate released catch of dhufish, pink snapper, baldchin groper.	379	0	70	4.39	7.94

- When other species catch is taken into account the following results emerged.
  - The average released catch for combined dhufish, snapper, groper and other species is 9.6 fish. Only 7.7 percent of respondents had zero released catch.
  - The average retained catch for combined dhufish, snapper, groper and other species is 8.6 fish. Only 2.9 percent of respondents had zero retained catch.
  - The average of retained and released catch for combined dhufish, groper and other species is 18.2 fish. Only 1.1 percent of respondents had zero for combined retained and released catch.

Importance and Satisfaction relative to the General West Coast 'Wetline' fishing experience

- From a given set of factors (see Q10 of Appendix 9), almost 90 per cent of the respondents rated having an enjoyable time on the ocean as very important, whilst 82 per cent rated having an enjoyable fishing experience regardless of the number of retained fish as also being very important for a successful fishing trip in the West Coast 'Wetline' fishery. In relation to both of these factors, more than 90 per cent of the respondents were satisfied. Indeed, two-thirds were very satisfied.
- Other factors such as the size of the retained catch, the retained catch species, catching enough fish for a decent feed and no congestion at the boat ramp were also rated important. In relation to these factors, the survey respondents were generally satisfied.
- Factors like catching as many fish as expected, the number of retained fish, and the time taken to achieve the desired number of fish, whilst generally not rated important, around 60 per cent of the respondents were satisfied.

Most Recent Fishing Experience in West Coast Wetline Fishery

- For the most recent fishing experience, two thirds of the respondents indicated that they had not caught as many of the case study species as they wanted, although almost one quarter indicated that they had caught as many as they thought they would within the catch limit. Less than 2 per cent of the respondents indicated bag limit catches.
- In relation to the most recent fishing trip, 62 per cent of the respondents thought they would have caught more fish, whilst 34 per cent indicated that they had caught as many as they thought they would. Only 4 per cent thought they would have caught less.
- In term of fish kept, one half thought they would have kept more, whilst 47 per cent indicated that they had kept as many as they though they would. Only 2 per cent thought they would have kept less.
- Despite outcomes below expectations from their the most fishing experience in the West Coast Wetline fishery for most respondents:
  - two-thirds were happy with the number of fish they caught,

- two-thirds were happy with the number of fish they kept,
- 71 per cent were happy with the size of the fish they caught,
- three-quarters were happy with the type of fish kept, and
- three-quarters were happy with the type of fish they kept.

5.3 Revealed Travel Costs and Demand

The travel cost model was deemed unsuitable for valuing recreational fishing for the case study species in the West Coast 'wetline' fishery.

The underlying premise of travel cost models (TCM) applied to natural resource use is the cost of accessing the site of the recreational activity (a combination of out-of-pocket and time costs) can be used as a proxy for the 'price' paid to access the site and the associated recreational activity.

This being the case, those people living closest to the site will have the lower per trip access prices and will therefore tend to visit the site more frequently than those who live further away. This is because the access price as measured by the travel (out-of-pocket and time costs) of a return trip to the site is higher for those living further away and they will "demand" fewer trips. This type of modelling has been successfully in a variety of applications, especially for well-defined sites such as wildlife parks and reserves and lakes in the United States.

The implementation of the model requires an appropriate spatial distribution of users in terms of distance to the site so that users of the site are in effect paying a range of 'prices' measured on a travel cost basis.

Our survey respondents provided us with information on the number of trips to their preferred 'wetline' fishing location in the West coast fishery, the time spent away from home on these fishing trips, and the distances travelled for a return trip to that site.

Basic statistical analysis did not indicate any statistically significant relationships between the number of 'wetline' fishing trips and the distance travelled and the distance travelled per trip, the number of trips and socio-economic variables like income. The latter variables are the ones typically expected to be significant in a travel cost model.

On reflection this result is not surprising. Travel cost models are most appropriate where the population of the actual and potential user fishers is spatially distributed over a significant distance from the recreational fishing site. This ensures the required variability in distance and access time. In this fishery, the survey respondents were clustered in population pockets across this widely dispersed fishery and the preferred 'wetline' fishing locations were close in terms of both proximity and time. Consequently, there was no great variation in travel distances and access time and hence travel costs per trip.

The inappropriateness of the travel cost method in this fishery has meant that the analysis below is based on the use of a contingent valuation survey to estimate the social valuation at the margin for recreational fishing for the case study species in the West Coast 'wetline' fishery.

5.4 Stated Preferences and Contingency Valuation Modelling

Assuming sustainability is not an issue under the existing combined commercial and recreational fishing effort; the option considered in this study is a reallocation at the margin. Hence, the focus is on a comparison of the marginal values placed on extra catch of the case study species by recreational and commercial fishers.

The marginal value of extra catch rather than the marginal value of retained catch is the key question for this analysis. In particular, the extent of any increased 'consumer surpluses' from greater catch is the key variable to be considered. The basic theoretical model for approaching this issue is set out in Figure 22 below.

5.4.1 Consumer Choice Model

As already noted, contingent valuations surveys are used in this study to estimate the recreational marginal willingness to pay for Wetline fishing. The application of this technique is based on an underlying model of consumer choice and the notion of an individual recreational fisher "optimising" their fishing behaviour in a way that reflects their underlying preferences for fishing verus other activities and the constraints that they face. Based on the analysis just presented the surveys must deal with the marginal valuation or willingness to pay for an increase in catch limits in the Wetline fishery and the marginal valuation or willingness to pay to avoid a reduction in catch limits in the Wetline fishery.

The Wetline fishery is not a single species fishery. Hence, we need also to test whether the composition of the catch limits across the three preferred species of dhufish, pink snapper and baldchin groper also influences willingness to pay.

The underlying model is based on the assumption that individual Wetline fishers undertake fishing to maximize utility in the form,

$$u(x,q,z) \quad . \tag{1}$$

subject to the budget constraint,

$$y=px+z; \tag{2}$$

where x is wetline fishing trips, q is a measure of quality (catch, spec ies caught and size) achieved on each trip, z is expenditures on all other goods (p_z=1), y is income and p is the average price(cost) of a trip to the ocean reef to fish for the major species of dhufish, snapper and groper, including license fee costs.

This choice framework leads to an indirect utility function, which we can specify in the form;

$$v(p,q,y). \tag{3}$$

where p, q and y are as defined above.

In the context of these two scenarios, the wetline fisher survey respondent is faced with the following problem:

$$\Delta.v = v(p,q,y\text{-}A) - v(p,q=0,y) \neq 0 \tag{4}$$

where Δ.v is the change in utility associated with a change in fishing activity or entitlement to fishing activity, q=0 indicates that the Wetline fisher does not have the opportunity to catch or attempt to catch any more fish (the status quo) than currently allowed, A is the price to increase Wetline catch activity or the entitlement to attempt to catch or avoid a reduction and y-A is the income after paying A for an increased Wetline entitlement or two avoid a reduction in entitlement.

When an increase in Wetline fishing activity or entitlement is considered for the individual fisher, the model is based on a direct trade-off between having higher levels of general consumption and having less income and other consumption but greater Wetline fishing entitlement. Where a decrease in Wetline fishing activity or entitlement is considered for the individual fisher, the model is based on a direct trade-off between having more income and other consumption and having less income and other consumption but retaining access to the current fishing activity or entitlement.

5.4.2 The Contingent Valuation Scenario Used

To implement this model Wetline fishers were subjected to a phone survey that included a referendum style of contingent valuation. Each contingent valuation survey values a particular scenario. The scenario used is shown in Appendix 9.

The scenario was presented in terms of the respondent's willingness to pay for a defined catch limit bundle of dhufish, pink snapper and baldchin groper. These were expressed in terms of the 'offered' total daily catch limits where the range offered went above and below the existing 'official' daily bag limit.

The number of fish of each species and the amount of the license fee were varied and randomly assigned to respondents. The number of species in each bundle referred to 'catch and keep' limits.

The scenario was presented against the backdrop that there were no other changes to arrangements for Wetline fishing such as size limits and catches and release limits. Each respondent was asked to give a 'yes' or 'no' answer.

The 'yes' and 'no' responses were then 'teased out' to test the respondent's true stated preference. This is because a 'yes' response to a particular price for a given extra quantity may not be a true reflection of whether the individual respondent is willing to pay more than the price offered for that quantity. Similarly, a 'no' response may not be an indication of a willingness to pay a lower price for the quantity offered. In order to probe the maximum willingness to pay, respondents who said, 'yes' to the randomly assigned price were asked about their willingness to pay higher prices with the higher prices being offered in increments until they said 'no'. Respondents who said 'no' initially were offered lower prices until they said 'yes' or, were still saying 'no' at a zero price.

The responses received allowed an assessment of:

- the aggregate willingness to pay for various daily catch limits and;
- the marginal willingness to pay for a higher daily catch limit within the range offered in the survey

The scenario amounts to an increase in the average cost of each fishing trip and each fish caught and can be given a direct interpretation in terms of the choice model.

5.4.3 Interpretation of Scenario: Estimating the Marginal Willingness to Pay for Increased Catch Limits

The Model

For scenario used, if the two indirect utility functions are equal so that $\Delta.v$ in equation (4) above is zero, then the Wetline fisher is indifferent between having a higher bag limit or entitlement with the higher fee and not having a higher bag limit. If the utilities are not equal then the fisher will accept or reject the higher catch limit/higher fee combination offered. That is;

If $v(p,0,y) > v(p,q,y\text{-}A)$, then the utility without the catch limit increase is greater than the utility with the higher catch limit and the respondent will answer 'NO' to the survey question.

If $v(p,0,y) < v(p,q,y\text{-}A)$, the respondent will answer 'YES' because the utility with the higher catch limit is greater than without it.

The probability of a 'YES' response takes the form:

$Pr(YES) = P(\Delta.v + \varepsilon > 0)$

where ε is a random error. If the random error is distributed logistically then the probability can be estimated with logistic regression of the form:

$Pr(YES) = (1 + \exp(-\Delta.v))^{-1}$

Median willingness to pay can be found by setting the probability of a yes response equal to .5 (indifference in indirect utility) and solving for the increase in total cost that makes the respondent indifferent between having and not having the bag limit increase.

Δv or the difference in utility is usually posited to depend on the fee nominated, the quantity-quality available and a range of socio-demographic and attitudinal variables. The model is then estimated as a logistic regression with a form:

$$Log[\frac{\Pr ob(yes)}{1-\Pr ob(yes)}] = \alpha_0 - \beta_1 FEE + \beta_2 QTY + \sum \beta_i SOCIO_i$$

The estimated equation can be used to determine average willingness to pay and marginal or 'part worth' willingness to pay.

The median willingness to pay is found by finding the fee that would make the probability of a 'yes' equal to 0.5 which is the point at which the Wetline fisher would be indifferent between having the extra catch entitlement or not. This median willingness to pay cannot be generalized to the population. For this a mean willingness to pay is needed and this in turn requires integration to get the area under the logistic curve.

However, it can be shown that using the above specification, the untruncated mean willingness to pay is:

Mean Maximum WTP = $\frac{1}{\beta_1}[\ln(1 + e^{\alpha_0 + \beta_2 QTY + \sum \beta_i SOCIO_i})]$

Where, in the above, FEE is the specified fee, QTY is the specified quantity, and SOCIO is set of socio demographic and attitudinal variables. This mean estimate can be generalized to the population.

While the above is illustrated as a linear specification, non-linear specifications are allowable. Each equation then implies different marginal willingness to pay. The marginal willingness to pay or part worth is defined in terms of the trade off between quantity and price which is of the form:

Marginal willingness to pay = $(\partial(\Delta V)/\partial QTY)/(\partial \Delta V/\partial Fee)$,

Which for the linear case is β_2/β_1

The Results:

The randomly assigned prices ranged from \$20 to \$60. The final distribution of prices assigned in the survey is shown in Table 16.

Table 16: Recreational Fisher Survey: Distribution of Randomly Assigned Prices

Price	Frequency	Percent	Valid Percent	Cumulative Percent
20.00	78	20.5	20.5	20.5
30.00	75	19.7	19.7	40.3
40.00	82	21.6	21.6	61.8
50.00	78	20.5	20.5	82.4
60.00	67	17.6	17.6	100.0
Total	**380**	**100.0**	**100.0**	

Table 17 shows the initial response to the randomly assigned prices. Of the 380 respondents, 230 said "no" and 150 said "yes".

Table 17: Initial Responses to Randomly Assigned Prices by Survey Respondents

Response	Frequency	Percent	Valid Percent
No	230	60.5	60.5
Yes	150	39.5	39.5
Total	**380**	**100.0**	**100.0**

Each respondent was probed according to their initial 'yes' and 'no' response. An initial 'yes' was probed until a 'no' response was given to a higher price, and the initial 'no' until a 'yes' to a lower price was given. The probed higher prices and lower prices as described previously spread the price range from $0 to $100. The distribution of these final 'yes' price responses is shown in Table 18 below. The result of this probing was that 172 or 45.3 percent of respondents still said 'no' and 208 or 54.7% ultimately said 'yes'.

Table 18: Final Response to Prices by Respondents

Price for "yes"	Frequency	Percent	Valid Percent	Cumulative Percent
0.00	172	45.3	45.3	45.3
10.00	7	1.8	1.8	47.1
15.00	3	.8	.8	47.9
20.00	22	5.8	5.8	53.7
25.00	32	8.4	8.4	62.1
30.00	34	8.9	8.9	71.1
35.00	5	1.3	1.3	72.4
40.00	24	6.3	6.3	78.7
45.00	1	.3	.3	78.9
50.00	38	10.0	10.0	88.9
55.00	6	1.6	1.6	90.5
60.00	16	4.2	4.2	94.7
65.00	4	1.1	1.1	95.8
70.00	2	.5	.5	96.3
75.00	1	.3	.3	96.6
100.00	13	3.4	3.4	100.0
Total	**380**	**100.0**	**100.0**	

Logistic Choice Model Results

The analysis of the willingness to pay was based on the application of the logistic regression model described above to the survey data.

In general, we expect the choice to be related to the licence fee (price), the basket offered (quantity) and income. Beyond this the choice is likely to reflect a range of socio economic and attitudinal factors. It may relate to the past or typical fishing success had by the respondent; or to the level of satisfaction that the respondent derives from fishing in the Wetline fishery. The mix of fish in the licence basket may also be a factor as the dhufish is generally regarded as the premium species. Each of these propositions was tested.

Table 19 shows the variables used in the analysis of choice together with their descriptive statistics. Using these survey data, a number of logistic specifications were investigated. In respect of the aggregate basket size, logarithmic and inverse relationships were tested. A linear version was tried but performed very poorly. Logistic regression results for the best performing equations are shown below.

Table 19: Means and Std Deviations for Variables Used in Analysis

	Variable	N	Range	Min	Max	Mean	Std Dev
AGGBASK	Aggregate Fish in basket	380	7.00	1.00	8.00	5.35	1.78
IAGGBASK	Inverse of aggregate fish in basket	380	.88	.13	1.00	.22	.13
LAGGBASK	Log of aggregate fish in basket	380	2.08	.00	2.08	1.60	.41
SHSNAP	% Snapper in basket	380	100.00	.00	100.00	42.30	24.59
Q7#B	How many Pink Snapper caught and kept in last 12 months	380	20	0	20	.95	1.86
INC1	Income Range $0 to $25,999	333	1.00	.00	1.00	.24	.423
INC2	Income Range $26,999 to $51,999	333	1.00	.00	1.00	.41	.49
INC3	Income Range $52,000 up	333	1.00	.00	1.00	.34	.47
Q10AH	. Importance scale - Catching enough fish for a decent feed	380	3.00	1.00	4.00	2.78	.95
Q10BF	Satisfaction scale - The time it takes to catch the number of fish you expected to	378	4.00	1.00	5.00	3.54	1.15
Q10BI	. Satisfaction scale - Enjoying the fishing experience, regardless of the number of fish caught and kept	380	4.00	1.00	5.00	4.50	.77
	Valid N (listwise)	331					

Table 20: Logistic Model Results

Variable	Equation 1	Equation 2	Equation 3	Equation 4
FEE$	-.023*	-.024*	-.023*	-.026*
IAGGBASK	-1.979*	-2.036*		
LAGGBASK			.470	.324
SHSNAP	.009*	.008*	.009*	.008*
Q7#B	.100	.100	.098	.101
INC2	1.000*	.980*	.996*	.891*
INC3	1.292*	1.275*	1.295*	1.203*
Q10AH	-.332*	-.343*	-.330*	-.384*
Q10BF	-.277*	-.281*	-.276*	-.296*
Q10BI	.403*	.370*	.393*	.233*
Constant	-.261		-1.450	
% Correct	66.5	66.2	66.8	65.6
Pseudo R2	.178	.201	.173	.192

The models presented above vary in terms of the specification of the quantity offered which is included in inverse and logarithmic form, with and without a constant. The quantity offered in a linear form was tested but was never significant.

The models have similar performance in terms of coefficients significant at the 10% level, and in terms of percent of answers classified correctly and pseudo R2. The most significant variables are the fee charged for the basket (FEE$), the level of income (INC2, INC3). The size of the basket was significant when included as an inverse, but not in logarithmic form. The constant term was never significant.

Interestingly, the percentage share of the basket that was pink snapper turned out to be significant, suggesting that, all other things equal, baskets offered with a higher proportion of snapper in them, were more likely to be chosen. This is perhaps surprising because dhufish is regarded generally as the more prized species and the species targeted by most our survey respondents.

Applying the mean maximum willingness to pay equation as discussed above and the results from equation 2 above, yields the estimates given below in Table 21.

The estimates vary considerably across the model specifications. At 5 fish, which is close to the average number offered in the survey, the mean maximum willingness to pay is $42.64 for the inverse specification.

Table 21: Mean Willingness to Pay

Mean Maximum Willingness to Pay	
	Inverse Equation 4
Daily Increase in Limit *Fish in basket)	
1	12.5
2	28.21
3	35.76
4	39.98
5	42.64
6	44.48
7	45.81
8	46.83
9	47.63
10	48.27

The scenario used in the survey was based on the offer of a daily catch limit. The mean values can be scaled to the population estimates based on the estimate of 44,000 fishers. This being the case, the aggregate willingness to pay to achieve a daily catch limit of 5 fish is around $2 million for the inverse specification.

Table 22: Aggregate Value of the Mean Willingness to Pay

Aggregate Willingness to Pay	
	Inverse Equation 4
Daily Increase in Limit. (Fish in Basket)	
1	$2,049,227
5	$2,019,326
10	$1,952,213

The scenario presented a variety of daily catch limits to respondents. Therefore we know that not all fishers will catch the limit as proposed. In the survey the range of the aggregate basket offered was from 1 fish to 8 fish, with the species mix being varied across respondents. The mean quantum offered was 5.3 fish (all species). These fish could be caught and kept subject to the usual size limits.

The actual retained catch of dhufish, snapper and groper combined is on average, substantially less than this. For catch and keep of dhufish, snapper and groper combined, the average per person retail catch in the survey was less than one per trip at 0.45 fish. This is well below the average catch by respondents. The average number of these species for combined retained and released catches was three. There is also below the average offered for catch and keep in the basket.

Hence, on balance, the basket was likely to offer a fishing entitlement in excess of the current retained. In fact only four respondents actually caught more on average per trip in the previous twelve months than the basket they were offered. Hence, many respondents are actually acquiring and are exhibiting a willingness to pay for a licence to hunt and kill. This amounts to an option to catch up to the limit specified.

This is not inconsistent with other aspects of behaviour. The median spending by fishers per annum is $1888 on fishing equipment and operations. The proposed licence fee is quite low compared to this and is therefore a relatively low price to acquire fishing capacity, which can be exercised once out at sea. In the pilot study for the survey, tags were the mechanism offered to induce payments. The fishers rejected the tag concept because the expected catch was so uncertain. They recognized that the actual catch may well vary from the expected catch on which tag purchases would be based and they wanted the capacity to keep whatever legally sized fish they caught up to the bag limit.

Using the ‘part worth’ equation as discussed above yields the following marginal willingness to pay results in Table 23 below. The willingness to pay is $84.83 for the first fish using the inverse specification (equation 2 above) but falls quickly to $3.40 at the fifth fish. Beyond 9 fish the marginal value is less than $1.

Table 23: Marginal Willingness to Pay

Marginal Willingness to Pay	
	Inverse Equation 4
Daily Increase in Limit. (Fish in Basket)	Per fish in basket
1	84.83
2	21.21
3	9.43
4	5.30
5	3.39
6	2.36
7	1.73
8	1.33
9	1.05
10	0.85
11	0.70
12	0.59
13	0.50
14	0.43
15	0.38
16	0.33
17	0.29
18	0.26
19	0.23
20	0.21

The change in the marginal willingness to pay is illustrated in Figure 26 below.

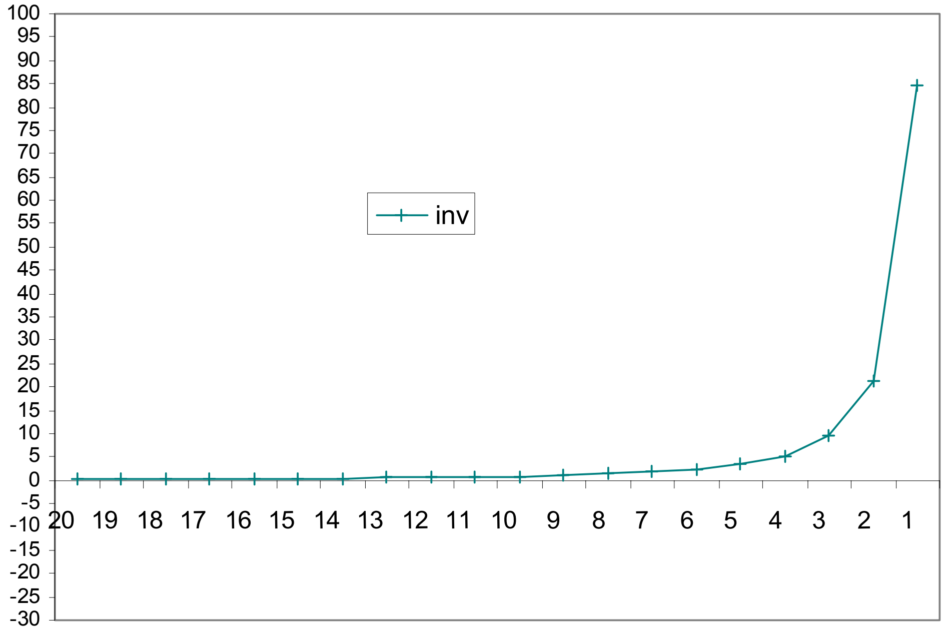

Figure 26: Marginal Willingness to Pay

As already discussed the inverse specification fits the survey data best. This is therefore the equation we will use in the allocation analysis. Essentially, the task is to compare the marginal consumer surplus from adding additional fish to the recreational sector with the marginal value of adding them to the commercial sector.

6. Optimising the Net Benefits from Resource Allocation Between Commercial and Recreational Use

In the first report from this study we developed the theoretical framework for considering the optimisation of the net benefits of resource sharing between the extractive recreational and commercial uses. This theoretical framework, which focused on resource allocation within a sustainable catch and effort, is summarized in Figure 27 below.

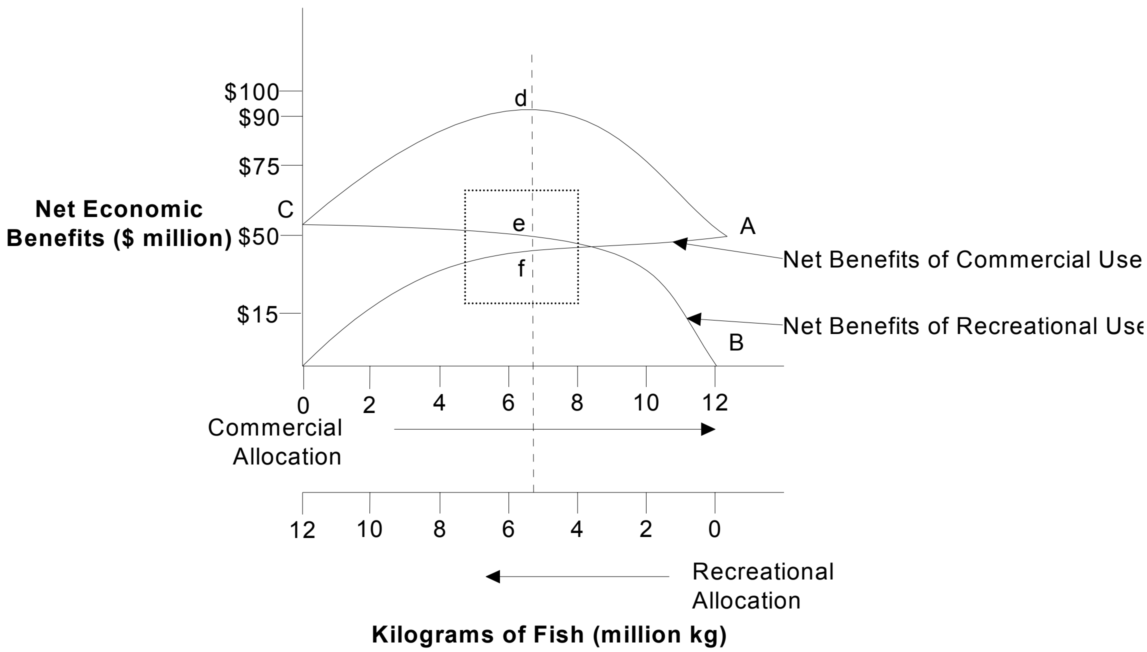

Figure 27: Net Benefits of Resource Allocation: A Theoretical Framework

In the diagram, curve BC is the net benefits attributable to recreational use, OA is the net benefits attributable to commercial production and local consumption or commercial use, and AC is the total net benefit attributable to the combined commercial and recreational use.

Point 'd', which represents the apex of curve AC, is the point at which the overall or aggregate net benefits are optimised from the combined commercial (point f) and recreational (point e) uses. This is the highest point on the aggregate surplus curve AC and at this point the marginal benefit is the same in both competing uses. At no other allocation is the overall net benefit as large. Moving away from this point to an alternative allocation could increase the benefits of one user group but would reduce the benefits to the other user group and would reduce overall benefits because the marginal benefit to the gaining group as we move away from point ‘d’ would be less than the loss to the losing group.

In economic terms, the overall net benefits from combined commercial and recreational use are maximized at the allocation where the marginal benefits to commercial and recreational use are the same. This is the point where the slope of the net benefit curve for recreational use is the same as the slope of the net benefit curve for commercial use.

In implementing this framework, our analysis therefore set out to focus on the marginal net benefits of the respective uses for the demonstration purposes of this project. That is, we set out to find the point at which the marginal net benefit curves for commercial and recreational catch of the case study species in the ‘Wetline’ fishery intersect.

6.1 Application of the General Theoretical Framework to the Wetline Fishery

For the demonstration purposes of this case study, our analysis focused on the values recreational fishers attached to specified daily catch limits, as per the logistic choice model results presented in Chapter 5 above. Following the basic model, the task is to compare the marginal consumer surplus of adding an additional fish (dhufish, snapper or groper) to the recreational fishers’ daily catch limit with the marginal benefits of an equivalent catch by the commercial sector.

However, the Wetline fishery poses some particular issues in considering this allocative approach.

The Wetline fishery is open access and the absolute sustainable catch is not defined. Hence there is no fixed aggregate catch to be shared. This conflict with the key assumption of the basic allocation model that an actual aggregate catch is defined and that, at the margin, competing users (recreational and commercial fishers) are playing a zero sum game - a fish caught/not caught by one would be not caught/caught by the other in a simple and straightforward way.

Not being a restricted fishery means that both commercial and recreational fishers can increase effort and seek more catches without there being any commensurate change in defined allocations.

These circumstances result in a situation where there is no simple way to reallocate fish between the fishers in the Wetline fishery.

If commercial fishers reduced actual effort at the margin, it is likely that commercial catch would fall. These fish would be available to be hunted by recreational fishers but, unlike the confined abalone fishery which was analysed as case study 2 in this project, there is no guaranteed that all or any of the fish not caught by commercial fishers would be caught by recreational fishers.

Given the large number of recreational fishers, the probability of catching an additional fish may not be much affected.

On the other hand, if the 'official' daily bag limits were reduced for recreational fishers, given the current position where actual catch is well below bag limits, there may be little change in actual catch and hence very little change in the availability of additional fish for commercial fishers to catch.

In order therefore to interpret the results in an allocation context, we have fixed the analysis on the potential reallocation of fish from commercial to recreational sectors based on allocating from the former to the latter in blocks of 1 fish per recreational fisher. This corresponds to a situation where a fish so allocated represents a one fish increase in catch or bag limit. The fisher may or may not catch the additional fish and can only catch it once. That is, although fishers in our sample made on average over 12 fishing trips per year, the quantum allocated is not one fish per trip but one fish per fisher.

The key data for this analysis is the marginal value of having an additional fish added to the 'offered' daily catch limits and the combined marginal producer and retail consumer surplus of that additional fish allocated to the commercial sector. The former is derived from the logistic choice model as discussed in Chapter 5 above, whilst the latter is derived from the analysis of producer costs and demand as discussed in Chapters 2 to 4.

In addition to the above, two other key pieces of data are required – the average weight of fish and the number of recreational fishers. The former has been set at 3.00 kg per fish and the latter at 45,000. The average weight figure is based on data provided by the Western Australian Fisheries Department from recreational catch and effort surveys, whilst the number of recreational participants is derived from the estimated aggregate annual catch and the average catch per fisher from our survey.

The results of our analysis are shown in Figure 28 below. The diagram is a graphical representation of results already presented previously for the commercial and recreational sectors.

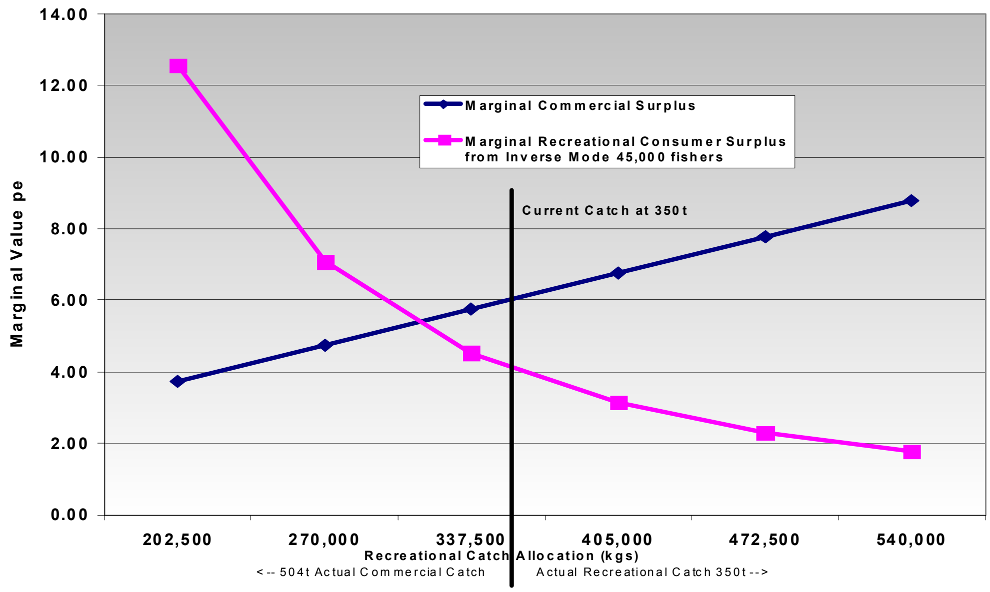

Figure 28: Optimising Net Benefit Recreational and Commercial Use

The relationship between the marginal benefits for commercial and recreational use is shown for an allocation to recreational fishers. This reflects the underlying supply and demand conditions on the commercial side and the underlying preferences on the recreational side for catch limits.

6.1.1 Determining the Theoretical Optimum Allocation

From right to left Figure 28 shows additional allocation to the recreational sector. At the existing catch of around 350,000 kgs for recreational and 504,000 kgs for commercial, the analysis shows that, the marginal benefits to recreational use are estimated to be lower than the marginal benefit from commercial use. If the existing catch levels are accepted as defining the total sustainable catch in the fishery, then a reduced allocation of up to 40,000 kgs of fish from the recreational sector (based on the inverse equation) is indicated.

In theory, this would increase the overall benefit to society for the combined commercial and recreational use of the resource. This is because the marginal benefit of an extra fish allocated to recreational use is less than the loss in combined retail consumer and producer surpluses at the margin up to this catch. Beyond this 40,000 kgs reallocation (that is left of where the two curves intersect in Figure 28), the marginal benefit to recreational use exceeds those from commercial use across the remainder of that volume range.

A critical issue in the successful application of the theoretical framework is the ability to specify the aggregate sustainable catch to be allocated between the competing uses. For the purposes of our analysis, we used the combined actual commercial (504 tonne) and recreational (350 tonnes) catches as being indicative of the sustainable (854 tonnes) catch. However, as already noted, there is no defined aggregate sustainable catch to be allocated and this would have to be defined before the model could be implemented in any meaningful way.

The results presented above relate to the determination of the optimal allocation at a point in time – it is a static analysis. Underlying conditions and economic and social values will of course change and the results would need to be reviewed and updated over time. This could be achieved by integrating a formal dynamic element into the analysis that would capture the way that valuations are likely to change over time.

6.1.2 How Close is Good Enough?

In a practical sense, the theoretical optimum allocation at a retained recreational catch of 310,000kgs corresponds to a take of around 2.3 fish per person of the case study species. At this point, the marginal benefits from commercial and recreational use are the same, that is, around $5.50 per kg of whole fish. This individual take level is marginally less than the existing average recreational take of 2.6 fish at 350,000 kgs during the 2001-2002 year, if our estimated 45,000 recreational participants in the fishery and if the 3 kg average weight per fish in the recreational catch basket are reasonable.

From a pragmatic fisheries management viewpoint, if the sustainable catch level is 850,000 kgs, the gains in attempting to 'fine tune' the actual recreational take from 2.6 to 2.3 fish per person would be problematic and for what would be arguably little (if any) net improvement in the overall benefits from the combined commercial and recreational use of the resource.

The gains from shifting 40,000 kgs of actual catch between the two sectors, if achievable, would add around $76,000 to the overall net benefits from the combined commercial and recreational use of the resource. This is small when viewed in the context of the combined benefit of around $6.6 million from the existing commercial and recreational use. The estimated gain is also based on the assumption that there are no additional management (i.e. transaction) costs in enforcing a reduced recreational take of 40,000 kgs. To the extent that transaction costs are likely to be involved, the potential net gain from such a reallocation would be less than $76,000.

In broad terms the analysis suggests that, if the combined existing commercial and retained recreational catch is sustainable, then a reallocation of actual catch between the two sectors is unlikely to markedly improve the overall net benefits from the combined use of the resource at the present time. The gains in attempting to 'fine tune' the actual retained recreational catch from 2.6 to 2.3 fish per person would be problematic in the current fisheries management environment.

In this context, the results suggest that, on balance, if the combined existing commercial and recreational catch is sustainable at the current level of participation, then a change in the actual catch shares between the two sectors is unlikely to materially add to the overall net benefit from the combined use of the resource at the present time.

6.1.3 Possible 'Lumpiness' of Allocation Changes

We suspect that the values that recreational fishers would ascribe to an extra retained catch of the case study species where there was a greater degree of certainty may be higher than these outcomes. However, in this fishery, the reallocation may need to be quite 'lumpy' if there were to be any significant lowering in the probability of an increased recreational catch of the case study species, particularly in the heavily fished ocean off the more populated Perth-Fremantle- Mandurah region.

6.1.4 Optimal Composition of the Recreational Bag Limit

The species and size composition of the recreational basket that might optimise the marginal net benefits could not be determined from the recreational data available. Further research would be needed to establish the socially optimal allocation options in these areas. However, two broad observations can be made from the data available.

First, the percentage share of the basket that was pink snapper turned out to be significant, suggesting that, all other things equal, baskets offered with a higher proportion of snapper in them, were more likely to be chosen. This is perhaps surprising because dhufish is regarded generally as the more prized species and the species targeted by most our survey respondents.

Second, the recreational fishers' responses to our survey suggest that there may be net benefit gains in differentiating the size of the fish that can be retained by commercial and recreational fishers. For example, the commercial fisher is paid by the kilogram of fish caught and the marginal benefits may be indifferent to the size of the individual fish caught so long as aggregate catch tonnage objective is achieved. On the other hand, recreational fishers' option is to hunt and retain fish and possibly the marginal willingness to pay may be higher for larger-sized fish and lower for the smaller sized fish within the existing size limits. In that case, the marginal benefits for a larger sized fish allocated to the recreational sector may be higher than the value placed on that fish by the commercial sector. The opposite may be the case for fish at the lower end of the size limit. Further research would be needed to establish the socially optimal allocation options in these areas.

6.1.5 Exercising Options to Fish

With actual recreational catch below the daily bag limit, the official bag limit provides recreational fishers with an option to take additional fish above their existing actual if they seek to do so. If for example all existing recreational participants chose to do so and achieved a catch of 6 fish, the recreational take would be close to 850,000 kgs or the current combined commercial and recreational catch.

The analyzed results show that recreational fishers' marginal willingness to pay for an option of three or more fish in a basket of the case study species was less than the marginal benefits if those fish were to be available to the commercial sector to satisfy domestic and export market demands. This suggests the recreational fishers' option to take additional fish above the existing catch levels, if exercised, is unlikely to be consistent with increasing the overall net benefit from the use of the resource at the present time.

If there were additional sustainable catch available to be taken, then the overall benefit to society is likely to be more if that option were available to be exercised by the commercial sector. This is because the marginal benefits of an extra fish allocated to the commercial sector above existing catch levels is higher than the marginal benefit if that fish were allocated to the recreational sector.

Similarly, a *de facto* option exists in the commercial sector. This is in the form of unused commercial fishing unit entitlements. Typically, only 250 of the 1350 eligible unit entitlements are exercised in any year. If the option were taken to exercise more of these commercial entitlements and to the extent that this threatened to reduce the retained recreational catch below the existing actual catch level, this is unlikely to be consistent with increasing the overall net benefits to society from the combined use of the resource at the present time. This is because the marginal values of recreational catches in the range of one to two fish exceed the marginal benefits of that fish in commercial use.

6.2 Underlying Assumptions for Applying Inter-Sectoral Allocation Models

This analysis is based on certain assumptions. It assumes that:

- The combined existing commercial and recreational catch is all that is sustainable and available for inter-sectoral allocation,
- All recreational participants are subject to binding constraints (catch limits), that is, there is no unused or spare capacity,
- For all commercial operators it is optimal to take the total sustainable catch, that is, there is no spare capacity, and
- All commercial operators are internally structured to maximize producer surpluses from catches of the case study species in the West Coast' Wetline' fishery

In what is effectively and 'open access' fishery, the immediate issue is a sustainable catch not resource allocation. Both commercial and recreational fishers can increase effort to achieve increased catch without any commensurate and explicit changes in catch allocations.

Nevertheless, the analysis in this case study provides a responsible starting point for thinking about allocation needs in the fishery.

There is currently ambiguity around the total sustainable catch in this fishery. Also, the results of our analysis indicate that the above assumptions relating to the commercial and recreational activity do not hold.

Reality Checking of Model Outcomes

The results of the modelling are illustrative only and a ‘snapshot’ in time. The outcomes are dependent on the robustness of the assumptions behind the models. Nevertheless, we did undertake a series of ‘reality checks’ of the data sets and statistical outputs in the course of the assessment to ensure the results appeared consistent with what was happening in the industry. This focused on whether the results appeared sensible and rational in economic terms, made sense in terms of the actual operation of the market and was consistent with the overall circumstances in the fishery.

Injection of a Dynamic Component

As already noted, for any actual implementation, the analysis would need to be updated (and recalibrated) once the sustainable catches are addressed and explicitly determined and as the underlying conditions behind economic and social values change over time.

While the development of a dynamic element would be required to ensure that the analysis approximates more closely contemporary circumstances as they change over time, it is beyond the scope of the current study.

Overview

The case study demonstrates that the general theoretical framework based on economic principles can be applied. The results are broadly consistent with economic theory and can be the basis for developing allocation policy.

7. Glossary of Terms

Average total cost	Average total cost is the sum of all the production costs for a commercial fishing activity divided by the number of units produced.
Choke price	The lowest price at which the quantity demanded is zero. At every price higher than the choke price demand is zero.
Consumer surplus	The benefit consumers gain from being willing to pay more than the equilibrium market price. This is based on the notion that consumers (e.g. recreational fishes or retail consumers)m derive greater benefit from consuming a product or activity (e.g. recreational fishing or retail purchase of fish for consumption) than the cost to them of purchasing it.(e.g. time and money for recreational fishers).
Contingent valuation	The use of structured surveys to estimate the willingness of respondents to pay for public projects or programs. (e.g. access to fish stocks for recreational fishing).
Demand (curve or equation)	It shows the amount of a good that consumers are willing and able to buy at various prices.
Existence value	The benefit derived by an individual (s) from the knowledge that an environmental resource (e.g. fish stocks) exists.
Fixed cost	Costs that do not vary with the level of output. They are therefore constant in total as output

	changes..
Marginal cost	The amount spent on producing one extra unit. The marginal cost is the increase in total cost when one more unit is produced.
Opportunity cost	The decision to produce or consume a product or undertake an activity involves giving up another product. The real cost (opportunity cost) of an action is the next best alternative forgone in order to do it..
Option Value	The benefit derived by and individual(s) from retaining the option to use an environmental resource at some future date (e.g. to fish up to a bag limit in the future). Option value arises from the combination of the individual's uncertainty about future demand for the resource and uncertainty about its future availability.
Optimum allocation	Occurs when resources are allocated between competing uses (e.g. fish between recreational and commercial uses) such that it is not possible to redistribute resources to increase the welfare of any one consumer without reducing the welfare of some other consumer.
Price elasticity of demand	A measure of responsiveness of some other variable to a change in price
Producer surplus	The difference between the minimum price a producer would accept to supply a given quantity of a good and the price actually received. (e.g. the difference between the price received in the market place for commercially caught fish and the minimum price which

	reflects the marginal cost of catching).
Variable cost	Variable costs are costs that vary with the level of output/activity.(e.g. bait for commercial fishing)
Supply (curve or equation)	The relationship between the price of a good and the quantity of the good supplied by producers (firms).

8. APPENDICES

Appendix 1: 'Wetline' Fishery Case Study – Canning Vale Fish Markets

Q1. Fish Offered and Sold: 2001-2002 Financial Year

	Type of Fish	Volume offered (kg whole weight)	Value of Cleared Fish	Average Clearance Price ($/kg whole weight)
(a)	Dhufish	kg	$	$
(b)	Baldchin Groper	kg	$	$
(c)	Pink Snapper	kg	$	$

Q2. What is the commission charged on the fish sold through the fish market? ....%

Q3. Daily Offerings and Clearance Prices

Pick a week when you consider offerings of local catches of each of these species were low, moderate and high during the 2001/2002 year, and please provide the following daily information for that week. Your best estimates will do.

3.1 Dhufish

	Low Availability		Moderate Availability		High Availability	
Month	....		....		....	
Week	....		....		....	
Days	Volume offered (kg) [1]	Average Daily Clearance Prices ($/kg) [1]	Volume offered (kg) [1]	Average Daily Clearance Prices ($/kg) [1]	Volume offered (kg) [1]	Average Daily Clearance Prices ($/kg) [1]
(a) Mon						
(b) Wed						
(c) Fri						

[1]Estimated 'whole weight' equivalent.

3.2 Baldchin Groper

	Low Availability		Moderate Availability		High Availability	
Month	………………………………		………………………………		………………………………	
Week	………………………………		………………………………		………………………………	
Days	Volume offered (kg) [1]	Average Daily Clearance Prices ($/kg) [1]	Volume offered (kg) [1]	Average Daily Clearance Prices ($/kg) [1]	Volume offered (kg) [1]	Average Daily Clearance Prices ($/kg) [1]
(a) Mon						
(b) Wed						
(c) Fri						

[1]Estimated 'whole weight' equivalent.

3.3 Pink Snapper

	Low Availability		Moderate Availability		High Availability	
Month	………………………………		………………………………		………………………………	
Week	………………………………		………………………………		………………………………	
Days	Volume offered (kg) [1]	Average Daily Clearance Prices ($/kg) [1]	Volume offered (kg) [1]	Average Daily Clearance Prices ($/kg) [1]	Volume offered (kg) [1]	Average Daily Clearance Prices ($/kg) [1]
(a) Mon						
(b) Wed						
(c) Fri						

[1]Estimated 'whole weight' equivalent.

Appendix 2: 'Wetline' Fishery Case Study- Post Harvest Fishing Enterprises

Q1. Fish Sales: 2001-2002 Financial Year

	Type of Fish	WA Sales			Export Sales		
		Volume[1] (kg)	Value[2]	Av Return[2] ($/kg)	Volume[1] (kg)	Value[3]	Av Return ($/kg)
(a)	Dhufish	kg	$	$	kg	$	$
(b)	Baldchin Groper	kg	$	$	kg	$	$
(c)	Pink Snapper	kg	$	$	kg	$	$

[1]Estimated 'whole weight' equivalent.
[2]Ex- your establishment door.
[3]f.o.b.

Q2. Fish Purchase: 2001-2002 Financial Year

	Type of Fish	(1) Volume[1]	(2) Cost	(3) Ave Cost ($/kg)
(a)	Dhufish	kg	$	$
(b)	Pink Snapper	kg	$	$
(c)	Baldchin Groper	kg	$	$

[1]Estimated 'whole weight' equivalent.

Q3. Other costs attributable to your sales of these three species for the 2001/2002 financial year (your best estimates will do)

		WA Sales ($/kg)[1]	Export Sales ($/kg)[1]
(a)	Fixed Costs[2]	$	$
(b)	Variable Costs[3]	$	$
(c)	**Total**	$	$

[1]Based on 'whole weight' equivalent
[2]Exclude any 'lease' costs
[3]Exclude any interest costs

Q4. Would these other unit costs vary significantly among these fish species? Yes / No

If yes, please provide a broad rule of thumb where pink snapper is treated as the benchmark. (For example, if the other unit costs attributable to dhufish sales are 5% higher than pink snapper, then dhufish would show 1.05 – if 5% lower, then the dhufish percentage would be 0.95).

	Type of Fish	WA Sales	Export Sales
(a)	Dhufish		
(b)	Pink Snapper	1.00	1.00
(c)	Baldchin Groper		

Q4. Price Sensitivity to Volume Changes

Pick a week when you consider availability of local catches of each of these species were low, moderate and high during the 2001/2002 year, and please provide the following daily information for each species during that week. Your best estimates will do.

4.1 Dhufish

	Low Availability			Moderate Availability			High Availability		
Month	………………………………			………………………………			………………………………		
Week	………………………………			………………………………			………………………………		
Days	Volume[1] (kg)	Prices Received[1] ($/kg)	Prices paid for fish sold ($/kg)	Volume[1] (kg)	Prices Received[1] ($/kg)	Prices paid for fish sold ($/kg)	Volume[1] (kg)	Prices Received[1] ($/kg)	Prices paid for fish sold ($/kg)
(a) 1									
(b) 2									
(c) 3									
(d) 4									
(e) 5									
(f) 6									
(g) 7									

[1]Based on 'whole weight' equivalent

4.2 Baldchin Groper

	Low Availability			Moderate Availability			High Availability		
Month	………………………………			………………………………			………………………………		
Week	………………………………			………………………………			………………………………		
Days	Volume[1] (kg)	Prices Received[1] ($/kg)	Prices paid for fish sold ($/kg)	Volume[1] (kg)	Prices Received[1] ($/kg)	Prices paid for fish sold ($/kg)	Volume[1] (kg)	Prices Received[1] ($/kg)	Prices paid for fish sold ($/kg)
(a) 1									
(b) 2									
(c) 3									
(d) 4									
(e) 5									
(f) 6									
(g) 7									

[1]Based on 'whole weight' equivalent

4.3 Pink Snapper

Month **Week** **Days**	Low Availability ……………… ………………			Moderate Availability ……………… ………………			High Availability ……………… ………………		
	Volume[1] (kg)	Prices Received[1] ($/kg)	Prices paid for fish sold ($/kg)	Volume[1] (kg)	Prices Received[1] ($/kg)	Prices paid for fish sold ($/kg)	Volume[1] (kg)	Prices Received[1] ($/kg)	Prices paid for fish sold ($/kg)
(a) 1									
(b) 2									
(c) 3									
(d) 4									
(e) 5									
(f) 6									
(g) 7									

[1]Based on 'whole weight' equivalent

Appendix 3: West Coast 'Wetline' Fishery – Commercial Use Questionnaire

We are seeking information regarding your business activities associated with commercial catches of dhufish, baldchin groper and pink snapper taken from the West Coast 'Wetline' Fishery. All figures should relate to the 2001/02 financial year.

Your information will be treated in the strictest of confidence. The data will be combined with that provided by other businesses and used by the research team for aggregate statistical analysis only.

Please complete the questionnaire by ticking boxes or providing the requested details where indicated. Please return your completed questionnaire in the enclosed reply paid envelope (addressed to Economic Research Associates, PO Box 3004, Broadway Nedlands, WA, 6009) by 16 December 2002. Completed questionnaires marked for John Nicholls' attention can also be faxed to (08) 9386 3202.

Business Information

Q1 *What is your business enterprise structure? (Please tick one only)*

Sole Trader .1
Family Partnership .2
Other Partnership .3
Incorporated Company .4
Other (please specify) .5

Q2 *What is your primary business associated with baldchin groper, pink snapper and dhufish in the Wetline Fishery?*

Fisherman .1
Processor 2
Wholesaler/Distributor .3
Retailer .4
Exporter .5
Other (please specify) .6

Q3. *Please provide the number of employees.*

	Employment type	**Number**
(a)	Full time Employment	__________
(b)	Part time (Seasonal)	__________
(c)	Casual	__________
(d)	Total	__________

Q4. *What percentage of your employees time would you attribute to your business activities associated with baldchin groper, dhufish, and pink snapper? %*

Catch Value

Q5a. *Please provide the following details of total volume for dhufish, pink snapper and baldchin groper handled by your business during 2001/02.*

	Type of Fish	**Catching**	**PROCESSING**	**Wholesaling/ Distributing**	**Exporting**	**Retailing**
(a)	Dhufish	kg	kg	kg	kg	kg
(b)	Pink Snapper	kg	kg	kg	kg	kg
(c)	Baldchin Groper	kg	kg	kg	kg	kg
(d)	**TOTAL**	**kg**	**kg**	**kg**	**kg**	**kg**

Q5b. Please provide the following details of total value (quantity x sale price) for dhufish, pink snapper and baldchin groper handled by your business during 2001/02.

	Type of Fish	Catching	PROCESSING	Wholesaling/ Distributing	Exporting	Retailing
(a)	Dhufish	kg	kg	kg	kg	kg
(b)	Pink Snapper	kg	kg	kg	kg	kg
(c)	Baldchin Groper	kg	kg	kg	kg	kg
(d)	**TOTAL**	**kg**	**kg**	**kg**	**kg**	**kg**

Q6 ***a)*** *Are the prices that you used in Q5b..*
Ex Wharf prices? 1
Ex Business door prices? 2
Other? (please specify) ____________________

b) What percentage do you sell at each level? % % %

Q7. ***a)*** *How do you sell your fish? Fresh Whole Fish Whole, Chilled or Frozen Filletted, Chilled or Frozen*

b) What percentage of each type do you sell? % % %

Q8. *What percentage of the quantities shown in question 5 are sold to the following areas?*

	WA Caught Fish	WA Fish Markets	WA Fish Processors	WA Wholesalers/Distributors	Exporters	WA Retailers
(A)	Dhufish	%	%	%	%	%
(b)	Pink Snapper	%	%	%	%	%
(c)	Baldchin Groper	%	%	%	%	%

Q9. *For the financial year 2001/2002, select two separate months (preferably one high volume and one low volume) where catch and price data is available. For these months, please provide quantity and price for ten sequential days (for example, Day 1 - 50kg at $10 per kg).*

Days	**Supply Month 1 (Low Volume Month)**					
	Whole Dhufish		Whole Pink Snapper		Whole Baldchin Groper	
		Q	Price	Q	Price	Q
(A)	1	kg	$	kg	$	kg
(b)	2	kg	$	kg	$	kg
(c)	3	kg	$	kg	$	kg
(d)	4	kg	$	kg	$	kg
(e)	5	kg	$	kg	$	kg
(f)	6	kg	$	kg	$	kg
(g)	7	kg	$	kg	$	kg
(h)	8	kg	$	kg	$	kg
(i)	9	kg	$	kg	$	kg
(j)	10	kg	$	kg	$	kg

Days	**Supply Month 1 (Low Volume Month)**					
	Whole Dhufish		Whole Pink Snapper		Whole Baldchin Groper	
		Q	Price	Q	Price	Q
(A)	1	kg	$	kg	$	kg
(b)	2	kg	$	kg	$	kg
(c)	3	kg	$	kg	$	kg
(d)	4	kg	$	kg	$	kg
(e)	5	kg	$	kg	$	kg
(f)	6	kg	$	kg	$	kg
(g)	7	kg	$	kg	$	kg
(h)	8	kg	$	kg	$	kg
(i)	9	kg	$	kg	$	kg
(j)	10	kg	$	kg	$	kg

Expenditure

Q10 *Please specify in the table below costs associated with the volumes of dhufish, pink snapper and baldchin groper from the West Coast Wetline Fishery handled by your business during 2001/2002 (see question 5 above). (If you do not have exact figures, your best estimate will do).*

		Catching	**Processing**	**Distribution & Marketing**	**Retailing**	**Total**
(a)	Wages and Salaries	$	$	$	$	$
(b)	Fuel	$	$	$	$	$
(c)	Repairs and Maintenance	$	$	$	$	$
(d)	Depreciation	$	$	$	$	$
(e)	Bait	$	$	$	$	$
(f)	Lease Payments	$	$	$	$	$
(g)	Interest Payments	$	$	$	$	$
(h)	Fees and Taxes (including fisheries and Transport fees)	$	$	$	$	$
(i)	Insurance	$	$	$	$	$
(j)	Freight	$	$	$	$	$
(k)	Office Administration	$	$	$	$	$
(l)	Other: ______________________________	$	$	$	$	$
(m)	TOTAL	$	$	$	$	$

Q11 *What proportion of these costs would you consider to be fixed costs, that is, the level of the cost would not change regardless of volume (eg depreciation on a boat)*
%

Q12 *If the volume of dhufish, pink snapper and baldchin groper handled by your business during 2001/2002 changes by the following percentages, how will this increase or decrease your total costs (please estimate a percentage)?*

	Increase in volume	**Change in costs**		**Decrease in volume**	**Change in costs**
(a)	5%	%	(e)	-5%	%
(b)	10%	%	(f)	-10%	%
(c)	15%	%	(g)	-15%	%
(d)	20%	%	(h)	-20%	%

Q13 *Estimate the capital replacement value of the business assets associated with Dhufish, Pink Snapper, Baldchin Groper in the West Coast Wetline Fishery? $*

Appendix 4: A Theoretical Total Cost Model For a Multi-Species Fishing Operation

A total cost function in its most simplistic linear form can be expressed as follows:

$Y = a + bQ + e$ (1)

Where Y = the total cost

Q = the total catch of the case study species.

This specification of the total cost function can be appropriate in the case of a single specie enterprise such as those identified in the Perth Abalone Fishery case study. In a multi-species fishery and enterprise like the West Coast Wetline fishery, the quantity for an individual fishing enterprise can be specified as follows:

Q = f{dhufih+ pink snapper + baldchin groper + other species caught}(2);

and whilst the total cost can be specified as follows:

Y = f{the days fished, the number of fishing trips, vessel size, gear used, distance travelled }(3).

Substituting equations (2) and (3) into equation (1), a total cost function for a commercial fishing operation can be specified as follows:

$$\mathbf{Y = a + bD + cP_s + dB_g + gO_s + D_f + T_f + V_s + G + D_t \quad (4)}$$

where: D = dhufish caught

P_s = pink snapper caught

B_g = baldchin groper caught

O_s = other fish species caught

D_f = number of days fished for the case study species

T_f = number of fishing trips for the case study species

V_s = size of vessel used on these fishing trips

G = gear used on these trips (hand and/or drop lines)

D_t = distance travelled on each of these fishing trips.

In this form, the marginal cost of an extra or reduced dhufish catch, all other things remaining unchanged can then be specified as follows:

$dY/dD = b$,

whilst the marginal cost of pink snapper and baldchin groper catches can be specified as:

$dY/dP_s = c$ and $dY/dB_g = d$, respectively.

Appendix 5: Producer Surpluses, Local Consumer Surpluses and Net Economic Benefit from Commercial Use of Dhufish

	Local Sales-Producer Surpluses			Export Sales-Producer Surpluses			Total Producer Surpluses			Local Consumer Surpluses Choke Price $25.75/kg whole			Total Net Benefits from Commercial Use	
Catch Volumes (kg)	Quantity (kg)	Value (S)	Unit Value ($/kg)	Quantity (kg)	Value ($)	Unit Value ($/kg)	Quantity (kg)	Value ($)	Unit Value ($/kg)	Quantity (kg)	Value ($)	Unit Value ($/kg)	Value ($)	Unit Value ($/kg)
161,100	145,000	1,426,800	9.84	16,100	82754	5.14	165,000	1,509,554	9.14	145,000	475,600	3.28	1,985,154	12.33
172,200	155,000	1,432,200	9.24	17,200	88408	5.14	175,000	1,520,608	8.68	155,000	554,900	3.58	2,075,508	12.05
183,350	165,000	1,432,200	8.68	18,350	94319	5.14	185,000	1,526,519	8.25	165,000	636,900	3.86	2,163,419	11.79
194,450	175,000	1,428,000	8.16	19,450	99973	5.14	195,000	1,527,973	7.83	175,000	721,000	4.12	2,248,973	11.56
205,500	185,000	1,417,100	7.66	20,500	105370	5.14	205,000	1,522,470	7.42	185,000	808,450	4.37	2,330,920	11.34
219,065	197,644	1,399,320	7.08	21,421	110103.9	5.14	219,065	1,509,423	6.89	197,644	921,021	4.66	2,430,444	11.09
227,750	205,000	1,381,700	6.74	22,750	116935	5.14	225,000	1,498,635	6.66	205,000	990,150	4.83	2,488,785	10.92
238,900	215,000	1,358,800	6.32	23,900	122846	5.14	235,000	1,481,646	6.30	215,000	1,083,600	5.04	2,565,246	10.73
250,000	225,000	1,329,750	5.91	25,000	128500	5.14	245,000	1,458,250	5.95	225,000	1,180,125	5.245	2,638,375	10.55
261,100	235,000	1,297,200	5.52	26,100	134154	5.14	255,000	1,431,354	5.61	235,000	1,278,400	5.44	2,709,754	10.37
272,200	245,000	1,261,750	5.15	27,200	139808	5.14	265,000	1,401,558	5.28	245,000	1,378,125	5.62	2,779,683	10.21

Appendix 6: Producer Surpluses, Local Consumer Surpluses and Net Economic Benefit from Commercial Use of Pink Snapper

	Local Sales-Producer Surpluses			Export Sales-Producer Surpluses			Total Producer Surpluses			Local Consumer Surpluses Choke Price $18.25/kg whole			Total Net Benefits from Commercial Use	
Catch Volume (kg)	**Quantity (kg)**	**Value ($)**	**Unit Value ($/kg)**	**Quantity (kg)**	**Value ($)**	**Unit Value ($/kg)**	**Quantity (kg)**	**Value ($)**	**Unit Value ($/kg)**	**Quantity (kg)**	**Value ($)**	**Unit Value ($/kg)**	**Value ($)**	**Unit Value ($/kg)**
194,450	175,000	1116500	6.38	19,450	66130	3.4	194,450	1182630	6.08	175,000	491,750	2.81	1,674,380	8.61
205,500	185,000	1104450	5.97	20,500	69700	3.4	205,500	1174150	5.71	185,000	557,775	3.015	1,731,925	8.43
216,650	195,000	1090050	5.59	21,650	73610	3.4	216,650	1163660	5.37	195,000	624,975	3.205	1,788,635	8.26
227,750	205,000	1072150	5.23	22,750	77350	3.4	227,750	1149500	5.04	205,000	693,925	3.385	1,843,425	8.09
238,900	215,000	1049200	4.88	23,900	81260	3.4	238,900	1130460	4.73	215,000	765,400	3.56	895,860	7.94
250,077	225,069	1026315	4.56	25,008	85027.2	3.4	250,077	1111342	4.44	225,069	837,257	3.7200014	1,948,599	7.79
261,100	235,000	994050	4.23	26,100	88740	3.4	261,100	1082790	4.14	235,000	912,975	3.885	1,995,765	7.64
272,200	245,000	962850	3.93	27,200	92480	3.4	272,200	1055330	3.87	245,000	988,575	4.035	2,043,905	7.51
283,350	255,000	925650	3.63	28,350	96390	3.4	283,350	1022040	3.60	255,000	1,067,175	4.185	2,089,215	7.37
294,450	265,000	887750	3.35	29,450	100130	3.4	294,450	987880	3.35	265,000	1,146,125	4.325	2,134,005	7.25
305,500	275,000	847000	3.08	30,500	103700	3.4	305,500	950700	3.11	275,000	1,226,500	4.46	2,177,200	7.13

Appendix 7: Producer Surpluses, Local Consumer Surpluses and Net Economic Benefit from Commercial Use of Baldchin Groper

	Local Sales - Producer Surpluses			Export Sales – Producer Surpluses			Total Producer Surpluses			Local Consumer Surpluses			Total Net Benefits From Commercial Use	
Catch Volumes (kg)	Quantity (kg)	Value ($)	Unit Value ($/kg)	Quantity (kg)	Value ($)	Unit Value ($/kg)	Quantity (kg)	Value ($)	Unit Value ($/kg)	Quantity (kg)	Value ($)	Unit Value ($/kg)	Value ($)	Unit Value ($/kg)
25,550	23,000	129720	5.64	2,550	7140	2.8	25,550	136860	5.35	23,000	51,060	2.22	187,920	7.35
27,200	24,500	128625	5.25	2,700	7560	2.8	27,200	136185	5.00	24,500	59,045	2.41	195,230	7.17
28,900	26,000	127660	4.91	2,900	8120	2.8	28,900	135780	4.69	26,000	67,210	2.585	202,990	7.02
30,550	27,500	125675	4.57	3,050	8540	2.8	30,550	134215	4.39	27,500	75,763	2.7550182	209,978	6.87
32,200	29,000	123250	4.25	3,200	8960	2.8	32,200	132210	4.10	29,000	84,535	2.915	216,745	6.73
33,898	30,508	120811.7	3.96	3,390	9492	2.8	33,898	130303.7	3.84	30,508	93,354	3.0599843	223,658	6.59
35,550	32,000	117440	3.67	3,550	9940	2.8	35,550	127380	3.58	32,000	102,560	3.205	229,940	6.46
37,200	33,500	113565	3.39	3,700	10360	2.8	37,200	123925	3.33	33,500	112,058	3.3450149	235,983	6.34
38,900	35,000	110250	3.15	3,900	10920	2.8	38,900	121170	3.11	35,000	121,625	3.475	242,795	6.24
40,550	36,500	105120	2.88	4,050	11340	2.8	40,550	116460	2.87	36,500	131,400	3.6	247,860	6.11
42,200	38,000	100320	2.64	4,200	11760	2.8	42,200	112080	2.65	38,000	141,360	3.72	253,440	6.00

Appendix 8: Producer Surpluses, Local Consumer Surpluses and Net Economic Benefit from Commercial Use of All Three Case Study Species

	Producer Surpluses									Local Consumer Surpluses			Net Benefits from	
	Local Sales			Export Sales			Total Producer Surpluses			Choke Price $18.25/kg whole			Commercial Use	
Catch Volume (kg)	**Quantity (kg)**	**Value ($)**	**Unit Value ($/kg)**	**Quantity (kg)**	**Value ($)**	**Unit Value ($/kg)**	**Quantity (kg)**	**Value ($)**	**Unit Value ($/kg)**	**Quantity (kg)**	**Value ($)**	**Unit Value ($/kg)**	**Value ($)**	**Unit Value ($/kg)**
381,100	343,000	2,673,020	7.79	38,100	156,024	4.10	381,100	2829044	7.42	343,000	1,018,410	2.97	3,847,454	10.10
404,900	364,500	2,665,275	7.31	40,400	165,668	4.10	404,900	2830943	6.99	364,500	1,171,720	3.21	4,002,663	9.89
428,900	386,000	2,649,910	6. 87	42,900	176,049	4.10	428,900	2825959	6.59	386,000	1,329,085	3.44	4,155,044	9.69
452,750	407,500	2,625,825	6.44	45,250	185,863	4.11	452,750	2811688	6.21	407,500	1,490,688	3.66	4,302,376	9.50
476,600	429,000	2,589,550	6.04	47,600	195,590	4.11	476,600	2785140	5.84	429,000	1,658,385	3.87	4,443,525	9.32
503,040	453,221	2,546,446	5.62	49,819	204,623	4.11	503,040	2751069	5.47	453,221	1,851,632	4.09	4,602,701	9.15
524,400	472,000	2,493,190	5.28	52,400	215,615	4.11	524,400	2708805	5.17	472,000	2,005,685	4.25	4,714,490	8.99
548,300	493,500	2,435,215	4.93	54,800	225,686	4.12	548,300	2660901	4.85	493,500	2,184,233	4.43	4,845,134	8.84
572,250	515,000	2,365,650	4.59	57,250	235,810	4.12	572,250	2601460	4.55	515,000	2,368,925	4.60	4,970,385	8.69
596,100	536,500	2,290,070	4.27	59,600	245,624	4.12	596,100	2535694	4.25	536,500	2,555,925	4.76	5,091,619	8.54
619,900	558,000	2,209,070	3.96	61,900	255,268	4.12	619,900	2464338	3.98	558,000	2,745,985	4.92	5,210,323	8.41

Appendix 9: Survey of Recreational Wetline Fishery between Augusta and Kalbarri (Pilot 1)

Introduction

Hi, I'm _______ from __ and we're conducting research into recreational fishing. Can I please speak to _____________?
You would have received a letter from the Department of Infrastucture and Planning about this recently. This survey is about fishing experiences, particularly in the West Coast Wetline Fishery offshore between Augusta and Kalbarri, and should take about 15 minutes. Your answers are strictly confidential and will be reported in aggregate. Nothing in this survey should be taken to be current or intended policy of government or the opposition parties.

2. Bottom Fishing Offshore in the West Coast Wetline Fishery Between Augusta and Kalbarri

Q 1 *To start with, do you go 'bottom fishing' (from a boat) in the West Coast Wetline fishery offshore between Augusta and Kalbarri for such species as dhufish, baldchin groper and pink snapper?*

Yes	1
No (Terminate interview)	2
Don't know (Terminate interview)	3

Q 2 *In the last twelve months, what percentage of your offshore trips (from a boat) between Augusta and Kalbarri were bottom fishing for such species as dhufish, pink snapper or baldchin groper offshore?*

_______ %

Q 3 *In the last twelve months, how long on average per trip did you spend bottom fishing offshore (from a boat) between Augusta and Kalbarri?*

_______ days or _______ hours

Q 4 *In the last twelve months, where did you go bottom fishing offshore between Augusta and Kalbarri for such species as dhufish, baldchin groper and pink snapper? (Accept multiples) (Probe for departure point and distance offshore, eg 5km off Hillaries boat ramp)*

___________________________ ( )
___________________________ ( )
___________________________ ( )

Q 5 *In the last twelve months, which of these species did you specifically target when you went bottom fishing offshore between Augusta and Kalbarri?*
(Read out) (One answer for each species)

	Yes	No
a) Dhufish	1	2
b) Pink Snapper	1	2
c) Baldchin groper	1	2
d) Other species	1	2

Q 6 *How did you find out what places were likely to be the best for bottom fishing of such species as dhufish, pink snapper or baldchin groper? (Accept multiples) (Do not read out) (Do not prompt)*

I don't find out - just take pot luck	1
Word of mouth	2
Always go there / I just know / habit	3
Newspapers, magazines and publications	4
Angling/Fishing Club	5
Other (specify)	
____________________________	( )

Q 7 *I am going to read out factors about bottom fishing for such species as dhufish, pink snapper or baldchin groper offshore between Augusta and Kalbarri. As I read out each one, please tell me how important a role it plays in a successful fishing trip, and how satisfied you are with each factor. (Read out each statement.) (One importance rating and one satisfaction rating per statement.)*

	Not important	Quite very	Very	Very important	dissatisfied		Neutral	Very	NA satisfied	
a. No congestion at the boat ramp	1	2	3	4	1	2	3	4	5	9
b. Catching as many fish as you expect to	1	2	3	4	1	2	3	4	5	9
c. The number of fish you catch and keep	1	2	3	4	1	2	3	4	5	9
d. The size of the fish you catch and keep.....	1	2	3	4	1	2	3	4	5	9
e. The species of the fish you catch and keep..	1	2	3	4	1	2	3	4	5	9
f. The time it takes to catch the number of fish you expected to	1	2	3	4	1	2	3	4	5	9
g. The time it takes to catch the number of fish you want to keep...................................	1	2	3	4	1	2	3	4	5	9
h. Catching enough fish for a decent feed	1	2	3	4	1	2	3	4	5	9
i. Enjoying the fishing experience, regardless of the number of fish caught and kept.......	1	2	3	4	1	2	3	4	5	9
j. Having an enjoyable time out on the ocean..	1	2	3	4	1	2	3	4	5	9

4. Most Recent Offshore Bottom Fishing Trip in the West Coast Wetline Fishery Offshore Between Augusta and Kalbarri for Such Species as Dhufish, Pink Snapper and Baldchin Groper

Q 8 *When was the last time you went bottom fishing offshore in the West Coast Wetline fishery between Augusta and Kalbarri for such species as dhufish, pink snapper or baldchin groper?*

_______________ (date/month or # weeks ago)

Q 9 *Where was the boat launched? (Probe for boat ramp, pen or mooring) (One only)*

_________________________________ ( )

Q 10 *Roughly how far did you go offshore? (Probe for rough location or distance)*

_________________________________ *( )*

Q 11 *How long did it take you travel (on the ocean from the boat ramp to the fishing spot back to the boat ramp) on the fishing trip?*

_______ *hrs*

Q 12 *How long did you spend actually bottom fishing offshore between Augusta and Kalbarri trying to catch such species as dhufish, pink snapper or baldchin groper?*
_______ *hours or* _______ *days*

Q 13 *How far did you travel (from home to the boat ramp and back again) to go on the offshore bottom fishing trip? (Include any side trips related to the fishing trip, eg getting petrol for boat, getting bait, picking up mates, etc. Exclude travel in the boat on the water.)*

_______ *kms*

Q 14 *And how long did it take you to travel that far?*

_______ *hours or* _______ *days*

Q 15 *How long were you away from home on your fishing trip?*

_______ *hours or* _______ *days*

Q 16 *What percentage of the time on the ocean did you spend: (Read out each statement first, then record percentage against each)*

a)	Fishing (either from the boat or diving from the boat)	____ %
b)	Recreational diving	____ %
c)	Cruising (excluding travelling to fishing spot)	____ %
d)	Other (specify) ______________	____ %
	TOTAL (check)	**100 %**

Q 17 *What species did you target to catch on that offshore bottom fishing trip? (Accept multiples)*

Dhufish	1	
Pink snapper	2	
Baldchin groper	3	
No species in particular	4	
Other (specify)		
___________________________		( )

Q 18 *Including yourself, how many people were in the fishing group on that trip?*

_______ people (If = 1, SKIP to Q20)

Q 19 *What was the relationship of the other people to you? (Accept multiples)*

Friend(s)	1	
Spouse, partner or 'significant other'		2
Parent(s)	3	
Children	4	
Extended family	5	
Other (specify)		
___________________________		( )

Q 20 *On that trip, how many dhufish did you personally: (Read out)*

a) catch and release? _______ dhufish
b) catch and keep? _______ dhufish

Q 21 *(On that trip) how many pink snapper did you personally: (Read out)*

a) catch and release? _______ pink snapper
b) catch and keep? _______ pink snapper

Q 22 *(On that trip) how many baldchin groper did you personally: (Read out)*

a) catch and release? _______ baldchin groper
b) catch and keep? _______ baldchin groper

Q 23 *(On that trip) how many other species of fish did you personally: (Read out)*
a) catch and release? _______ other species
b) catch and keep? _______ other species

Q 24 *On that trip, did you personally:*
(Read out) (One only)

Catch and keep the limit of dhufish, pink snapper or baldchin groper? 1
Catch as many of these fish as you wanted within the limit? 2
Not catch as many of these fish as you wanted? 3
(None of these) 4

Q 25 *Were you happy with the number of fish you personally caught (and not necessarily kept) that trip? (One only)*

Yes 1
No 2

Q 26 *Were you happy with the number of fish you personally kept that trip? (One only)*

Yes 1
No 2

Q 27 *Were you happy with the size of fish you personally caught (and not necessarily kept) that trip? (One only)*

Yes 1
No 2

Q 28 *Were you happy with the type of fish you personally caught (and not necessarily kept) that trip? (One only)*

Yes 1
No 2

Q 29 *Were you happy with the type of fish you personally kept that trip? (One only)*
Yes 1
No 2

Q 30 *Did you catch as many fish as you thought you would? (One only) (If no, ask if they thought they'd catch more or less)*

No, thought I'd catch more 1
No, thought I'd catch less 2
Yes, caught as many as I thought I would 3

Q 31 *Did you keep as many fish as you thought you would? (One only) (If no, ask if they thought they'd catch more or less)*

No, thought I'd keep more	1
No, thought I'd keep less	2
Yes, kept as many as I thought I would	3

Costs of Fishing

Q 32 *Do you still own your registered boat?*

Yes	1
No (SKIP to Q37)	2

Q 33 *How long is your boat?*

_____ feet or _____ metres

Q 34 *Over the past twelve months, about what percentage of your boat's use was offshore between Augusta and Kalbarri bottom fishing for such species as dhufish, pink snapper or baldchin groper?*

_______ %

Q 35 *What is the current market value of your boat including the motor? (round to the nearest $10)*

$ __________

Q 36 *In the last twelve months, how much money did you spend on: (round to the nearest $1) (Read out.)*

a. Boat and trailer licence fees? $_______
b. Boat, motor or trailer maintenance? $_______
c. New equipment such as GPS or sounder or motor? $_______
d. Parts for the boat, motor or trailer? $_______
e. Insurance for boat, motor or trailer? $_______
f. Boat club membership and pen fees? $_______

Q 37 *In the last twelve months, how much money did you spend on: (round to the nearest $1) (Read out)*

a. Fishing-related equipment for a motor vehicle such as roof racks or a tow bar? $______
b. Life jackets and safety gear? $_______
c. Recreational fishing club membership? $_______
d. Rods, reels or other fishing equipment? $_______
e. Books, magazines, videos etc on boat fishing, locations, fishing gear, etc to help you find and catch fish $_______
f. Angling Club membership fees $_______

Q 38 *On a typical offshore bottom fishing trip for such species as dhufish, pink snapper or baldchin groper between Augusta and Kalbarri, how much did you spend on the following? (round to the nearest $1) (Read out)*

a. Accommodation? $_______
b. Food, drink and refreshments? $_______
c. Transport - petrol for vehicle? $_______
d. Petrol for boat? $_______
e. Parking and boat launching fees? $_______
f. Special clothing, hats, footwear or sunglasses for fishing? $_______

g. Bait and ice? $_______

Q 39 *A fishing management strategy could be developed that increases your chances of catching more dhufish, pink snapper and baldchin groper in the same amount of time that you fish for these species in the West Coast Wetline fishery offshore between Augusta and Kalbarri.*

The strategy could be funded in two parts. The first could be an annual recreational fishing license that would entitle you to go fishing in the West Coast Wetline fishery. The second part involves buying colour-coded, non-refundable fishing tags for each of the dhufish, pink snapper and baldchin groper you catch and wish to keep. The tags would be limited in number, valid for one week, and purchased in any number or combination within the availability limits at boat ramps and mooring jetties.

The money collected would go to a dedicated fund to be used to improve coastal recreational fishing.

The alternative to the strategy is to leave things as they are, where no fee is charged to fish in the fishery. However, the locations, number and size conditions applying to these species may need to be tightened to sustain the fishery.

Are you willing to pay an annual fee of $* for a recreational fishing license that entitles you to fish in the West Coast Wetline fishery? (One only)

Yes 1
No 2

**Randomly assigned fees of $5, $10, and $15.*

Q 40 *The price of a dhufish tag is $**, a baldchin groper tag is $*** and a pink snapper tag is $****. On top of the annual license fee of $*, how many of the following fish tags are you willing to pay for to keep any of these species you catch whilst fishing in the West Coast Wetline fishery?*
(Read out each one and record number of tags)

Number of tags		Randomly Assigned Alternative Price Scenarios					
a) How many $** Dhufish tags?	____ tags	**	$15	$20	$25	$30	$35
b) How many $*** Baldchin Groper tags?	____ tags	***	$10	$15	$20	$25	$30
c) How many $**** Pink Snapper tags?	____ tags	****	$5	$10	$15	$20	$25

Q 41 *(If number of tags = 0, ie Q40 a), b) and c) is '0' in each case) What price are you prepared to pay for the fish tags? (Accept multiples) (Probe to find out the reason why they won't buy tags – if price is the issue or the whole idea of the fish tags – as they will need to pre-purchase the tags to keep the dhufish, baldchin groper or pink snapper they catch)*
If answer to Q40 a), b) and c) is '0' in each case, SKIP to Q43.

Q 42 *How far in advance of a fishing trip are you willing to purchase these fish tags? (Do not read) (One only)*

Up to a week	1
1 to less than 2 weeks	2
2 weeks to less than a month	3
1 month to less than 6 months	4
6 months to less than a year	5
A year or more	6
Not willing to pay in advance	7

5. Demographics

Q 43 Gender (record automatically)

Male 1
Female 2

Q 44 Which of these age categories do you belong to? (One only) (Read out)

15 to 19 years 1
20 to 29 years 2
30 to 39 years 3
40 to 49 years 4
50 to 59 years 5
60 to 69 years 6
70 years or older 7
(Refused) 99

Q 45 Which of the following best describes your situation? (One only) (Read out)

Full time employment 1
Full-time student (not in paid employ) 2
Part time or casual employment 3
Unemployed 4
Home duties 5
Retired 6
Pensioner (disability, illness, age, etc) 7
Other (specify) __________________ ( )
(Don't know) 98

Q 46 What is your personal weekly income before tax? (annual income indicated in brackets)
(One only) (Read out)

Negative income 01
Nil income 02
$1–$79 ($1–$4,159) 03
$80–$159 ($4,160–$8,319) 04
$160–$299 ($8,320–$15,599) 05
$300–$499 ($15,600–$25,999) 06
$500–$699 ($26,000–$36,399) 07
$700–$999 ($36,400–$51,999) 08
$1,000–$1,499 ($52,000–$77,999) 09
$1,500 or more ($78,000 or more) 10
(Don't know) 98
(Refused) 99

That concludes the interview. Thank you for your time. (Standard Interview Closing Spiel.)

Appendix 10: Survey of Recreational Fishing in the West Coast Wetline Fishery (Pilot 2)

1 Introduction

Hi, I'm _______ from __ and we're conducting research into recreational fishing. Can I please speak to ______________?
You would have received a letter from the Department of Infrastructure and Planning about this recently. This survey is about fishing experiences, particularly in the West Coast Wetline Fishery offshore between Augusta and Kalbarri, and should take about 15 minutes. Your answers are strictly confidential and will be reported in aggregate. Nothing in this survey should be taken to be current or intended policy of government or the opposition parties.
Bottom Fishing Offshore in the West Coast Wetline Fishery Between Augusta and Kalbarri

Q 2 *To start with, do you go 'bottom fishing' (from a boat) in the West Coast Wetline fishery offshore between Augusta and Kalbarri for such species as dhufish, baldchin groper and pink snapper?*

Yes	1
No (Terminate interview)	2
Don't know (Terminate interview)	3

Q 3 *Over the past twelve months, about what percentage of your boat's use was offshore between Augusta and Kalbarri bottom fishing for such species as dhufish, pink snapper or baldchin groper?*

_______ %

Q 4 *In the last twelve months, how many times have you been bottom fishing offshore between Augusta and Kalbarri for such species as dhufish, baldchin groper and pink snapper?*

_______ times

Q 5 *In the last twelve months, how long on average per trip did you spend bottom fishing offshore (from a boat) between Augusta and Kalbarri?*

_______ days or _______ hours

Q 6 *In the last twelve months, where did you go bottom fishing offshore between Augusta and Kalbarri for such species as dhufish, baldchin groper and pink snapper? (Accept multiples) (Probe for departure point and distance offshore, eg 5km off Hillaries boat ramp)*

____________________________ ( )
____________________________ ( )
____________________________ ( )
____________________________ ( )

Q 7 *In the last twelve months, which of these species did you specifically target when you went bottom fishing offshore between Augusta and Kalbarri?*
(Read out) (One answer for each species)

	Yes	**No**
a) Dhufish	1	2
b) Pink Snapper	1	2

c) Baldchin groper 1 2
d) Other species 1 2

Q 8 *In the last twelve months, on average per trip, how many of the following species did you catch and keep when you went bottom fishing offshore between Augusta and Kalbarri?*
(Read out) (One answer for each species)

a) Dhufish fish
b) Pink Snapper fish
c) Baldchin groper fish
d) Other species fish

Q 9 *In the last twelve months, on average per trip, how many of the following species did you catch and release when you went bottom fishing offshore between Augusta and Kalbarri? (Read out) (One answer for each species)*

a) Dhufish fish
b) Pink Snapper fish
c) Baldchin groper fish
d) Other species fish

Q 10 *How did you find out what places were likely to be the best for bottom fishing of such species as dhufish, pink snapper or baldchin groper? (Accept multiples) (Do not read out) (Do not prompt)*

I don't find out - just take pot luck 1
Word of mouth 2
Always go there / I just know / habit 3
Newspapers, magazines and publications 4
Angling/Fishing Club 5
Other (specify) __________________ ( )

Q 11 *I am going to read out factors about bottom fishing for such species as dhufish, pink snapper or baldchin groper offshore between Augusta and Kalbarri. As I read out each one, please tell me how important a role it plays in a successful fishing trip, and how satisfied you are with each factor. (Read out each statement.) (One importance rating and one satisfaction rating per statement.)*

		Not at all important	Not very	Quite	Very important	Very dissatisfied		Neutral		Very satisfied	NA
a.	No congestion at the boat ramp	1	2	3	4	1	2	3	4	5	9
b.	Catching as many fish as you expect to	1	2	3	4	1	2	3	4	5	9
c.	The number of fish you catch and keep	1	2	3	4	1	2	3	4	5	9
d.	The size of the fish you catch and keep.....	1	2	3	4	1	2	3	4	5	9
e.	The species of the fish you catch and keep..	1	2	3	4	1	2	3	4	5	9
f.	The time it takes to catch the number of fish you expected to	1	2	3	4	1	2	3	4	5	9
g.	The time it takes to catch the number of fish you want to keep...................................	1	2	3	4	1	2	3	4	5	9
h.	Catching enough fish for a decent feed	1	2	3	4	1	2	3	4	5	9
i.	Enjoying the fishing experience, regardless of the number of fish caught and kept.......	1	2	3	4	1	2	3	4	5	9
j.	Having an enjoyable time out on the ocean...	1	2	3	4	1	2	3	4	5	9

4 Most Recent Offshore Bottom Fishing Trip in the West Coast Wetline Fishery Offshore Between Augusta and Kalbarri for Such Species as Dhufish, Pink Snapper and Baldchin Groper

Q 12 *When was the last time you went bottom fishing offshore in the West Coast Wetline fishery between Augusta and Kalbarri for such species as dhufish, pink snapper or baldchin groper?*

______________ (date/month or # weeks ago)

Q 13 *Where was the boat launched? (Probe for boat ramp, pen or mooring) (One only)*

_______________________________ ( )

Q 14 *Roughly how far did you go offshore? (Probe for rough location or distance)*

_______________________________ ( )

Q 15 *How long did it take you travel (on the ocean from the boat ramp to the fishing spot back to the boat ramp) on the fishing trip?*

_______ hrs

Q 16 *How long did you spend actually bottom fishing offshore between Augusta and Kalbarri trying to catch such species as dhufish, pink snapper or baldchin groper?*

_______ hours or _______ days

Q 17 *How far did you travel (from home to the boat ramp and back again) to go on the offshore bottom fishing trip? (Include any side trips related to the fishing trip, eg getting petrol for boat, getting bait, picking up mates, etc. Exclude travel in the boat on the water.)*

_______ *kms*

Q 18 *And how long did it take you to travel that far?*

_______ *hours or* _______ *days*

Q 19 *How long were you away from home on your fishing trip?*

_______ *hours or* _______ *days*

Q 20 *What percentage of the time on the ocean did you spend: (Read out each statement first, then record percentage against each)*

a)	Fishing (either from the boat or diving from the boat)	____ %
b)	Recreational diving	____ %
c)	Cruising (excluding travelling to fishing spot)	____ %
d)	Other (specify) ______________	____ %
	TOTAL (check)	**100 %**

Q 21 *What species did you target to catch on that offshore bottom-fishing trip? (Accept multiples)*

Dhufish	1
Pink snapper	2
Baldchin groper	3
No species in particular	4
Other (specify) ___________________	( )

Q 22 *Including yourself, how many people were in the fishing group on that trip?*

_______ people (If = 1, SKIP to Q23)

Q 23 *What was the relationship of the other people to you? (Accept multiples)*

Friend(s) 1
Spouse, partner or 'significant other' 2
Parent(s) 3
Children 4
Extended family 5
Other (specify) _________________ ( )

Q 24 *On that trip, how many dhufish did you personally: (Read out)*

a) catch and release? _______ dhufish
b) catch and keep? _______ dhufish

Q 25 *(On that trip) how many pink snapper did you personally: (Read out)*

a) catch and release? _______ pink snapper
b) catch and keep? _______ pink snapper

Q 26 *(On that trip) how many baldchin groper did you personally: (Read out)*

a) catch and release? _______ baldchin groper
b) catch and keep? _______ baldchin groper

Q 27 *(On that trip) how many other species of fish did you personally: (Read out)*

a) catch and release? _______ other species
b) catch and keep? _______ other species

Q 28 *On that trip, did you personally:*
(Read out) (One only)

Catch and keep the limit of dhufish, pink snapper or baldchin groper? 1
Catch as many of these fish as you wanted within the limit? 2
Not catch as many of these fish as you wanted? 3
(None of these) 4

Q 29 *Were you happy with the number of fish you personally caught (and not necessarily kept) that trip? (One only)*

Yes 1
No 2

Q 30 *Were you happy with the number of fish you personally kept that trip? (One only)*

Yes 1
No 2

Q 31 *Were you happy with the size of fish you personally caught (and not necessarily kept) that trip? (One only)*

Yes 1
No 2

Q 32 *Were you happy with the type of fish you personally caught (and not necessarily kept) that trip? (One only)*

Yes	1
No	2

Q 33 *Were you happy with the type of fish you personally kept that trip? (One only)*

Yes	1
No	2

Q 34 *Did you catch as many fish as you thought you would? (One only) (If no, ask if they thought they'd catch more or less)*

No, thought I'd catch more	1
No, thought I'd catch less	2
Yes, caught as many as I thought I would	3

Q 35 *Did you keep as many fish as you thought you would? (One only) (If no, ask if they thought they'd catch more or less)*

No, thought I'd keep more	1
No, thought I'd keep less	2
Yes, kept as many as I thought I would	3

Costs of Fishing

Q 36 *Do you still own your registered boat?*

Yes	1
No (SKIP to Q40)	2

Q 37 *How long is your boat?*

_____ feet or _____ metres

Q 38 *What is the current market value of your boat including the motor? (round to the nearest $10)*

$ __________

Q 39 *In the last twelve months, how much money did you spend on: (round to the nearest $1) (Read out.)*

a.	Boat and trailer licence fees?	$_______
b.	New equipment such as GPS or sounder or motor?	$_______
c.	Parts for the boat, motor or trailer?	$_______
d.	Boat, motor or trailer maintenance?	$_______
e.	Insurance for boat, motor or trailer?	$_______
f.	Boat club membership and pen fees?	$_______

Q 40 *In the last twelve months, how much money did you spend on: (round to the nearest $1) (Read out)*

a. Fishing-related equipment for a motor vehicle such as roof racks or a tow bar? $_______
b. Life jackets and safety gear? $_______
c. Recreational fishing club membership? $_______
d. Rods, reels or other fishing equipment? $_______
e. Books, magazines, videos etc on boat fishing, locations, fishing gear, etc to help you find and catch fish $_______
f. Angling Club membership fees $_______

Q 41 *On a typical offshore bottom fishing trip for such species as dhufish, pink snapper or baldchin groper between Augusta and Kalbarri, how much did you spend on the following? (round to the nearest $1) (Read out)*

a. Accommodation? $_______
b. Food, drink and refreshments? $_______
c. Transport - petrol for vehicle? $_______
d. Petrol for boat? $_______
e. Parking and boat launching fees? $_______
f. Special clothing, hats, footwear or sunglasses for fishing? $_______
g. Bait and ice? $_______

Q 42 *A recent fisheries survey shows that many people on recreational fishing trips in the West Coast Wetline fishery for species such as dhufish, pink snapper and baldchin groper return without any of these fish. When people return with a catch, it is usually with less than 3 of these species, whilst 6 is exceptional.*

A fishing management strategy could be developed that increases the chances of more reliable recreational catches of these prized species in the West Coast Wetline fishery. The strategy involves setting a limit for both commercial and recreational fishers on the number of these prized species that can be taken from the fishery per season.
The strategy could be funded in two parts. The first part could be an annual recreational fishing license that would entitle you to go fishing in the West Coast Wetline fishery.
The second part involves buying non-refundable fishing tags for each of these prized species you catch and wish to keep during the fishing season. The government is currently looking to use tags as a management tool. The tags would be limited in number, valid for the fishing season, and purchased in any number or combination within the availability limits.
All money collected from recreational fisher would be paid into a dedicated fund to be used to improve recreational coastal fishing. Commercial fishers would have a similar funding model.
The alternative to the strategy is to leave things as they are, where no fee is charged to fish in the fishery. However, the locations, number and size conditions applying to these species may need to be tightened to sustain the fishery.
Are you willing to buy an annual recreational fishing license for $* that entitles you to fish in the West Coast Wetline fishery? (One only)

Yes 1
No 2

*Randomly assigned fees of $5, $10, and $15.

Q 43 *The price of a dhufish tag is $**, a baldchin groper tag is $*** and a pink snapper tag is $****. On top of buying the annual recreational fishing license of $*, how many tags are you willing to buy to keep any of these species you catch while on a fishing trip in the West Coast Wetline fishery?*
(Read out each one and record number of tags)

Number of tags Scenarios		Randomly Assigned Alternative Price					
a) How many $** Dhufish tags?	____ tags	**	$15	$20	$25	$30	$35
b) How many $*** Baldchin Groper tags?	____ tags	***	$10	$15	$20	$25	$30
c) How many $**** Pink Snapper tags?	____ tags	****	$5	$10	$15	$20	$25

Q 44 *(If number of tags = 0, ie Q42 a), b) and c) is '0' in each case) What price are you prepared to pay for the fish tags? (Accept multiples) (Probe to find out the reason why they won't buy tags – if price is the issue or the whole idea of the fish tags – as they will need to pre-purchase the tags to keep the dhufish, baldchin groper or pink snapper they catch)*
If answer to Q42 a), b) and c) is '0' in each case, SKIP to Q45.

Q 45 *How far in advance of a fishing trip are you willing to purchase these fish tags? (Do not read) (One only)*

Up to a week	1
1 to less than 2 weeks	2
2 weeks to less than a month	3
1 month to less than 6 months	4
6 months to less than a year	5
A year or more	6
Not willing to pay in advance	7

5 Demographics

Q 46 *Gender (record automatically)*

Male	1
Female	2

Q 92 *Which of these age categories do you belong to? (One only) (Read out)*

15 to 19 years	1
20 to 29 years	2
30 to 39 years	3
40 to 49 years	4
50 to 59 years	5
60 to 69 years	6
70 years or older	7
(Refused)	99

Q 93 *Which of the following best describes your situation? (One only) (Read out)*

Full time employment	1
Full-time student (not in paid employ)	2
Part time or casual employment	3
Unemployed	4
Home duties	5
Retired	6
Pensioner (disability, illness, age, etc)	7
Other (specify) __________________	( )
(Don't know)	98
(Refused)	99

Q 94 *What is your personal weekly income before tax? (annual income indicated in brackets)*
(One only) (Read out)

Negative income	01
Nil income	02
$1–$79 ($1–$4,159)	03
$80–$159 ($4,160–$8,319)	04
$160–$299 ($8,320–$15,599)	05
$300–$499 ($15,600–$25,999)	06
$500–$699 ($26,000–$36,399)	07
$700–$999 ($36,400–$51,999)	08
$1,000–$1,499 ($52,000–$77,999)	09
$1,500 or more ($78,000 or more)	10
(Don't know)	98
(Refused)	99

That concludes the interview. Thank you for your time. (Standard Interview Closing Spiel.)

Appendix 11: Survey of Recreational Fishing in the West Coast Wetline Fishery

Introduction

Hi, I'm _______ from __ and we're conducting research into recreational fishing. Can I please speak to _____________?
You would have received a letter from the Department of Infrastructure and Planning about this recently. This survey is about fishing experiences, particularly in the West Coast Wetline Fishery offshore between Augusta and Kalbarri, and should take about 15 minutes. Your answers are strictly confidential and will be reported in aggregate. Nothing in this survey should be taken to be current or intended policy of government or the opposition parties.

Bottom Fishing Offshore in the West Coast Wetline Fishery Between Augusta and Kalbarri

Q 1 To start with, do you go 'bottom fishing' (from a boat) in the West Coast Wetline fishery offshore between Augusta and Kalbarri for such species as dhufish, baldchin groper and pink snapper?

Yes	1
No (Terminate interview)	2
Don't know (Terminate interview)	3

Q 2 Over the past twelve months, about what percentage of your boat's use was offshore between Augusta and Kalbarri bottom fishing for such species as dhufish, pink snapper or baldchin groper?

____ % (If '0%', terminate interview)

Q 3 In the last twelve months, how many times have you been bottom fishing offshore between Augusta and Kalbarri for such species as dhufish, baldchin groper and pink snapper?

____ times (If '0 times', terminate interview)

Q 4 In the last twelve months, how long on average per trip did you spend bottom fishing offshore (from a boat) between Augusta and Kalbarri?

_______ days or _______ hours

Q 5 In the last twelve months, where did you go bottom fishing offshore between Augusta and Kalbarri for such species as dhufish, baldchin groper and pink snapper? (Accept multiples) (Probe for departure point and distance offshore, eg 5km off Hillaries boat ramp)

__________________________ ( )
__________________________ ( )
__________________________ ( )
__________________________ ( )

Q 6 In the last twelve months, which of these species did you specifically target when you went bottom fishing offshore between Augusta and Kalbarri?
(Read out) (One answer for each species)

	Yes	No
a) Dhufish	1	2
b) Pink Snapper	1	2

c) Baldchin groper 1 2
d) Other species 1 2

Q 7 In the last twelve months, on average per trip, how many of the following species did you catch and keep when you went bottom fishing offshore between Augusta and Kalbarri?
(Read out) (One answer for each species)

a) Dhufish fish
b) Pink Snapper fish
c) Baldchin groper fish
d) Other species fish

Q 8 In the last twelve months, on average per trip, how many of the following species did you catch and release when you went bottom fishing offshore between Augusta and Kalbarri? (Read out) (One answer for each species)

a) Dhufish fish
b) Pink Snapper fish
c) Baldchin groper fish
d) Other species fish

Q 9 How did you find out what places were likely to be the best for bottom fishing of such species as dhufish, pink snapper or baldchin groper? (Accept multiples) (Do not read out) (Do not prompt)

I don't find out - just take pot luck 1
Word of mouth 2
Always go there / I just know / habit 3
Newspapers, magazines and publications 4
Angling/Fishing Club 5
Other (specify) __________________ ( )

***Q 10** I am going to read out factors about bottom fishing for such species as dhufish, pink snapper or baldchin groper offshore between Augusta and Kalbarri. As I read out each one, please tell me how important a role it plays in a successful fishing trip, and how satisfied you are with each factor. (Read out each statement.) (One importance rating and one satisfaction rating per statement.)*

Not at all	Not important	Quite very	Very	Very important	dissatisfied		Neutral	Very	NA satisfied	
a. No congestion at the boat ramp	1	2	3	4	1	2	3	4	5	9
b. Catching as many fish as you expect to	1	2	3	4	1	2	3	4	5	9
c. The number of fish you catch and keep	1	2	3	4	1	2	3	4	5	9
d. The size of the fish you catch and keep	1	2	3	4	1	2	3	4	5	9
e. The species of the fish you catch and keep	1	2	3	4	1	2	3	4	5	9
f. The time it takes to catch the number of fish you expected to	1	2	3	4	1	2	3	4	5	9
g. The time it takes to catch the number of fish you want to keep	1	2	3	4	1	2	3	4	5	9
h. Catching enough fish for a decent feed	1	2	3	4	1	2	3	4	5	9
i. Enjoying the fishing experience, regardless of the number of fish caught and kept	1	2	3	4	1	2	3	4	5	9
j. Having an enjoyable time out on the ocean	1	2	3	4	1	2	3	4	5	9

Most Recent Offshore Bottom Fishing Trip in the West Coast Wetline Fishery Offshore Between Augusta and Kalbarri for Such Species as Dhufish, Pink Snapper and Baldchin Groper

Q 11 *When was the last time you went bottom fishing offshore in the West Coast Wetline fishery between Augusta and Kalbarri for such species as dhufish, pink snapper or baldchin groper?*

______________ (date/month or # weeks ago)

Q 12 *Where was the boat launched? (Probe for boat ramp, pen or mooring) (One only)*

_______________________________ ( )

Q 13 *Roughly how far did you go offshore? (Probe for rough location or distance)*

_______________________________ ( )

Q 14 *How long did it take you travel (on the ocean from the boat ramp to the fishing spot back to the boat ramp) on the fishing trip?*

_______ hours

Q 15 *How long did you spend actually bottom fishing offshore between Augusta and Kalbarri trying to catch such species as dhufish, pink snapper or baldchin groper?*

_______ hours

Q 16 *How far did you travel (from home to the boat ramp and back again) to go on the offshore bottom fishing trip? (Include any side trips related to the fishing trip, eg getting petrol for boat, getting bait, picking up mates, etc. Exclude travel in the boat on the water.)*

_______ kms

Q 17 *And how long did it take you to travel that far?*

_______ hours or _______ days

Q 18 *How long were you away from home on your fishing trip?*

_______ hours or _______ days

Q 19 *What percentage of the time on the ocean did you spend: (Read out each statement first, then record percentage against each)*

a)	Fishing (either from the boat or diving from the boat)	____ %
b)	Recreational diving	____ %
c)	Cruising (excluding travelling to fishing spot)	____ %
d)	Other (specify) ______________	____ %
TOTAL (check)		100 %

Q 20 *What species did you target to catch on that offshore bottom fishing trip? (Accept multiples)*

Dhufish	1
Pink snapper	2
Baldchin groper	3
No species in particular	4
Other (specify) ___________________	( )

Q 21 *Including yourself, how many people were in the fishing group on that trip?*

_______ people (If = 1, SKIP to Q23)

Q 22 *What was the relationship of the other people to you? (Accept multiples)*

Friend(s) 1
Spouse, partner or 'significant other' 2
Parent(s) 3
Children 4
Extended family 5
Other (specify) ________________ ( )

Q 23 *On that trip, how many dhufish did you personally: (Read out)*

a) catch and release? _______ dhufish
b) catch and keep? _______ dhufish

Q 24 *(On that trip) how many pink snapper did you personally: (Read out)*

a) catch and release? _______ pink snapper
b) catch and keep? _______ pink snapper

Q 25 *(On that trip) how many baldchin groper did you personally: (Read out)*
a) catch and release? _______ baldchin groper
b) catch and keep? _______ baldchin groper

Q 26 *(On that trip) how many other species of fish did you personally: (Read out)*

a) catch and release? _______ other species
b) catch and keep? _______ other species

Q 27 *On that trip, did you personally:*
(Read out) (One only)

Catch and keep the limit of dhufish, pink snapper or baldchin groper? 1
Catch as many of these fish as you wanted within the limit? 2
Not catch as many of these fish as you wanted? 3
(None of these) 4

Q 28 *Were you happy with the number of fish you personally caught (and not necessarily kept) that trip? (One only)*

Yes 1
No 2

Q 29 *Were you happy with the number of fish you personally kept that trip? (One only)*

Yes 1
No 2

Q 30 *Were you happy with the size of fish you personally caught (and not necessarily kept) that trip? (One only)*

Yes 1
No 2

Q 31 *Were you happy with the type of fish you personally caught (and not necessarily kept) that trip? (One only)*

Yes 1
No 2

Q 32 *Were you happy with the type of fish you personally kept that trip? (One only)*

Yes 1
No 2

Q 33 *Did you catch as many fish as you thought you would? (One only) (If no, ask if they thought they'd catch more or less)*

No, thought I'd catch more 1
No, thought I'd catch less 2
Yes, caught as many as I thought I would 3

Q 34 *Did you keep as many fish as you thought you would? (One only) (If no, ask if they thought they'd catch more or less)*

No, thought I'd keep more 1
No, thought I'd keep less 2
Yes, kept as many as I thought I would 3

Costs of Fishing

Q 35 *Do you still own your registered boat?*

Yes 1
No (SKIP to Q39) 2

Q 36 *How long is your boat?*

_____ feet or _____ metres

Q 37 *What is the current market value of your boat including the motor? (round to the nearest $10)*

$ __________

Q 38 *In the last twelve months, how much money did you spend on: (round to the nearest $1) (Read out.)*

a. Boat and trailer licence fees? $_______
b. New equipment such as GPS or sounder or motor? $_______
c. Parts for the boat, motor or trailer? $_______
d. Boat, motor or trailer maintenance? $_______
e. Insurance for boat, motor or trailer? $_______
f. Boat club membership and pen fees? $_______

Q 39 *In the last twelve months, how much money did you spend on: (round to the nearest $1) (Read out)*

a. Fishing-related equipment for a motor vehicle such as roof racks or a tow bar? $_______
b. Life jackets and safety gear? $_______
c. Recreational fishing club membership? $_______
d. Rods, reels or other fishing equipment? $_______
e. Books, magazines, videos etc on boat fishing, locations, fishing gear, etc to help you find and catch fish $_______
f. Angling Club membership fees $_______

Q 40 *On a typical offshore bottom fishing trip for such species as dhufish, pink snapper or baldchin groper between Augusta and Kalbarri, how much did you spend on the following? (round to the nearest $1) (Read out)*

a. Accommodation? $________
b. Food, drink and refreshments? $________
c. Transport - petrol for vehicle? $________
d. Petrol for boat? $________
e. Parking and boat launching fees? $________
f. Special clothing, hats, footwear or sunglasses for fishing? $________
g. Bait and ice? $________

Q 41 *A recent fisheries survey shows that many people on recreational fishing trips in the West Coast Wetline fishery for species such as dhufish, pink snapper and baldchin groper return without any of these fish. When people return with a catch, it is usually with less than 3 of these species, whilst 6 is exceptional.*
A fishing management strategy could be considered for the West Coast Wetline fishery to sustain the fishery and increase the chances of more reliable recreational catches of these prized species. The strategy would be funded by an annual recreational licence fee, which would entitle you to fish in the West Coast Wetline fishery and to catch and keep these and other species within daily catch and size limits.
All money collected would be paid into a dedicated fund to be used to improve coastal recreational fishing.
The alternative to the strategy is to leave things as they are. However, the locations, number and size conditions applying to these species may still need to be tightened to sustain the fishery.
Are you willing to buy an annual recreational fishing licence for $* that entitles you to go fishing in the West Coast Wetline fishery and to catch and keep up to x dhufish, y baldchin groper and z pink snapper per trip within existing size limits, and any other species within the existing catch and size limits? (One only)

Yes (Skip to Q42) 1
No (Skip to Q43) 2

* Randomly assigned fees of $20, $30, $40, $50 and $60.
x, y, z: Assign values from a look up table of fish baskets (see end of questionnaire).

Q 42 *(If 'yes' to Q41) Are you willing to buy an annual recreational fishing licence for $**?*
(Increase the start price by using the $5 intervals below and ask until a 'no' response is received. Record the price given for the last 'yes' response.)

** $25 $30 $35 $40 $45 $50 $55 $60 $65 $70 $75 $80 $85 $90 …
Last 'Yes' Price $________

*Q **43** If 'no' to Q41) Are you willing to buy an annual recreational fishing licence for $***?*
(Decrease the start price by using the $5 intervals below and ask until a 'yes' response is received. Record the price given for the 'yes' response.)
*** $55 $50 $45 $40 $35 $30 $25 $20 $15 $10 $5 $0
'Yes' Price $________

12. Demographics

*Q **44** Gender (record automatically)*

Male 1
Female 2

Q 45 *Which of these age categories do you belong to? (One only) (Read out)*

15 to 19 years	1
20 to 29 years	2
30 to 39 years	3
40 to 49 years	4
50 to 59 years	5
60 to 69 years	6
70 years or older	7
(Refused)	99

Q 46 *Which of the following best describes your situation? (One only) (Read out)*

Full time employment	1
Full-time student (not in paid employ)	2
Part time or casual employment	3
Unemployed	4
Home duties	5
Retired	6
Pensioner (disability, illness, age, etc)	7
Other (specify) ___________________	( )
(Don't know)	98
(Refused)	99

Q 47 *What is your personal weekly income before tax? (annual income indicated in brackets)*
(One only) (Read out)

Negative income	01
Nil income	02
$1–$79 ($1–$4,159)	03
$80–$159 ($4,160–$8,319)	04
$160–$299 ($8,320–$15,599)	05
$300–$499 ($15,600–$25,999)	06
$500–$699 ($26,000–$36,399)	07
$700–$999 ($36,400–$51,999)	08
$1,000–$1,499 ($52,000–$77,999)	09
$1,500 or more ($78,000 or more)	10
(Don't know)	98
(Refused)	99

That concludes the interview. Thank you for your time. (Standard Interview Closing Spiel.)

Fish Baskets

The baskets are the numbers of dhufish, pink snapper and baldchin groper that people can catch on each fishing trip. Use the answers to Q6 and Q20 (prized species targeted when bottom fishing in the West Coast Wetline Fishery) to make sure that the basket offered to the respondent includes a minimum of one fish for each of the species they target.
For example:
If they target dhufish only (of the three prized species), randomly select a proposed basket with at least 1 dhufish.
If they target pink snapper and dhufish, randomly select a basket with at least 1 dhufish, at least 1 pink snapper.
If they target all three of the prized species, randomly select a proposed basket with at least 1 dhufish, at least 1 pink snapper and at least 1 baldchin groper.
If they don't target any of the prized species, randomly select any of proposed baskets.

Basket	Dhufish(x)	Baldchin Groper (y)	Pink Snapper (z)	Basket	Dhufish(x)	Baldchin Groper (y)	Pink Snapper (z)
1	1	0	0	40	1	2	2
2	0	1	0	41	4	2	0
3	0	0	1	42	0	4	2
4	0	0	2	43	2	0	4
5	2	0	0	44	2	2	2
6	0	2	0	45	3	1	2
7	1	1	0	46	2	3	1
8	0	1	1	47	1	2	3
9	1	0	1	48	4	1	1
10	1	1	1	49	1	4	1
11	3	0	0	50	1	1	4
12	0	3	0	51	3	3	0
13	0	0	3	52	0	3	3
14	2	1	0	53	3	0	3
15	0	2	1	54	4	3	0
16	1	0	2	55	0	4	3
17	4	0	0	56	3	0	4
18	0	4	0	57	4	1	2
19	0	0	4	58	2	4	1
20	2	2	1	59	1	2	4
21	1	2	1	60	2	2	3
22	1	1	2	61	3	2	2
23	3	1	0	62	2	3	2
24	0	3	1	63	3	3	1
25	1	0	3	64	1	3	3
26	2	2	0	65	3	1	3
27	0	2	2	66	4	4	0
28	2	0	2	67	0	4	4
29	4	1	0	68	4	0	4
30	0	4	1	69	2	2	4
31	1	0	4	70	4	2	2
32	3	2	0	71	2	4	2
33	0	3	2	72	3	2	3
34	2	0	3	73	3	3	2
35	3	1	1	74	2	3	3
36	1	1	3	75	1	3	4
37	1	3	1	76	4	1	3
38	2	1	2	77	3	4	1