PRICE FORMATION ON THE SYDNEY FISH MARKET

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Foreword

Market prices are largely ignored in the management of fisheries. However, marketing factors potentially have a large impact on the efficiency of fisheries resources use. The relationships between prices and both the quantity supplied and the characteristics of the product influence the decisions of operators to target particular species of fish and the income they earn as a result of their activities.

If prices received by fishing operators are determined by catches in the fishery then the effects on industry incomes of any changes in catch will be partly offset by changes in prices received. Information on price relationships for different size grades of fish is also relevant both to guiding operators' decisions to target particular sizes and to developing strategies for marketing their catches. It is also relevant to addressing key fisheries management issues, such as catch discarding, which tends to be of smaller size fish, unsuited to market demands.

The second part of this study was undertaken to establish whether seafood auction prices reflect differences in the quality of product. It is important that prices clearly reflect the characteristics sought by consumers because fishing operators are more likely to adopt the appropriate quality and handling practices when these are clearly reflected in price premiums.

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Summary

Australian fisheries are managed by governments to ensure that commercial fishing is undertaken in a sustainable and economically efficient manner. Fisheries management decisions influence the level of catch from a fishery, either directly through setting the total allowable catches that the industry may take or indirectly through restrictions on the number of operators and the equipment they may use. It is therefore important that the impacts of fisheries management decisions can be evaluated in the light of their impact on the fishing industry and on the public.

The relationships between the volume of fish landed and the prices that operators receive are central to considerations of economic efficiency. The commercial value of fisheries is determined by the volume, the species and size composition of catches and the values placed on them at commercial markets. To establish the benefits and costs of fisheries management options, such as reducing the catch in a fishery or changing the composition of catches through introducing gear restrictions, it is desirable to know how industry revenue will be affected by the change.

The objective in the first part of this study is to establish the relationships between prices received by operators and the volume supplied to the market. The analysis is conducted for product landed from the south east fishery, which is a major source of fresh fish for domestic consumption. The fishery is managed under an individual tradable quota system, based on setting of total allowable catches to restrict the commercial harvest. The analysis covered the quota species of the south east fishery which were sold on the Sydney market.

If relationships exist between the quantity of fish produced from the fishery and the prices received by fishing operators, industry revenue will be affected by market factors. For example, if prices received by fishing operators are responsive to changes in volume sold then the impact on revenue of a reduction in total catches will be partly offset by higher prices. Where prices are determined by the catch in the fishery then the economically optimal catch will be lower than the optimal catch where prices are determined independently, such as by overseas markets.

In this study it is found that prices formed at the Sydney Fish Market for the major high volume species from the inshore sector of the fishery are relatively responsive to changes in the volume sold. This response was found to be similar for redfish, school whiting, silver trevally and tiger flathead, with the expected price rising by around 6 per cent with each 10 per cent fall in the volume sold.

Prices for other quota species from the southern trawl fishery were found to be less responsive to volume changes. The likely response to a 10 per cent fall in volume ranged from a price increase of 4 per cent for silver warehou and 3 per cent for morwong, down to a 1 per cent increase in prices for ling. That is, for these species, less of the volume effects of a reduction in catch would be offset by price increases. Conversely, any increase in production and marketing of the species would result in smaller falls in wholesale prices than for the high volume species.

In addition to the volume sold on the day, other factors influence the price for quota species — for example, the volume sold on previous days, the total volume of all fish on the market, the size grade of the fish, the number of buyers and the day of the week. A significant proportion of the variation in prices remained unexplained by either the volume changes or other market factors. Other influences on prices (not examined in this study) may include fish supplied through other marketing channels (such as through wholesalers or importers), and the effect of supplies of other fish species on the quota species examined.

Demand differed significantly for different size grades of a number of the species examined. To take advantage of such differences and increase industry revenue, it would be necessary to move from emphasis on total allowable catches to focusing more on the age cohorts that make up these catches. Marketing problems with fish of sizes for which consumer demand is only limited is a major factor behind the discarding of catches.

Price–quality relationships

The relationships between prices play important roles in efficient resource use. Prices provide signals to fishing operators about what is required, when, in what volumes, and with what characteristics. An important issue is whether quality differences important to buyers are reflected in the prices received by fishing operators.

To examine the impact of quality differences on price, ABARE conducted a separate study of nine species. This analysis was based on an experienced assessor's visual evaluation of the accuracy of grading, icing and six appearance/quality characteristics of individual lots sold through the Sydney Fish Market over a twelve month period.

The majority of quality assessments fell within a limited range of scores, restricting the analysis of their impact on price but indicating that the industry uses relatively consistent handling standards. However, some problem areas were apparent — for example, while 76 per cent of the product had sufficient ice, the distribution of ice was identified as a problem in 40 per cent of the product assessed. It is likely that some variation in quality found during the study reflected operators' failure to adequately compensate for changing climatic conditions in their handling of fish, through failure to increase the use of ice and to improve its distribution within the box during warmer weather.

Seventy-three per cent of all lots covered by the survey met the size grade standards set by the Sydney Fish Market and the accuracy of size grading was positively linked to the prices received for all species assessed. For most species, there were premiums for accurate size grading, good icing practices and strong color. However, most other quality factors assessed were found to have a mixed impact on prices, with several of the quality–price relationships contrary to expectations — for example, inadequate distribution of ice was not generally linked to a price discount.

The analysis of price–quality relationships showed that the quality factors assessed during the trial explained part of the variation in prices received by operators. Yellowfin tuna and whole snapper — species where appearance is a key selling characteristic — had the strongest impact of the quality factors on prices received. Differences in the quality factors assessed explained around 30 per cent and 14 per cent respectively of the total variation in prices for these species. However, for most other species in the analysis, the quality factors used explained only a relatively small proportion of the daily spread in prices — from around 5 per cent of variation for morwong to around 2 per cent for ling and flathead.

Marketing efficiency issues

The main marketing efficiency issue is whether prices established at markets convey price signals to the catching sector that effectively reflect consumer

quality requirements. With some exceptions, the relationships between quality factors and price were not strong, supporting industry perceptions that prices received do not strongly reflect differences in product quality. Further, it was difficult to identify the differences in prices received resulting from differences in quality because a number of factors simultaneously influence prices.

The development and adoption of standardised grades could improve price signals between consumers and producers. The basis used to trade a commodity has been shown to have a major impact on the production focus of commodities such as wool and wheat, and improve the marketable characteristics of the product traded. The fishing industry potentially stands to benefit from such a change in focus, if consumer preferences could be more explicitly reflected in price differences.

The benefits of improved standardised grades for trade may include an improved focus on quality issues and improved returns to industry (through better targeting of effort on grades in most demand and potentially through increased prices from better meeting market requirements). Standardised grades are also a prerequisite for adopting a range of marketing methods that may reduce costs throughout the marketing chain.

The development of standard product descriptions for the domestic seafood market is likely to be a major undertaking. Issues to be addressed may include the level of information needed by consumers and buyers to adequately specify their quality requirements. The value of the additional information provided needs to be assessed against the costs of developing a more suitable framework for trade and of providing that information in normal fishing and marketing operations.

1

Introduction

Australian fisheries management aims to ensure that fishing is undertaken in a sustainable and economically efficient manner. Achieving this objective depends on a range of biological, economic and marketing considerations. Of these, marketing factors have been given the least consideration by managers, but have a large potential impact on resource use efficiency.

The relationships between consumer demand and supply determine whether one fish is valuable and others are not. Consumer demand, in turn, is driven by factors such as prices and incomes, taste preferences, attitudes toward health and risks associated with consumption of seafood and other products, and the convenience of purchasing and preparation.

Product prices received by fishing operators reflect the relationships between supply and demand, not only for volume, but also in relation to the composition of supplies and the product characteristics preferred by consumers. Suppliers and buyers establish prices at the wholesale level, but the buyers interpret the requirements of their customers. The efficiency with which customer requirements are met ultimately determines the profitability of the catching sector.

The relationships between prices received and quantity supplied at the wholesale level determine the likely revenue implications of any decisions by fishing operators to target particular species or size of fish. They also guide fisheries managers in setting desired catches of target species, managing bycatch and in resolving resource access issues.

Price analysis is also useful in addressing marketing efficiency issues in the fishing industry, because it can be used to establish the impact of different marketing practices on prices. One such issue is whether prices established at markets convey price signals to the catching sector that effectively reflect consumer requirements. It is often difficult for fishing operators to ascertain the premiums and discounts involved with different practices because a large number of factors may simultaneously influence the prices they receive. Unless fishing operators supplying the market are aware of the effects of different factors on their returns, they are unlikely to adapt their fishing and handling practices to meet consumer requirements.

Many factors are believed to influence domestic seafood prices, including the level of supplies; the impact of overseas market developments (particularly developments for products that are also exported and those directly competing with imports); consumer attitudes to seafood and alternative products, and their relative prices. Moreover, seafood covers a wide range of products sold through a number of wholesale and retail market channels, and different combinations of factors are likely to determine the prices of these products.

Objective

The objective in this study is to establish the relative importance of different factors on prices paid at auction for selected species on the Sydney Fish Market. These include:

- the impact of volume changes on prices; and
- the influence of handling and quality attributes of products.

Background

The study was undertaken on sales made at the Sydney Fish Market because it is an important outlet for fish from the south east fishery; it plays a significant role in establishing domestic seafood prices; and both its marketing and accounting systems could provide the information necessary to assess the importance of nonvolume factors, such as quality, to seafood prices.

The seafood auction market in Sydney is an important channel for domestically produced seafood sold on the Australian market and a major outlet for fish landed from the south east fishery. Prices on that market usually reflect a number of factors, including the aggregate volume of product on the market floor, the species and forms of that product, the 'quality' of available product, the availability of supplies from alternative sources, the number of potential buyers and underlying retail demand conditions.

The importance of quality attributes in setting seafood prices is acknowledged. However, seafood demand studies mostly have not addressed these attributes (Anderson and Wessells 1994). Quality covers many dimensions, including taste, appearance, odor, convenience and safety considerations, and is inherently difficult to measure objectively (Anderson and Anderson 1991). A wide range of factors — including fishing methods, holding facil-

ities, and handling practices on boats and elsewhere in the marketing chain — are likely to influence such quality aspects.

A previous study of marketing in the south east fishery (Smith, Tran and Ruello 1995) found that there was a widely held perception that differences in product quality were not reflected in the prices received. The initial focus of this project was to examine the relationships between prices received by fishing operators and quality factors, to identify whether prices at auction reflected these factors. The Fisheries Research and Development Corporation then requested that the project be expanded to examine volume–price relationships for major species from the south east fishery in addition to those species targeted for the quality study.

The project comprised two stages. The objective of the first stage, reported in chapters 2–4, was to establish the volume–price relationships for major species from the south east fishery. The second stage, outlined in chapter 5, examined quality–price relationships using assessment data on quality attributes of selected fish species sold at the Sydney Fish Market over a twelve month period, covering an overlapping range of products from the first stage. The contributions of both sets of factors to seafood price formation, along with some implications for management and marketing, are examined in chapter 6.

2 *Structural factors*

To examine the price–volume relationships in the south east fishery using market relationships established on the Sydney Fish Market, it is important to understand the links between the fishery and that market. If different marketing channels are used for different species of fish, then any price analysis based on only the Sydney Fish Market could have only restricted application to management and marketing issues concerning the fishery. Identifying the major features of both the fishery and the market is also useful to ensure the validity of the approaches and assumptions used.

It was necessary to adopt a common year base for both the south east fishery production and the market data. The convention adopted has been to use the year 1 April to 31 March to be consistent with the reporting period used by the Sydney Fish Market. The data used cover the period 1 April 1992 to 31 March 1996.

The south east fishery

The south east fishery is a multispecies fishery located in Commonwealth waters of the Australian Fishing Zone from just north of Sydney to Beachport in South Australia. Managed by the Australian Fisheries Management Authority, the fishery comprises a trawl sector and a much smaller nontrawl sector, covering gillnet, hook and trap fisheries. Only the trawl sector is considered in this study.

Over 80 species are caught, but sixteen commercial species dominate the catch and provide the majority of operators' revenue — 85 per cent in 1994-95 (ABARE 1995). Catches of these species by the south east fishery trawl sector in the period covered by the study are shown in table 1.

The fishery has been managed under an individual transferable quota arrangement based on total allowable catches since 1992. The change was introduced to address the continued increase in fishing effort, poor economic performance in the fishery, and threats to several of the fish stocks. The initial arrangement only allowed for leasing of quotas; permanent transfer of quotas between operators was not allowed until 1994. Quota was allocated on the basis of the historical catch of boats in the fishery and on the hull and engine

1 Total catches of south east fishery quota species a

	1992-93	1993-94	1994-95	1995-96
	t	t	t	t
John dory	189.8	280.0	250.8	191.8
Mirror dory	230.7	341.9	332.2	327.4
Flathead	2 574.8	2 206.6	1 961.1	2 080.6
Gemfish	706.8	430.7	284.9	221.7
Blue grenadier	3 351.3	3 222.4	3 128.7	2 659.3
Ling	746.1	1 055.2	1 096.1	1 506.3
Morwong	1 027.2	985.3	889.1	801.1
Orange roughy	13 767.3	10 978.0	7 219.0	4 888.7
Royal red prawns	139.7	445.7	290.9	439.9
Redfish	1 946.7	2 130.9	1 573.1	1 338.8
Ocean perch	230.8	339.8	286.4	344.5
Blue eye	78.6	91.3	108.0	85.4
Silver trevally	397.0	442.2	525.6	407.9
Silver warehou b	2 233.0	2 109.7	2 533.7	2 718.4
Blue warehou	196.4	937.0	1 035.2	955.9
School whiting c	1 028.1	1 521.3	1 055.9	1 313.6
Total	28 844.4	27 518.0	22 570.6	20 281.3

a Year from 1 April to 31 March. b Also known as spotted warehou. c Also marketed as red spot whiting.
Source: Australian Fisheries Management Authority.

capacity of those boats (which had been regulated under a previous management plan to restrict a buildup in fishing effort in the fishery). The catch history was associated with the vessels rather than the operator (Campbell, Battaglene and Brown 1996).

Total landings from the fishery declined from almost 29 000 tonnes in 1992-93 to just over 20 000 tonnes in 1995-96, mainly reflecting lower catches of orange roughy (which fell by 65 per cent as a result of a decline in the fishery) and blue grenadier (which fell by 20 per cent). However, the catches of most species except orange roughy and eastern gemfish (two aggregating stocks considered vulnerable to overexploitation) have been well below the limits set by total allowable catches.

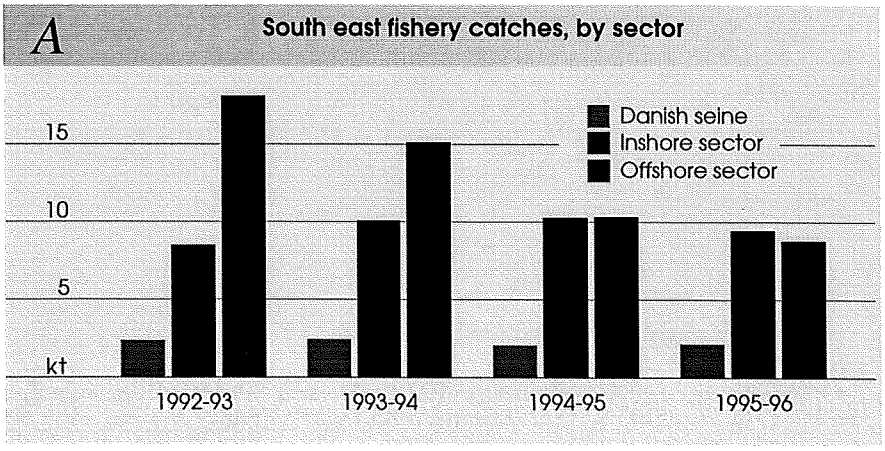
A key question for marketing in the fishery is whether the introduction of individual transferable quotas to the fishery has had a major impact on either the level or timing of catches. An individual transferable quota management system offers greater incentive to maximise the value of quota holdings and

less incentive to maximise catches. Some changes in the timing of catches and their sale could be expected to result as operators avoid peak market situations where high volumes of product on the market result in depressed prices. The introduction of tradable quotas was also expected to expedite adjustment in the fishery through the trading of quota from less efficient to more efficient operators.

Some initial problems in introducing individual transferable quotas may have had some impact on catches. The initial allocation process assigned the quota to vessels that were often sold and moved to other parts of the fishery, so operators' quota holdings were often not suited to their current operations. Adjustment to the individual transferable catch system was also constrained by the small initial allocation to some operators, the lack of full quota transferability until the beginning of 1994, and initial problems operating under a new management system.

The fishery comprises three separate subfisheries. Boats in the inshore sector generally operate off the south coast of New South Wales and the west coast of Victoria, targeting a range of species for domestic fish markets in Sydney and Melbourne. The Danish seine fleet operates in shallower waters mostly off Lakes Entrance; it targets flathead for domestic fish markets and whiting (some of which is exported). Boats in the offshore sector mainly operate from Tasmanian and Victorian ports, mostly targeting orange roughy and blue grenadier (ABARE 1996).

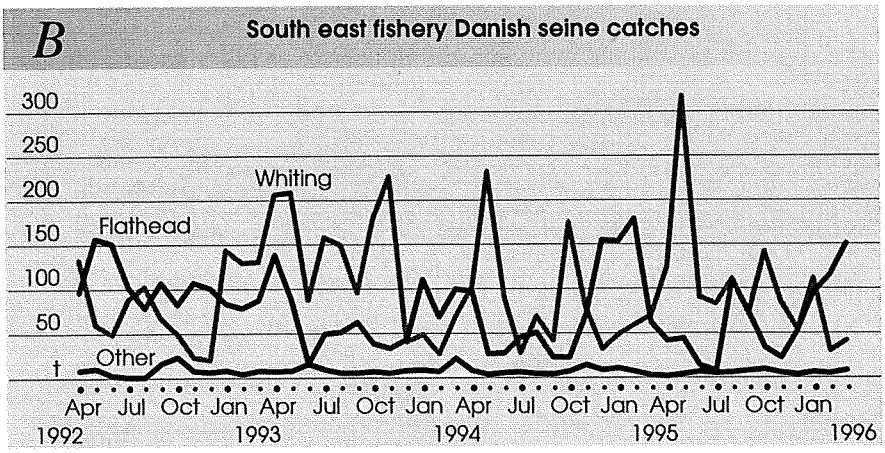
Most of the decline in catches has occurred in the offshore sector of the industry as a result of the decline in the orange roughy fishery (figure A).



Consequently, boat numbers in this sector fell from 33 in 1992-93 to 23 in 1995-96. These boats focused their operations in the inshore sector, resulting in boat numbers in the inshore sector rising from 54 to 64 over the same period. Catches of inshore species increased between 1992-93 and 1994-95 but declined by 8 per cent in 1995-96. The number of boats operating in the Danish seine sector of the fishery increased from 18 in 1992-93 to 21 in 1995-96, and catches have been reasonably stable.

Danish seine sector

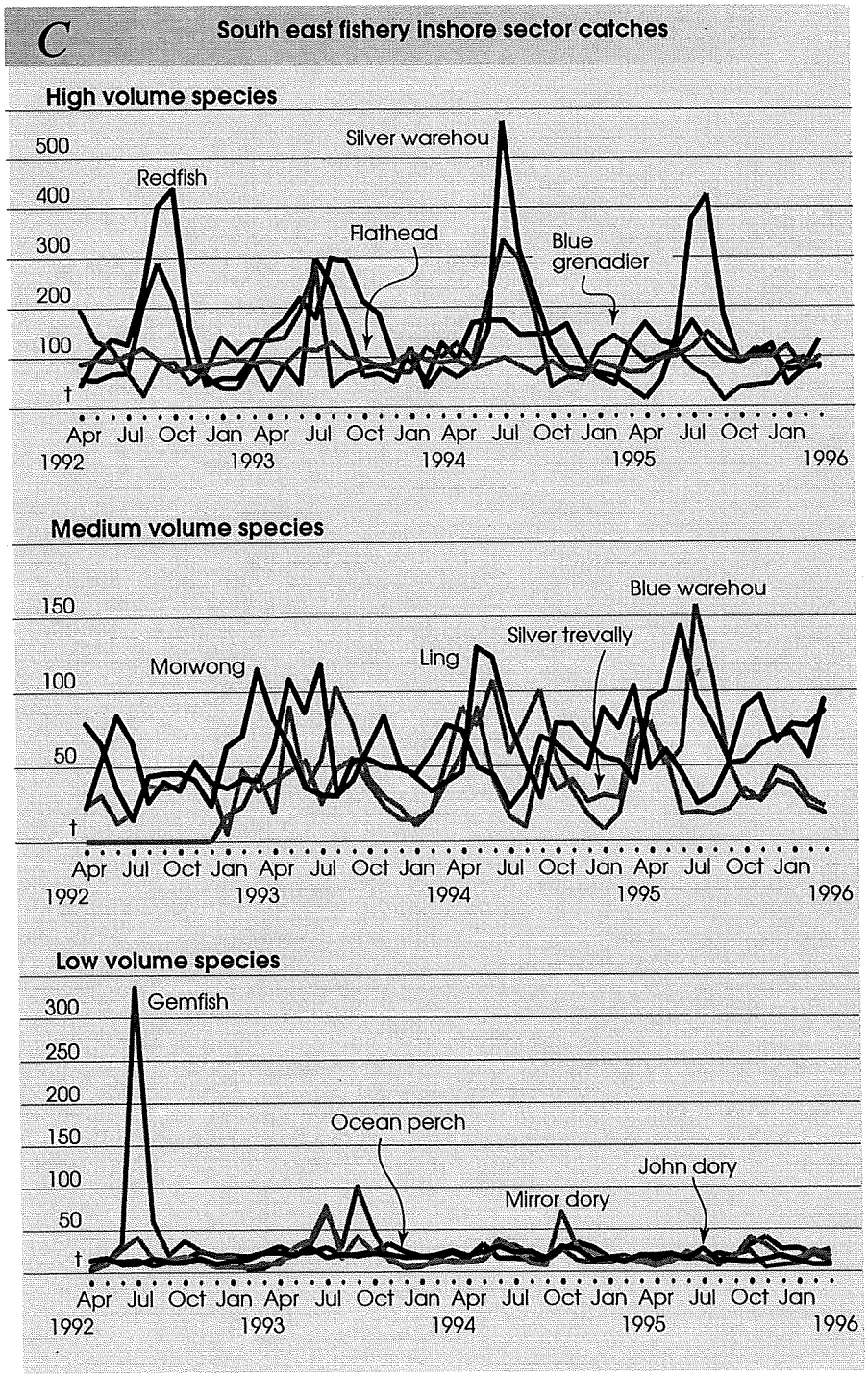
The Danish seine fleet generally comprises smaller vessels with around half the catch of the inshore fleet and a quarter that of the offshore fleet. Annual catches per boat ranged from 100.5 tonnes (valued at $158 000) in 1993-94 to around 124.5 tonnes (valued at $238 000) in 1995-96 (ABARE 1997).



School whiting (sold on the Sydney Fish Market as red spot whiting) and flathead together represent around 96 per cent of catches. School whiting landings have been highly seasonal, with two periods of peak production around April and October each year, while flathead production has been less seasonal and generally corresponds to periods of low whiting catches (figure B).

Inshore sector

Inshore sector landings over the period 1992-93 to 1995-96 averaged 192 tonnes a boat, valued at around $446 000 (ABARE 1997). Catch composition was more diverse than in the Danish seine fishery, with four species (redfish, silver warehou, blue grenadier and flathead) making up 60 per cent of total landings over the four years to 1995-96 and the next four most impor-


C
South east fishery inshore sector catches
High volume species
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Silver warehou
Redfish
Flathead
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Apr Jul Oct Jan Apr Jul Oct Jan Apr Jul Oct Jan Apr Jul Oct Jan
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Apr Jul Oct Jan Apr Jul Oct Jan Apr Jul Oct Jan Apr Jul Oct Jan
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tant (ling, morwong, blue warehou and silver trevally) comprising a further 25 per cent.

Of the high volume species, silver warehou has been the most seasonal, while flathead has shown the least seasonal variation (figure C). Redfish landings were highly peaked around October in the first two years of the period, but have since become less seasonal as operators have appeared to increasingly target larger fish and to adapt fishing strategies to avoid glut supply periods. Blue grenadier catches peaked around July in the two middle years of the period examined, but no pattern of landings was evident in the other years.

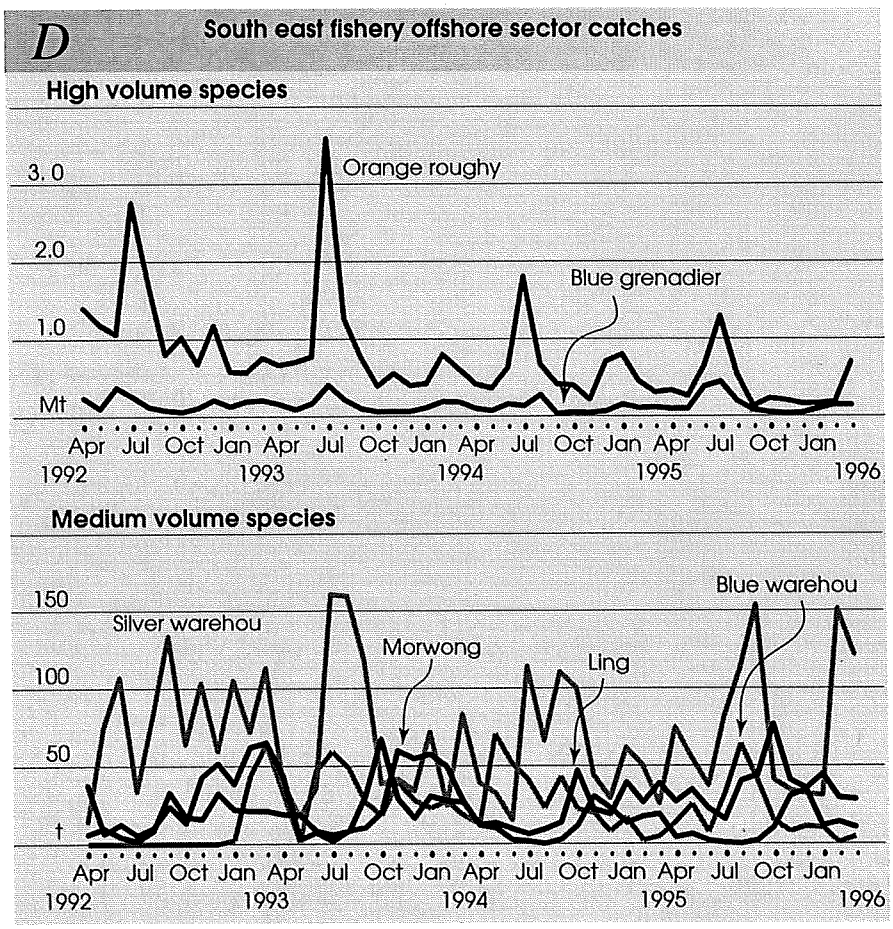
The medium volume species caught by the inshore sector have shown an increasing catch trend and strong monthly variation (figure C). Ling has been caught mainly in May, June and July, while morwong catches have peaked in March. Blue warehou have had two main peaks, around May and August–September. Silver trevally landings exhibited little pattern during 1992-93 and 1993-94 but a pronounced targeting in April–May over the two years to 1995-96.

The introduction of catch restrictions on eastern gemfish in 1993 strongly influenced inshore sector landings of the low volume species (figure C). Catches of eastern gemfish have since been restricted to 200 kilograms a trip to allow for incidental catches. Western gemfish continue to be caught off western Victoria, with a total allowable catch of around 355 tonnes. Of the remaining low volume species caught by the inshore sector, only mirror dory has shown any seasonality (with peaks around July and October).

Offshore sector

Two species, orange roughy and blue grenadier, dominate the offshore sector catches. Catches of orange roughy fell over the study period with the introduction of progressively lower total allowable catches (reduced from 18 250 tonnes in 1992 to 9250 tonnes in 1995) to protect the stock from overfishing. Orange roughy has been highly seasonal (figure D), with the peak catch in July targeting spawning fish. Blue grenadier catches, while lower, have also been seasonal, with peak catches around June to August.

The fall in orange roughy catches has led operators to target a range of other species in the offshore sector, including ling, blue warehou and silver warehou (figure D). Landings of these species have been highly variable but have exhibited relatively little seasonality.



Marketing of south east fishery catches

The south east fishery covers four states (New South Wales, Victoria, Tasmania and South Australia), so operators have a range of marketing options. The main market channels include direct sales through the Sydney or Melbourne fish markets, the landing of product with fishing cooperatives (mainly for subsequent dispatch to the capital city markets) and direct sales to processors, wholesalers or retailers.

When the main fishing activity was off New South Wales, the fishery was mainly geared to supplying the Sydney Fish Market through cooperatives located from Wollongong through to Lakes Entrance. Catches landed in New South Wales were required to be sold through the Sydney Fish Markets or

a cooperative unless the (then) New South Wales Fish Marketing Authority gave exemption. Some south east trawl fish catches were granted exemptions — mainly to allow processing of relatively high catches of gemfish — but most product landed to cooperatives was subsequently sold through the Sydney Fish Market (Smith and Reid 1993).

As the focus of fishing operations has moved south, away from the New South Wales coast, the supply relationship between the south east fishery and the Sydney Fish Market has also changed. Marketing has changed greatly with the development of the offshore fishery based on orange roughy and the subsequent fall in catches. Processing expanded in Tasmania and Victoria, for example, and a high level of vertical integration (involving catching orange roughy and blue grenadier, processing the fish into fillet form, and wholesaling these fillets on export and domestic markets) has developed. These facilities are increasingly important outlets for inshore catches as the offshore fishery contracts. The growth of the Melbourne Fish Market has also drawn increased product from southern New South Wales areas. The impact of these changes is illustrated in table 2, which shows the primary distribution (the first point of sale) of quota species from the fishery.

2 Primary distribution of south east fishery quota species

	1992-93 a	1993-94 a	1994-95 a	1995-96 a
	%	%	%	%
New South Wales				
Sydney Fish Market	1.3	2.4	3.5	2.9
Cooperatives b	21.2	23	24.6	28.5
Other processors	3.6	4.5	2.7	6.2
Total	26.1	29.8	30.8	37.6
Victoria				
Melbourne Fish Market c	12.5	11.9	17.1	20.4
Cooperatives	11.4	14.5	13	12.9
Other processors	4.4	6.9	8.2	9.4
Total	28.3	33.4	38.3	42.8
Tasmania	41.9	33.7	30	19.5
South Australia	3.7	3.1	0.9	0.2
Total	100.0	100.0	100.0	100.0
Tonnes	*28 844*	*27 518*	*22 570*	*20 281*

a Year from April to March. b Includes a privately owned fish packing house which has similar functions. c Includes a processor based at the market.
Source: Australian Fisheries Management Authority.

The major link between the fishery and the market occurs through fishing cooperatives. Cooperatives in New South Wales and Victoria were the first point of sale for 33 per cent of total south east fishery catches in 1992-93, rising to 41 per cent in 1995-96. However, with the lower catch levels, this new share represented a 14 per cent fall in the absolute volume of fish handled by cooperatives over the period — from 9500 tonnes in 1992-93 to 8300 tonnes in 1995-96. By comparison, the Sydney Fish Market was the first point of sale (for quota monitoring purposes) for only 1.3–3.5 per cent of total quota species catches in the four years to 1995-96.

The importance of the different marketing channels for the south east fishery varies between species. The Sydney Fish Market and cooperatives are important market channels for only some species; almost all john dory, flathead, redfish and silver trevally from the south east fishery was sold through the Sydney Fish Market and cooperatives over the study period, yet these channels handled less than 50 per cent of total south east fishery landings of blue eye trevalla, silver warehou, blue warehou and gemfish. The Sydney Fish Market and cooperatives handled only 4 per cent of orange roughy and less than 10 per cent of blue grenadier in 1995-96 (table 3).

3 Sales of quota species to Sydney Fish Market and cooperatives
Proportion of landings

	1992-93	1993-94	1994-95	1995-96
	%	%	%	%
John dory	94	95	97	93
Mirror dory	63	80	78	58
Flathead	92	90	92	90
Gemfish	71	55	41	36
Blue grenadier	16	17	13	8
Ling	66	61	76	54
Morwong	67	79	71	70
Orange roughy	3	6	3	4
Royal red prawn	90	77	81	43
Redfish	96	96	97	93
Ocean perch	80	82	80	73
Blue eye trevalla	25	42	9	17
Silver trevally	94	87	96	93
Silver warehou	40	47	46	50
Blue warehou	46	33	49	46
School whiting	81	77	69	78

Source: Australian Fisheries Management Authority.

If a significant proportion of a species' catch is sold on other markets, it is necessary to assume that there are no difference in both the size and quality of product sold on the Sydney Fish Market and through other outlets. Operators using alternative channels usually expect to realise higher net returns. The impact on overall volume–price relationships will depend on the proportion of product sold on all markets and the specific relationships of prices to changes in volume on each market.

It is reasonable to assume that prices obtained on other markets are generally related to those on the Sydney Fish Market. Efficient marketing should mean that fish are distributed between markets to equalise the net price (market price less transport and marketing costs). For south east trawl fish, an earlier study of price relationships on the Sydney and Melbourne fish markets (Reid and Smith 1991) found that the species examined were distributed in a manner consistent with profit maximisation. However, distribution between markets was influenced by differing buyer preferences for the species on those markets. Sydney was found to be the dominant market for mirror dory, morwong, redfish, tiger flathead and blue eye, while Melbourne was the dominant market for ling, school whiting and blue grenadier.

The extent to which volume–price relationships on the Sydney Fish Market are representative of those in the south east fishery can also depend on the composition of supplies. Many of the same species can also be caught using other fishing methods, which may result in product with quality characteristics different from those produced by trawlers. Blue eye trevalla, for example, is caught by droplining as well as trawling, and the resultant catches of the former method receive higher prices than trawl caught product.

There was not a clear link between catches in the fishery and market supplies. Over the period of the study, the separations between fisheries were indistinct. In addition to working in the south east fishery, operators may also catch many of the same species in state waters; for example, south east fishery operators caught 3388 tonnes in state waters in 1994 (15 per cent of the total catches recorded by those operators), of which the main species were redfish, spotted warehou, flathead and ling. Before state trip limits were introduced for south east fishery quota species, catches of some species were misreported as coming from state waters (BRS 1995). Other fisheries can also supply the same species.

It was not feasible to determine precisely the volume of south east fishery product sold to the Sydney Fish Market because cooperatives supplying the

Sydney Fish Market may receive many of the same species from boats in other fisheries. However, it is reasonable to assume that most of the catches passing through these market channels came from the inshore fishery east of the Bass Strait and the Danish seine sectors of the fishery.

Cooperatives were the first point of receival for most fish caught in the inshore and Danish seine sectors of the fishery. The inshore sector of the south east fishery is based mainly on waters off New South Wales, so cooperatives were the first point of sale for 63 per cent of all product landed. The Danish seine sector is organised around the Lakes Entrance Cooperative which handles almost all product.

The Sydney Fish Market was only a minor market for product caught by the offshore sector. Nearly 60 per cent of offshore sector catches was landed to processors in Tasmania, closer to the main catching areas. Boats in the offshore sector were also significant suppliers to the Melbourne Fish Market, providing 17 per cent of landings. Orange roughy and blue grenadier were the main species sold either on the market or to processors located there. Cooperatives were the primary market for only 6 per cent of average landings by the offshore sector over the period; they sold mainly species associated with the inshore sector.

Any analysis of prices formed on the Sydney Fish Market is mainly relevant to the operations of the inshore and Danish seine sectors of the fishery. The impact on the offshore sector depends on the strength of the links between the Melbourne and Sydney fish markets and the links between the different market segments (such as between the Sydney Fish Market and outlets for processed fish). These links have not been established for some species.

Given the importance of cooperatives as a link between the Sydney Fish Market and operators in the south east fishery, the practices of cooperatives can have a significant impact on quality–price relationships. In particular, the practice of combining landings of individual operators before consignment to market distorts price signals and reduces individual incentives for providing quality fish (Smith and Reid 1993).

Sydney Fish Market

The Sydney Fish Market is the largest domestic market for fresh seafood, with throughput of around 16 000 tonnes of seafood a year (table 4). The total value of sales over the period covered by the study ranged from $52 million in 1993-94 to around $62 million in 1995-96. The market mainly handles seafoods from New South Wales but also draws product from all Australian states and New Zealand. It handles around 400 species, of which around 100 are regularly traded. Reflecting Australian fisheries resources, most species are seasonal and generally available in relatively low volumes. Being a fresh market, the Sydney Fish Market has limited provision for carry-over of product, so prices can potentially be relatively volatile.

The market is the cornerstone of New South Wales seafood marketing. Prior to October 1994, the market (operated by the then New South Wales Fish Marketing Authority) was the centre of statutory marketing arrangements which required New South Wales seafood to be marketed through fishing cooperatives, and product sold in Sydney to be offloaded through the Sydney Fish Market unless exemption was given by the marketing authority (see Smith and Reid 1993, pp. 21–39, for a discussion of the regulated system and its impacts). The arrangements did not cover interstate and New Zealand seafoods, and some New South Wales product was also sold outside the regulated market structure.

The statutory marketing requirements for fish caught in New South Wales were overturned in 1994, but removal of these arrangements was to be phased over three years to allow time for the necessary changes in structure and functions of cooperatives. The first stage of deregulation occurred in October 1994, with the dismantling of the authority, the sale of the auction premises and the transfer of selling functions to the Sydney Fish Market (a company jointly owned by tenants of the market and New South Wales commercial fishing operators). The second stage — removing the requirement that all fish caught in New South Wales be sold in a defined market (the Sydney Fish Market or cooperatives) — was due to occur in October 1997 (Crouch 1996) but has not yet been implemented.

The market continues to be regulated while this requirement remains in force, because most product caught in New South Wales continues to be directed through cooperatives and the Sydney Fish Market and fishing operators have few alternative market channels. To offset lower New South Wales landings, the Sydney Fish Market management has actively sought to broaden the

4 Sydney Fish Market: sales of major species

	1992-93		1993-94		1994-95		1995-96	
	weight	price	weight	price	weight	price	weight	price
	t	$/kg	t	$/kg	t	$/kg	t	$/kg
Fish								
Silver bream	371.92	6.22	490.62	5.82	452.51	6.56	416.19	7.21
Snapper	486.47	7.52	345.66	8.58	307.44	8.78	312.29	8.84
Tiger flathead a	1154.96	2.07	986.88	2.28	913.42	2.26	1030.17	2.19
Ling a	302.89	3.88	389.53	3.73	380.35	3.78	559.23	3.70
Yellowfin tuna	327.34	5.68	253.54	8.03	187.91	9.39	291.96	6.73
John dory a	215.02	5.72	358.51	4.69	330.87	5.46	219.14	7.63
Redfish a	1322.44	1.08	1803.10	1.00	1342.87	1.27	1202.59	1.35
Morwong a	642.70	2.25	661.93	2.46	575.39	2.52	537.02	2.66
Kingfish	304.43	4.47	270.81	5.09	254.84	6.12	181.47	6.88
Bully mullet	668.22	1.35	688.96	1.32	655.64	1.45	673.22	1.58
Silver trevally a	530.04	1.47	558.53	1.47	547.21	1.45	618.65	1.76
Ocean perch a	215.86	2.75	299.50	3.03	253.36	3.15	284.33	3.27
Gemfish a	239.23	3.50	206.84	3.79	170.76	4.28	158.13	4.90
Ocean jackets	336.17	2.70	258.65	2.50	253.67	2.77	230.56	3.00
School whiting a	351.70	1.32	283.91	1.65	264.82	1.88	293.71	1.91
Mirror dory a	190.61	2.26	313.77	2.22	257.35	2.37	262.61	2.18
Angel shark	212.90	2.69	185.90	3.17	138.97	3.32	207.87	2.65
Silver warehou a	198.45	1.60	300.82	1.58	359.23	1.40	373.23	1.42
Other	6246.32	2.05	4578.64	3.01	4329.18	3.38	4770.48	3.47
Total fish	14317.65	2.48	13236.08	2.88	11975.82	3.18	12622.87	3.27
Shellfish								
King prawn	303.75	13.42	355.75	15.43	355.50	14.20	403.67	14.36
Octopus	532.99	3.34	588.67	4.13	572.54	4.30	525.17	4.49
Black crab	169.60	11.40	166.25	12.75	133.48	14.30	153.09	13.86
Tiger prawn	89.75	11.83	92.02	12.77	111.41	12.26	119.06	12.83
Blue swimmer crab	219.29	4.93	229.87	5.39	240.47	5.50	241.10	5.60
Lobster, local	40.98	27.54	61.51	30.62	37.34	35.92	35.05	34.86
Balmain bug	65.01	6.50	49.38	8.40	54.29	9.98	93.89	10.00
Calamari squid	148.01	5.75	135.07	5.63	146.87	5.71	137.70	6.29
Royal red prawn a	242.72	3.16	301.08	2.98	248.85	3.72	195.32	4.22
Cuttlefish	249.78	1.34	305.68	1.50	318.53	1.55	314.33	1.89
Seined squid	325.41	1.51	217.72	1.68	171.54	1.76	220.47	1.74
Pippies	94.49	1.67	141.55	2.08	191.48	2.54	216.72	2.75
Prawn, school river	93.59	4.90	21.34	4.91	35.16	5.62	83.37	5.80
School prawn	40.85	6.67	8.52	8.09	20.92	7.36	39.38	7.88
Botany prawn	20.21	12.06	9.58	15.63	9.26	15.19	13.32	12.92
Other	358.91	3.83	251.38	4.69	205.77	5.23	212.52	5.26
Total shellfish	2995.35	5.71	2935.38	6.65	2853.41	6.62	3004.15	6.88
Total	15715.11	3.30	16171.46	3.53	14829.24	3.83	15627.01	3.97

a South east fishery quota species.
Source: Sydney Fish Market.

supply base for the market, with increased interstate and New Zealand product.

The Sydney Fish Market is the central component of the Sydney seafood marketing structure and services different buyer segments (including retail fish shops, restaurants and wholesalers) with fresh (unfrozen) fish and seafood. A 1994 survey of Sydney seafood buyers found that wholesalers purchased 50 per cent of their fish supplies, 15 per cent of crustaceans and 6 per cent of their mollusc supplies from the market. Seafood retailers purchased 72 per cent of their fish, 21 per cent of their crustaceans and 13 per cent of their mollusc supplies from the market directly (Smith, Tran and Ruello 1995). Wholesalers located in the market complex were the second most important source of retailers' seafood supplies after purchases on the market.

The market is based on a Dutch auction using an electronic clock bidding system, introduced in 1989 to replace a voice auction which could not effectively handle the volume of trade. The principle of the Dutch auction is the reverse of a conventional auction, with the auction starting at a price higher than the expected clearing price and decreasing until a buyer makes a bid. On making the bid, the buyer identifies the number of boxes required from the sale lot. The remaining boxes are then returned to the auction and the clock is reset at a price $0.50 a kilogram above the price of the previous lot (or $1.00 for crustaceans). The process restarts until all boxes of the lot are sold.

Fish provide most of the volume of seafood (81 per cent) passing through the market and generate most of the revenue (62 per cent of the total sales revenue in 1995-96). South east fishery quota species form a significant component of total fish supplies on the market, comprising eleven of the top fifteen fish species (ranked in terms of total revenue) in 1995-96 (table 4).

Supplies

The Sydney Fish Market attracts supplies of the fish species from a number of sources (including many outside the south east fishery) that often incorporate different catching and handling methods. It would be desirable to establish the price–quantity relationships for south east fishery production separately from those of other supply sources, but it is not feasible to differentiate the production in the south east fishery and that in adjacent state waters and from other fisheries.

5 Supplies of quota species, by size grade

Average 1992-93 to 1995-96

	Large	Medium	Small	Ungraded	Extra large
	%	%	%	%	%
Blue eye	27.42	13.65	12.07	14.52	32.33
John dory	46.15	27.05	9.78	4.79	12.23
Mirror dory	61.20	16.85	5.61	3.72	12.61
Tiger flathead	24.46	24.12	6.74	6.57	38.10
Gemfish	55.60	18.77	12.24	3.85	9.54
Blue grenadier	32.34	10.90	54.02	1.64	1.10
Ling	35.31	36.81	9.30	2.59	15.98
Ocean perch	39.92	21.08	8.11	3.66	27.24
Redfish	24.87	57.19	3.41	9.15	5.39
Silver trevally	20.66	46.11	10.02	8.13	15.08
Silver warehou	25.89	27.68	12.37	2.23	31.83
School whiting	38.09	31.85	4.99	12.40	12.68
Morwong	40.58	17.07	5.28	2.60	34.47
Blue warehou	29.87	34.76	14.45	2.14	18.78
RR prawns	34.07	49.03	16.91	0.00	0.00

Source: Sydney Fish Market.

6 Price of quota species, by size grade

Average 1992-93 to 1995-96

	Large	Medium	Small	Ungraded	Extra large	Average
	$/kg	$/kg	$/kg	$/kg	$/kg	$/kg
Blue eye	6.69	6.69	6.28	6.07	6.22	6.45
John dory	7.66	5.70	3.69	5.79	7.76	6.20
Mirror dory	3.13	1.78	1.26	2.18	3.08	2.19
Tiger flathead	2.93	2.18	1.68	1.97	3.31	2.23
Gemfish	5.11	4.06	2.42	3.87	4.58	4.37
Blue grenadier	2.97	2.29	1.79	3.25		2.44
Ling	4.67	4.03	3.13	3.71	4.62	3.75
Ocean perch	3.9	2.38	1.46	2.49	4.52	3.23
Redfish	2.02	1.46	0.88	1.36	2.47	1.19
Silver trevally	1.95	1.89	1.41	1.83	1.62	1.65
Silver warehou	1.96	1.71	1.41	1.56	1.51	1.38
School whiting	2.56	1.69	1.1	1.92	3.18	1.83
Morwong	3.05	2.49	2.04	2.72	3.17	3.74
Blue warehou	2.66	2.05	1.41	2.03	2.39	2.54
RR prawns	4.31	2.88	1.79			1.90

Source: Sydney Fish Market.

Often not only the species is important to buyers, but also other factors such as size grade and product form. The Sydney Fish Market has an operational standard product size grading system that covers 28 of the more important species. This size grading system is based on *small*, *medium*, *large* and *extra large* categories, established on the length of some fish and crab species and on the weight of prawns and rock lobster. All of the quota species from the south east fishery are sold on a size grade system (although there is provision to sell ungraded product for each species). The size composition of south east fishery quota species supplied to the Sydney Fish Market over the period of the study is shown in table 5; average prices, by grade, over the four years are shown in table 6.

Both supplies and prices fluctuate significantly over the year for a number of the south east fishery quota species. As previously discussed, catches of several of the quota species sold on the Sydney Fish Market are highly seasonal, which is reflected in both prices and volumes sold on the market. Comparing the monthly variability of south east fishery catches with the variability of supplies on the Sydney Fish Market showed that the latter was more variable, suggesting that other, smaller (and presumably more profitable) markets were supplied first. Those quota species shown to have the greatest variability in catches also showed the greatest variability in prices received.

There were also differences in the form of the product sold on the Sydney Fish Market, which must be taken into account because yield differences are involved. Most of the south east fishery quota species were sold whole, except gemfish (65 per cent sold whole, 16 per cent gutted with head off; 7 per cent gutted only) and blue eye (21 per cent sold whole; 52 per cent sold gutted with head off).

3 Approach

There are different methods available for examining the relationships between production volume and prices. The general form of any demand relationship is generally the quantity demanded of a product expressed as a function of its own price (expected to be a negative relationship), the prices of competing products (positive relationships), complementary products (negative relationships) and income (positive relationship unless the product is an inferior good).

The objective of establishing the demand relationship is to determine the quantity demanded at each price level. The standard Marshallian demand function expresses the quantity of a product demanded as a function of prices and income:

$$q_i = f(p_i, p_s, p_c, y)$$

where q_i is the quantity of product i demanded in the period; p_i is the price of product i; p_s is prices of all substitute products; p_c is prices of all complementary products; and y is total income or expenditure, which is subject to a budget constraint.

Demand elasticities derived from these models measure the quantity changes associated with changing prices and incomes.

Standard demand models are also based on a range of assumptions, including the homogeneity of products and a well defined set of consumer preferences. Fish products are not homogeneous. Within a species sold there are important differences in size and presumably in quality. Further, buyers may have a defined set of preferences over a limited range of products that may vary from a market's supply of many different species of seafood in widely different volumes over the period. However, it is more likely that buyers demand different generic types of product (such as table fish, filleting fish and so on). The demand for different species of fish within those generic types is likely to involve a range of tradeoffs between characteristics and prices.

One approach to including product characteristics in demand analysis is the hedonic method. The market price can be thought of as the sum of values of the attributes contained in the product. Thus the value of the individual attributes can be established by examining products that have different combinations of attributes. The market price of a commodity may be regressed on its size, shape, maturity and blemishes, for example, by the equation:

$$P = \pi_0 + \pi_1 X_1 + \pi_2 X_2 + \pi_3 X_3 + \ldots + \pi_n X_n + e$$

where p is the price of the commodity; π_i is the implicit value of attribute X_i in the commodity; and e is a random error term.

The hedonic approach is a useful means of addressing the relationships between seafood quality and price. However, to apply the approach to the Sydney Fish Market, other problems needed to be overcome: first, the absence of a means of measuring seafood quality was addressed by developing quality criteria for a sample of seafood types (see appendix A); second, these criteria needed to be applied to fish supplied to the market so a limited number of species on the market were surveyed over a twelve month period; and third, the effect of changes in supply and demand on market prices needed to be established before the impact of quality factors could be evaluated.

The general form of the model developed to explain prices at the Sydney Fish Market combined both the Marshallian and hedonic approaches. The approach taken in this study was to estimate a separate demand equation for each fish species. Prices for a particular species on the market on a day were expected to be a function of a combination of market factors (such as the number of buyers at the market), volume factors (such as the amount of the target species and substitute products for sale) and the quality of those fish — that is:

$$Ps = \alpha + \beta\,(\text{market demand factors}) + \gamma\,(\text{supply factors}) + \delta\,(\text{quality factors}) + \varepsilon$$

where Ps was the average daily price of the species being examined on each sale over the period examined; the coefficient β corresponds to the impact of demand factors (such as the number of buyers operating and day of the week) on price levels; the coefficient γ corresponds to the species' own-price–quantity relationship and to that with other species; and the coefficient δ corresponds to the relationships between prices and quality factors for each species (most quality factors are category related, so a coefficient from the

group would be interpreted as the price differential for membership of a given class of the corresponding quality factor).

There are constraints to examining the impact of supply changes and quality factors in one model. Market factors and supply factors are appropriate to explaining the differences in daily average prices for each of the species. However, in establishing the importance of quality differences in determining prices, the main focus is on differences in prices between sales within a day. Quality factors in aggregate may vary over time and thus have some impact on average prices over that period, but the main impact of interest is their importance in explaining the variation in prices received on any day. Moreover, quality information was collected on only a sample of the Sydney Fish Market throughput, covering only one year in comparison to the four years used in establishing the impact of supply changes. Accordingly, analysis of the contribution of quality factors to prices was undertaken separately (chapter 5).

Selection of variables

For the first stage of the analysis, to establish the impact of volume on average daily prices for south east fishery quota species at the Sydney Fish Market, the model used was restricted to:

$$Ps = \alpha + \beta\,(\text{market factors}) + \gamma(\text{supply factors}) + \varepsilon$$

In selecting the variables for inclusion in each group, considerations included:

Market factors

- ***Number of buyers*** participating in the sale. It was expected that there would be a positive relationship between the number of buyers participating in the sale and the average prices for the species.

- ***Type of buyer***, identified on the basis of main activity to evaluate whether the number of buyers or the concentration of activities was important. Five types of activity were identified from the list of the main buyers active over the period — wholesalers, wholesalers/retailers (where the buyer undertook both activities), retailers, restaurateurs and unspecified. Wholesalers were identified as the major buyers of the south east fishery quota species at the market.

- ***Day of the week***, which was expected to reflect differences in daily retail demand. Sydney Fish Market is a fresh fish market so it was expected that demand would be stronger over the latter part of the week (because retailers cater for weekend trade) and at the beginning of the week (to replenish stocks for that week).

- ***Seasonal impact.*** Both demand and supply are expected to be seasonal. Supplies of many fish species have demonstrated seasonality; for those species that have strong seasonality in landings, the responsiveness of prices to changes in volume would be expected to be quite different for peak than for offpeak seasons. (For seasonal species, the analysis was undertaken separately for peak and offpeak seasons as well as in aggregate.)

Supply factors

- ***Total weight of the quota species***. The analysis was undertaken only on those species of fish for which the Sydney Fish Market was an important outlet for catches from the fishery. Consequently, sales of orange roughy or blue grenadier were not analysed.

  Because the objective in the model is to establish the responsiveness of prices to a change in the volume sold, the appropriate measure of this change is the price flexibility. An own-price flexibility is the change in the price of a commodity resulting from an isolated 1 per cent change in the quantity sold of that commodity (other factors held constant) — that is:

$$Fs = \Delta Ps/\Delta Qs)*(Qs/Ps)$$

  where Fs is the price flexibility of species s, ΔPs is the change in price, ΔQs the change in volume of the species, Qs is the quantity, and Ps the price.

  Examination of the relationships between price and quantity of the quota species showed that an improvement in fit was gained for some species if a quadratic form was used instead of a linear relationship. In these cases both the weight and the square of the weight of the quota species was used in modeling.

- ***Size grades of the quota species***. The relationship between price and the size grade is important for some species because prices differ between grades (see table 6, chapter 2). The factors influencing the establishment

of prices for those different grades could also be expected to be different, reflecting both supply and demand factors. The differences in market response to volume changes for different size grades are potentially important from a fisheries management perspective, given the relationships between size grade and the age of fish.

The size grades used in the analysis were those nominated by suppliers as the basis for sale. While this study has established, for a significant number of the species assessed, that the nominated size grades deviated significantly from the true size composition (see chapter 5), the price analysis could not account for the 'true' grade. Buyers can assess the size composition of catches in particular lots to account for incorrect grading and adjust their bids accordingly. The auctioneer may also comment on the actual size composition of fish within a lot when there are significant deviations from the size grade nominated by the supplier. These discrepancies will be a source of error in the analysis.

- ***Process***. While most species were sold in a range of forms (such as whole, headed and gutted, or filleted), generally only the dominant form was used in the analysis. Supplies of two quota species (blue eye and gemfish) were relatively evenly split between whole and headed and gutted. Both forms were included in the analysis.

- ***Stock carryover***. There is only limited provision for carryover of stock from one sale to the next. Over the four years covered by the data, only 0.7 per cent of total sales of south east fishery quota species involved product carried over from earlier sales. These sales mainly involved redfish (3.3 per cent of total sales) and silver warehou (1.1 per cent), which are both subject to high seasonality of catches and variation in the daily volume sold.

  Any short term adjustment of stocks in response to high market supplies on particular days is more likely at the wholesale or retail levels, and may involve purchasing higher than usual volumes of a species that may be available in abundance (at relatively lower prices) on one day and staying out of the market until those stocks are sold. This could be expected to result in disturbances to prices on days subsequent to large volume sales, such that prices do not improve even if supplies of the species were lower because there is a lack of buyer interest. However, these adjustments are likely to be small because the product is sold unfrozen and most buyers have limited abilities to hold stocks.

Given these factors, the weight of the species sold on previous days of the week was incorporated in the model. This was achieved by including the two previous days for trading on Wednesday, Thursday and Friday, Monday's trading on Tuesday and no carryover on Mondays.

- ***Substitute and complementary species***. A change in the daily volume of one fish species (the target species) could be expected to have three different types of impact. The first impact is the ***own-price effect***: a change in daily volume would be expected to change the price needed to clear supplies of the target species. The second impact is the ***cross-price effect***: the change in price of the target species would be expected to change the demand for some other species on the market. Given that the model is structured in terms of the price flexibilities (the response in price to a change in quantity sold) the appropriate definition of a cross-price–quantity relationship is:

$$F_{ij} = (\Delta P_i / \Delta Q_j)^*(Q_j/P_i) \neq 0$$

where F_{ij} is the cross-price flexibility between the target species i and other species j.

A cross-price–quantity relationship may be positive or negative. A negative value indicates a substitute relationship, where the falling price of the target species (i) is linked with the increasing volume of the other species (j). A positive cross-price flexibility value indicates a complementary relationship, where the increasing volume of the other species is linked with the rising price of the target species (i). A zero cross-price relationship indicates that the demand for the commodities is independent (Eales and Unnevehr 1993).

The third impact is the ***expenditure effect***. A change in price of one species may also have an impact on the buyers' expenditure on other seafood. A fall in prices, other things being equal, would reduce buyers' total expenditure on seafood. However, all or part of that saving could be spent either on more of the species whose price has fallen or other products. As a result, a price change in one commodity may alter expenditure on others, even when those products are not technical substitutes.

The importance of expenditure effects depends on the size of spending on the commodity relative to total expenditure (Tomek and Robinson 1977). While south east trawl product constitutes a significant proportion of

buyers' total seafood expenditure at the Sydney Fish Market (table 4), buyers' total expenditure on *all* seafood from all sources is unknown. It is not possible to assess expenditure effects without this information on total seafood expenditure.

Substitute species

In undertaking the analysis of the target species, the only close substitutes included were other grades of the same species and 'technical' substitutes — that is, those species that would be used if the target species were not available. Details of these species were obtained from buyers operating on the market.

Given the large number of species sold at the market, a range of price relationships between species was expected. While techniques have been used to establish such relationships (see, for example, Gordon et al. 1994), these involved a limited number of species. The Sydney Fish Market trades in a large number of species, so such approaches were beyond the scope of this study. Other techniques, including factor analysis, were used to identify the wider relationships between different species but did not provide useful results that could be incorporated in the model.

Relationships with other markets

An important assumption is that the demand for fresh fish at the Sydney Fish Market is independent of the demand for other products (such as meats), or other seafood product forms (such as frozen imported fish and fresh fish bought at other locations).

No close relationships with other meats were apparent in an earlier aggregate model developed to examine price formation for fish and shellfish at the Sydney Fish Market (Pascoe, Geen and Smith 1987). That study used monthly data (from January 1980 to June 1986) on aggregate quantities and prices of fish and shellfish at the market, supplies of imported fish, prices of meats and income to establish the prices of fish and shellfish. The study found only the volumes of fish and shellfish on the market to be significant determinants of fish prices at the market. The demand for fish was found to be relatively flexible with respect to volume changes, with a 1 per cent change in quantity leading to a –0.54 per cent change in prices.

Shellfish prices were found to be influenced by a greater range of factors, including the quantities of both fish and shellfish sold at the market, the volume of imports, the prices of beef and poultry, and seasonal influences. In aggregate, fish and shellfish were found to be complements, a potentially reasonable finding given that a number of shellfish, particularly prawns, are marketed as product leaders (used to attract custom to the outlet). However, the results were likely to have been influenced by problems with the model, including simultaneity between domestic fish prices and imports, multicollinearity between variables, and issues of model specification resulting from the use of highly aggregated data.

Potential relationships between prices at the Sydney Fish Market and imports are likely to have changed between the two studies. New Zealand exports of chilled (as opposed to frozen) fish to Australia have increased in importance, with the main exports being sent to Sydney and Melbourne. The links between Australian and New Zealand seafood companies have also strengthened over recent years, and an increasing volume of supply of New Zealand product that is comparable with several south east fishery species may influence Sydney Fish Market prices. These links, and those of interstate products traded outside the market, were not examined in this study. However, they are more likely to influence the general levels for seafoods than to have specific and direct influence on the daily prices formed on the market.

Prices formed at the Sydney Fish Market are likely to be interdependent with those of other wholesalers (traders who purchase fish for resale to other sellers such as retail shops and restaurants), of whom several have seafood outlets at the market site. Over the period covered by the data, wholesalers purchased approximately 33 per cent of the total supplies of south east fishery quota species sold at the Sydney Fish Market. This would suggest, for some species, that auction prices influence prices set by these wholesalers rather than vice versa. For other species, such as john and mirror dory and blue eye trevalla, the volume of trade through wholesalers is much greater than that sold at the Sydney Fish Market and prices are more influenced by external factors.

Form of the model

The general form of the demand model used, expressed in its inverse (price flexibilities) form was:

$$P_{s,g,p,d} = f_{s(d)}\,(W_{s,g,p,d}, W_{s,g,p,d-1}, W_{s,g,p,d-2}, W_{s,p,d}, W_{s,d}, W_{sub(1),d}, \ldots, W_{sub(n),d}, Mon(d), \ldots, Fri(d), B_{s,g,p,d})$$

where:

$P_{s,g,p,d}$	is the average sale price on day d of species s, size grade g;
$f_{s(d)}(\ldots)$	indicates that the equations are to be found separately for peak and nonpeak seasons (if seasonality is indicated in the volumes brought to market);
$W_{s,g,p,d}$, $W_{s,g,p,d-1}$, $W_{s,g,p,d-2}$	denote the weights of the product composed of species s, size grade g subjected to process p,which were sold on the market on days d, d–1 and d–2 respectively;
$W_{s,p,d}$	denotes the total weight of species s, subjected to process p which was sold on the market on day d;
$W_{s,d}$	denotes the total weight of species s which was sold on the market on day d;
$W_{sub(1),d}$,..., $W_{sub(n),d}$	denotes the total weight of identified substitute species $sub(1)$, ..., $sub(n)$ that were sold on the market on day d;
Mon(d), ..., Fri(d)	denote 0/1 dummy variables indicating whether day d was a Monday, Tuesday, and so on; and
$B_{s,g,p,d}$	denotes the number of buyers of the product composed of species s, size grade g subjected to process p, who purchased some of that product on day d.

All regressions were undertaken in logarithmic form to help calculate the relevant variables. The form of the model is:

$$\begin{aligned}\ln(P_{s,g,p,d}) = \alpha + \beta \ln(W_{s,g,p,d}) + \gamma\left[\ln(W_{s,g,p,d})\right]^2 + \varepsilon_1 \ln(W_{s,g,p,d-1})^* \\ + \varepsilon_2 \ln(W_{s,g,p,d-2})^* + \phi_1 \ln(W_{s,p,d} - W_{s,g,p,d}) \\ + \phi_2 \ln(W_{s,d} - W_{s,p,d}) + \sum_{j=1}^{n} \lambda_j \ln(W_{sub(j),d}) + \kappa_1 Mon(d) \\ + \kappa_2 Tue(d) + \kappa_3 Thu(d) + \kappa_4 Fri(d) + \nu \ln(B_{s,g,p,d})\end{aligned}$$

$\ln(W_{s,g,p,d-1})^*$ and $\ln(W_{s,g,p,d-2})^*$ will take the values $\ln(W_{s,g,p,d-1})$ and $\ln(W_{s,g,p,d-2})$ respectively unless the relevant trading days occur in the preceding week, when they will be given the value zero.

4

Price–volume relationships for south east trawl species on the Sydney Fish Market

In identifying the price–volume relationships for south east trawl species on the basis of sales at the Sydney Fish Market, several considerations can influence both the approaches used and the interpretation of results. The demand for particular species or types of fish is not set in isolation from the prices of other seafoods in Australia or overseas, which in turn are influenced by factors such as the prices of other foods and income levels.

The relationships between different markets for the same fish species are important in establishing demand relationships, as are the relationships between different fish species. The Sydney Fish Market is the largest of several physical markets for fish, but it is only one of many potential channels between producers and consumers. The market is the main outlet for only some of the quota species from the south east fishery, generally those caught by the inshore and Danish seine sectors. It is one of several markets available for a range of species, while for others, such as orange roughy and blue grenadier, it is a very minor market. Similarly, buyers operating on the Sydney Fish Market have a wide choice of suppliers, so their purchases do not represent their total demand for fish.

The model outlined in chapter 3 was applied to average daily prices (over the period April 1992 to March 1996) for each of the quota species to identify the relationships between average daily prices and the volume related variables. The price flexibilities were then identified through the model coefficients. The analysis was based on total supplies irrespective of fishery and average daily prices of each species, and was undertaken using ordinary least squares regressions in logarithmic form.

Species price–volume relationships

The relationships between average daily prices and the volume related factors used in the models varied widely between the species (table 7). The variables explained between 40 per cent and 60 per cent (indicated by the R^2 row in table 7) of the variation (in logarithms) of average daily price for redfish, silver trevally, john dory, morwong, flathead and school whiting,

but fell to around 10 per cent for ocean perch, gemfish and blue warehou and lower for mirror dory.

The use of daily price and quantity information strongly influenced the aggregate fit achieved between the variables. As discussed in chapter 2, daily supplies varied widely, so prices for a specific volume were within a relatively wide band.

The Sydney Fish Market is not a major marketing channel for several of the south east trawl quota species. Sales of blue warehou on the Sydney Fish Market averaged 75 tonnes over the period, for example, but this amount was less than 10 per cent of average south east fishery catch (781 tonnes caught, mainly by the offshore sector). Trawl catches of blue eye are only a relatively minor source of aggregate supplies, much of which is sold through

7 Price–volume relationships: south east fishery quota species

	Blue eye	Silver trevally	Ling	Morwong	Blue warehou
Intercept	1.983 (0.088)	2.427 (0.103)	1.439 (0.081)	1.68 (0.113)	1.083 (0.06)
Log (weight of fish)	0.059 (0.033)		0.228 (0.025)	0.089 (0.033)	
Log (weight of fish)^2	−0.008 (0.004)	−0.027 (0.002)	−0.018 (0.002)	−0.021 (0.002)	
Log (weight lagged 1 day)		−0.102 (0.01)	−0.05 (0.004)	−0.057 (0.005)	−0.021 (0.01)
Log (weight lagged 2 days)		−0.074 (0.011)	−0.028 (0.004)	−0.038 (0.006)	−0.014 (0.01)
Log (total weight / day)	−0.031 (0.004)	−0.018 (0.003)			
Number of buyers		0.258 (0.033)	−0.083 (0.019)	0.106 (0.025)	
Log (weight of substitute species)	−0.026 (0.008)	−0.016 (0.008)		0.021 (0.006)	−0.045 (0.01)
Monday		−1.162 (0.091)	−0.44 (0.039)	−0.577 (0.054)	
Tuesday		−0.518 (0.082)	−0.149 (0.033)	−0.228 (0.046)	
Thursday					0.117 (0.05)
Friday		0.125 (0.023)			
R^2	0.125	0.49	0.381	0.414	0.101
No. of observations	746	1 152	1 089	1 133	545

Continued

7 Price–volume relationships: south east fishery quota species *continued*

	Redfish		Redspot whiting		Silver warehou		Tiger flathead	
Intercept	2.137	(0.085)	2.01	(0.086)	1.008	(0.177)	2.596	(0.112)
Log (weight of fish)					0.232	(0.057)		
Log (weight of fish)^2	−0.028	(0.001)	−0.034	(0.002)	−0.04	(0.005)	−0.022	(0.001)
Log (weight lagged 1 day)	−0.083	(0.007)	−0.095	(0.009)	−0.054	(0.009)	−0.097	(0.01)
Log (weight lagged 2 days)	−0.060	(0.007)	−0.046	(0.01)	−0.044	(0.009)	−0.061	(0.01)
Number of buyers	0.375	(0.022)	0.339	(0.031)	0.205	(0.03)	0.313	(0.032)
Log (weight of substitute species)	−0.032	(0.008)			−0.037	(0.004)	−0.044	(0.005)
Log (weight of substitute species)^2	0.008	(0.004)					−0.008	(0.004)
Monday	−1.073	(0.074)	−0.927	(0.085)	−0.424	(0.078)	−1.091	(0.103)
Tuesday	−0.443	(0.065)	−0.290	(0.072)	−0.237	(0.07)	−0.421	(0.086)
Thursday	−0.053	(0.021)	0.081	(0.023)			−0.044	(0.021)
R^2	0.562		0.405		0.398		0.408	
No. of observations	1 137		1 143		886		1 147	

	Ocean perch		Gemfish		Mirror dory		John dory	
Intercept	1.140	(0.156)	1.077	(0.134)	1.091	(0.061)	0.578	(0.213)
Log (weight of fish)	0.276	(0.049)	0.178	(0.049)			0.914	(0.064)
Log (weight of fish)^2	−0.024	(0.004)	−0.035	(0.004)			−0.052	(0.005)
Log (weight lagged 1 day)	−0.073	(0.008)	−0.007	(0.004)	−0.035	(0.01)	−0.079	(0.01)
Log (weight lagged 2 days)	−0.030	(0.009)					−0.056	(0.01)
Number of buyers			0.260	(0.035)			−0.554	(0.034)
Log (weight of substitute species)			−0.009	(0.004)				
Monday	−0.621	(0.071)			−0.175	(0.067)	−0.810	(0.085)
Tuesday	−0.153	(0.061)					−0.319	(0.073)
Friday							0.053	(0.022)
R^2	0.139		0.116		0.014		0.442	
No. of observations	1 112		899		1 084		1 149	

Note: Figures in pare theses are standard errors, expressed as percentages of the estimates. In general, the smaller the standard error relative to the estimate, the more reliable that estimate.

wholesalers. There are also significant imports of blue eye, john dory and morwong sourced from New Zealand and sold fresh in Sydney.

Several of the species where a poor fit was achieved (mirror dory and gemfish) are sold mainly through the Sydney Fish Market. Average annual sales of mirror dory were around 256 tonnes over the period, and the south east fishery was a major supplier, with average catches of 308 tonnes (two-thirds of which went through cooperatives, traditionally the main suppliers to the Sydney Fish Market). Further analysis (discussed later in this chapter) revealed that the lack of a relationship between prices and quantities may occur because the use of aggregate supplies and prices of a species is not appropriate when there are major differences in price–quantity relationships for different size grades of the same species. Similarly, some products (such as gemfish) are sold in two product forms (whole and headed), which may have reduced the relationships for each.

While only a low proportion of the total price variation was linked to volume changes for some species, the aggregate relationships established between volume factors and prices generally met prior expectations. Volume on the day had a negative impact on prices in aggregate (allowing for the quadratic form used for most relationships), but this relationship varied (as demonstrated by the high standard errors for the own weight variables for several of the species).

Prices in aggregate for mirror dory and blue warehou were not found to be significantly influenced by the volume sold on that day. Moreover, only a weak relationship was found between prices for these species and the weight sold on the previous day. A positive relationship existed between volume and average daily price for john dory over most of the range of volumes sold at the market (although a negative relationship was found for higher volumes).

Prices for all species except blue eye were also influenced by the volume sold on previous days. Except for gemfish and mirror dory, the impact was over two days, with the sales volume on the previous day having a considerably stronger impact on current prices than for two days earlier. The impact of sales on the previous days was particularly strong for the high volume species (redfish, redspot whiting, flathead and silver trevally). This was to be expected, given that the market mainly sells fresh product in relatively small volumes to buyers with limited abilities to hold stocks.

While the level of supplies had the largest impact on prices, other influences were significant. The day of the week was important for eleven of the thirteen species, with the average prices on Mondays below those of Wednesdays (the benchmark used in the analysis); a premium existed for Friday trading for only two species. The species nominated as technical substitutes were significant in only seven cases, while a complementary relationship (a positive coefficient between the price of the quota species and the weight of the other species) was found in a further two cases.

A positive relationship existed between price and the number of buyers participating at the sale for seven of the thirteen species examined (although negative associations were shown for ling and john dory). However, for most species, a large increase in the number of buyers is required to effect a significant increase in prices. A significant relationship was found for the major high volume species (redfish, school whiting, silver trevally, morwong, silver warehou, flathead and gemfish).

Aggregate price flexibilities

For most of the species examined, a quadratic relationship, log (price) as a function of log (volume) and log (volume) squared, was found to provide a better fit than that provided by a simple linear price–volume relationship. As a result, the price flexibility for a species (the change in price associated with a 1 per cent change in volume supplied) was not constant, but varied according to the volume sold on the market.

To relate price flexibilities for each species to the volumes likely to be experienced under different trading conditions, days were ranked from low to high according to the daily throughput for each of the species over the study period. An average supply day was defined as one on which the median (or middle) volume of that species was traded; a low supply day was defined as one on which the volume traded was the lowest 25 per cent of daily volumes experienced over the four years; and a high supply day was the highest 25 per cent. The expected price and the price flexibilities associated with these volumes were then identified. The volume, expected price and the price flexibilities for average volume days for each quota species are shown in table 8. The price flexibilities for average, high and low volume days for each species are shown in appendix C.

The price flexibilities shown estimate the change in price in response to a change in volume spread equally on a day and the previous two days. The

8 Price flexibilities for south east fishery quota species

	Median daily volume	Average price at median volume	Price flexibility a	
	kg	$/kg	%	
Redfish	4 324	1.34	–0.61	(3)
School whiting	1 058	1.90	–0.61	(5)
Silver trevally	1 498	1.51	–0.57	(5)
Tiger flathead	3 337	2.60	–0.52	(5)
Morwong	1 730	2.94	–0.31	(12)
Silver warehou	960	2.02	–0.41	(16)
Blue warehou	365	2.01	–0.04	(20)
Gemfish	348	4.69	–0.23	(22)
Ling	1 001	4.13	–0.10	(28)
Ocean perch	803	3.60	–0.16	(35)
Mirror dory	578	2.86	–0.04	(27)
John dory	870	6.93	0.08	(88)
Blue eye	147	5.91	–0.03	(149)

a Change in price in response to a 1 per cent change in volume.
Note: Figures in parentheses are relative standard errors, expressed as percentages of the estimates.

median daily volume of redfish traded over the period examined, for example, was 4324 kilograms with an average price of $1.34 a kilogram over all days where supply was around this level. If the volume was increased by an additional 10 per cent on such a day and on the preceding two days, then the price would be expected to fall by 6.1 per cent to around $1.28 a kilogram.

The price flexibilities for the high volume species (redfish, school whiting, silver trevally and tiger flathead) were relatively high (between –0.5 and –0.6 for an average day) and relatively robust, with low associated standard errors. Prices response to a change in volume was greater on high sale days, with the price flexibility associated with redfish being around –0.64 per cent (compared with –0.61 for average volumes), with similar increases found for the other species.

The relatively high price flexibilities found for these species have important ramifications for management of the fishery. If total allowable catches were an effective constraint on catches of those species (they are not for most quota species), then changes in prices received would partly offset the impact of any changes in total allowable catches on industry revenue.

A range of other species were found to have very low price flexibilities, indicating that supplies on the market could be increased considerably before having a large impact on prices. This is consistent with prices being largely formed outside the market. Ling was a relatively high volume species (with sales averaging 1000 kilograms a day), for example, where the average price flexibility was around 10 per cent. However, the standard errors associated with the price flexibility estimates for some species (such as ling, blue eye and ocean perch) are relatively high, indicating that the relationships between aggregate price and quantity are not robust, particularly at low volumes. Prices fluctuate more at low volumes, depending on other factors such as the total volume of all fish on the market floor.

Most of the species affected were also sold through a number of market channels, so the price–quantity relationships found on the Sydney Fish Market are also likely to be influenced by the selling strategies of sellers. If the auction is used as the marginal market, supplied after other markets (that yield higher net returns to fishing operators) are met, then supplies to the Sydney Fish Market and prices will be more volatile.

Price–volume relationships, by species and grade

The use of aggregate prices and volumes to establish price–quantity relationships ignores the impact of size grades on price. There are often large differences in demand and prices received for the different size grades of the same species (table 6). Identification of the underlying price relationships by grade removes most of the fluctuations in prices resulting from changes in the size distribution. Not all of these fluctuations are removed because a significant proportion of many species is sold either ungraded or where the grade is not identified, and because there can be significant misclassification of size grades (discussed in chapter 5).

To examine these issues, price–quantity relationships were identified for each size 'grade' (ungraded, small, medium, large and extra large) of the quota species. For those species which exhibited high seasonality in catching, price relationships in the peak and nonpeak supply periods were also examined to establish whether any fundamental differences existed in demand between seasons. The analyses used the same techniques as those reported earlier for aggregate catches, and the results for redfish are reported in appendix B.

Identification of the price–quantity relationships for the quota species on the basis of their size grades improved the fit for around half the species. For

most species, the most consistent relationship between price and quantity was obtained for product graded large, and this deteriorated for those size grades that had wider size specifications (particularly small, ungraded and unspecified). The more robust relationships at the Sydney Fish Market — based on the number of days traded, the fit of the model and the standard errors for the price flexibility estimates — are summarised in table 9.

Disaggregation of total sales into grades also addressed the problem of the poor aggregate relationship between average daily price and total volume traded for a number of the species discussed earlier. There was a relatively

9 Price flexibilities of selected quota species, by grade

	Grade	Number of days traded	R^2	Median volume	Average price a	Price flexibility b	
				kg	$/kg	%	%
Redfish	ungraded	713	0.33	122	1.38	–0.10	(20)
	large	1 094	0.68	684	2.01	–0.36	(10)
	medium	1 078	0.50	1 882	1.32	–0.39	(10)
	unspecified	1 089	0.41	702	0.84	–0.28	(20)
	extra large	817	0.40	128	2.55	–0.24	(10)
School whiting	large	1 062	0.37	266	2.65	–0.34	(20)
	medium	941	0.27	234	1.76	–0.23	(10)
	unspecified	1 044	0.25	378	1.65	–0.40	(20)
	extra large	670	0.38	78	3.52	–0.19	(30)
Tiger flathead	large	1 119	0.38	613	2.98	–0.26	(30)
	medium	1 113	0.39	592	1.99	–0.33	(10)
	unspecified	819	0.37	632	1.77	–0.38	(10)
	extra large	1 109	0.48	736	3.14	–0.33	(10)
Silver trevally	large	791	0.32	148	1.81	–0.24	(20)
	medium	928	0.26	347	1.59	–0.24	(10)
	unspecified	1 044	0.40	654	1.60	–0.43	(10)
Gemfish	large	473	0.41	159	4.72	–0.13	(20)
	medium	455	0.21	83	3.68	–0.11	(20)
Ling	large	1 010	0.48	310	4.82	–0.11	(20)
Ocean perch	large	1 053	0.41	259	4.00	–0.18	(20)
Morwong	large	1 010	0.43	601	3.04	–0.26	(20)
	extra large	754	0.40	397	3.27	0.21	(20)
	unspecified	988	0.33	338	2.53	–0.28	(10)
Silver warehou	medium	603	0.36	514	1.75	–0.25	(10)
John dory	unspecified	1 038	0.31	77	4.19	–0.29	(10)
Mirror dory	large	948	0.49	289	3.39	–0.08	(30)

a Average price for the median volume shown. **b** Change in price in response to a 1 per cent change in volume.
Note: Figures in parentheses are relative standard errors, expressed as percentages of estimates, and rounded to the nearest 10 per cent.

strong relationship between price and quantity of large mirror dory (with R^2 of 0.49), for example, indicating that combining the grades had an important impact on the aggregate fit. Similar improvements in fit were achieved for large whole gemfish (R^2 of 0.41 compared with R^2 of 0.12 for all grades) and large ocean perch (R^2 of 0.41 compared with R^2 of 0.14 for all grades).

As with the aggregate price flexibilities, the analysis of Sydney Fish Market prices by grade provided better estimates the relationships for the main high volume species caught by the inshore sector of the south east fishery. While improved estimates were derived for ling and for gemfish, the latter were traded on only a limited number of days (consistent with the reduction of total allowable catches in the eastern sector of the fishery). No robust estimates of the price flexibilities for blue eye or blue warehou were generated, while the price flexibilities for most grades of john dory were associated with high standard errors (again consistent with prices being influenced by factors external to the Sydney Fish Market).

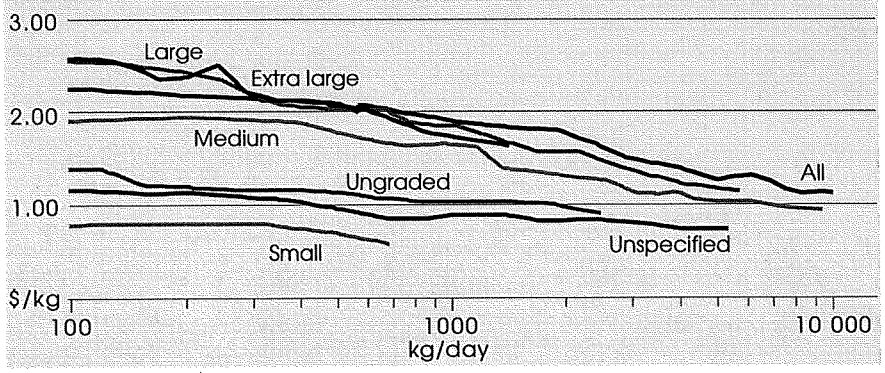
Both the proportion of catch in each grade and the price–quantity relationships between different grades are directly relevant to fisheries management, because the size distribution of catches can have a major impact on the total revenue from the fishery. The relationships also underpin a number of fisheries management problems experienced in the south east fishery. Given that these problems mainly relate to the inshore sector of the fishery, the grade relationships for the main high volume species were analysed.

Redfish

Redfish was the most important high volume species sold on the Sydney Fish Market, representing almost 11 per cent of fish sold in the study period. Most redfish sales were in medium and large grades, or where the grade was unspecified. Average daily prices by grade during the study ranged from over $2 a kilogram for large and extra large product to around $1 for unspecified product size and less for small product.

For all redfish grades, except small, the volume of the grade on the day was the most important factor influencing the price. There was a strong relationship between price and volume factors, particularly for large and medium grades, which together with unspecified were the major categories traded. The price flexibilities for the three key grades were found to be similar, at around –0.36 to –0.39 for average daily volumes. By comparison, prices for

E Redfish: average daily demand, Sydney Fish Market, by grade



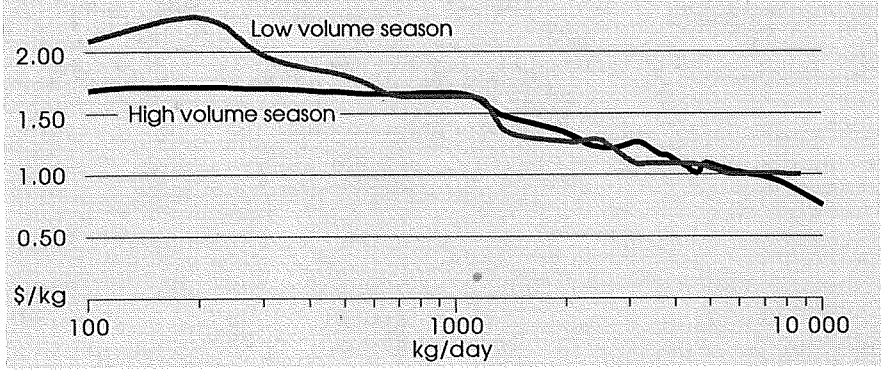
the minor categories in terms of the volume sold were all relatively inflexible over the limited range of volume sold, with changes in volume associated with only small price changes (figure E).

The other key volume factor influencing prices for redfish was the total volume of other grades of redfish on the day. The impact of total volume was less for large grades than for other grades. Similarly, while redfish prices were influenced by the number of buyers active on the market floor, prices for large redfish were less affected by a change in buyer numbers than were other grades. There was also a large discount associated with redfish sold on Mondays for most grades (using Wednesday as the benchmark for day effects). Tuesdays had a premium for large redfish but a discount for other grades.

For small redfish, the major factors determining the price were the weight of other sizes of redfish sold on the day and the weight of small redfish sold on the previous day. As a result, only a low price flexibility was found. Demand for small redfish was found to be residual to all other grades, with low demand if there are adequate supplies of other grades.

To assess the impact of seasonal factors, separate regressions were also undertaken for the peak (August–November) and nonpeak seasons for each of the grades (appendix B). Price was found to be more responsive to changes in supplies in the peak season at low volumes, while similar relationships were found for both seasons over much of the range of supplies (as illustrated in figure F which shows peak and offpeak price–quantity relationships for medium redfish).

F **Seasonal demand for medium size redfish**



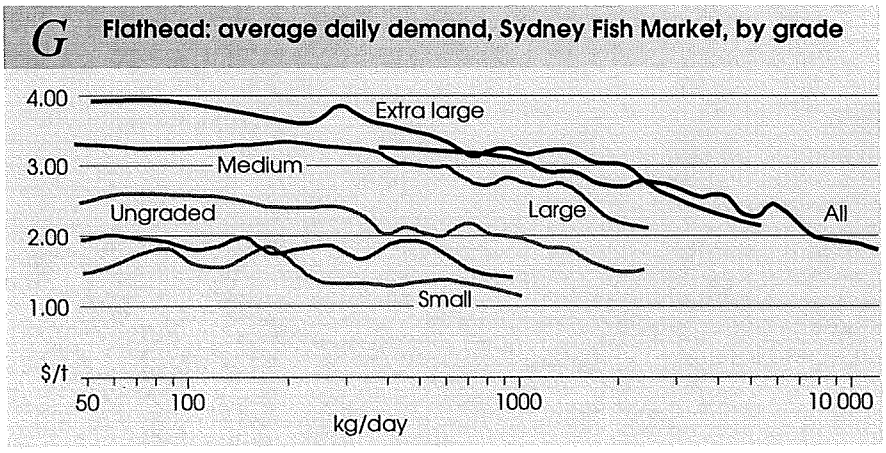
While the same factors were generally found to be important determinants of redfish prices in both periods, there were some differences. The number of active buyers had a stronger impact on prices in the peak season than in the offpeak period. The impact of previous sales on prices was only marginally stronger in the peak supply period for most grades.

Tiger flathead

Tiger flathead was the second most common fish species (after redfish) sold at the Sydney Fish Market, accounting for 7.8 per cent of all fish sold in the study period. Aggregate prices were found to be relatively flexible in relation to changes in volume, averaging –0.52 per cent +/– 0.03 per cent for high and low sales. The price flexibilities for the individual grades were lower, with medium and extra large grades averaging a price flexibility of –0.33 per cent and the large grade averaging –0.26 per cent.

There was less improvement in the relationships obtained by using different size grades for flathead compared with the improvements for redfish. All of the relationships were as expected, except the weight of latchet which (while nominated as a substitute for tiger flathead) had a complementary relationship across all grades. Sand flathead was found to be a substitute that had a relatively weak impact — a 10 per cent increase in sand flathead sales prompted a 0.25 per cent fall in prices for large and extra large tiger flathead and a 0.5 per cent fall in prices for other grades.

Flathead prices were relatively stable, with much of the price variation reflecting fluctuations in the grade composition and occasional short periods of



large supplies. The median volume was around 3.3 tonnes a day, for example, but 10 per cent of days had sales in excess of 8 tonnes a day. Prices showed only limited changes over most of the range in daily supplies but fell sharply when very large supplies were traded. Figure G shows the average price–quantity relationships for all size grades of tiger flathead at the Sydney Fish Market over the period examined.

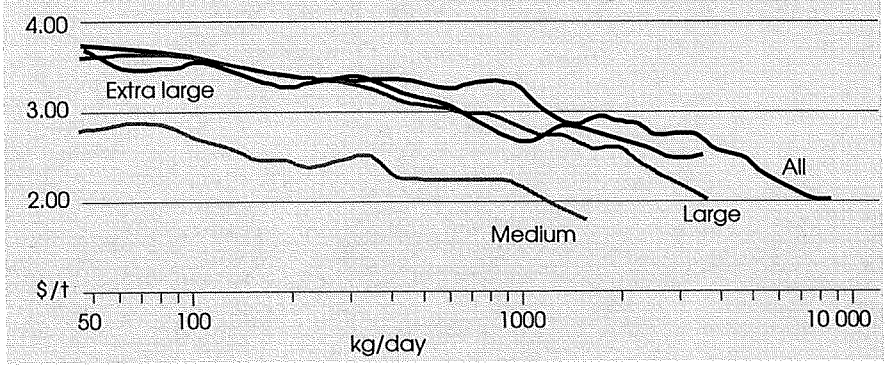
The impact of large supplies on prices was apparent in each grade. Seventy-five per cent of sales of extra large flathead were below 1700 kilograms a day, for example. At this level the expected price was around $3.05 a kilogram. Prices were highly flexible at higher volumes. Supplies for 10 per cent of sales were in excess of 2900 kilograms a day while 5 per cent of sales were in excess of 4000 kilograms a day, reducing prices to below $2.30 a kilogram.

Morwong

Most morwong sold was in the large and extra large grades; the models assessed by grade (appendix B) provided an improved fit, but limited by the high daily variability in the volume sold. The average daily variability for morwong in aggregate (as measured by the coefficient of variation) was 140 per cent, higher than for the variability of most important size grades.

The amount sold on previous days strongly influenced prices for morwong. As a result, price flexibilities were 30–50 per cent higher when established over three days than when determined on the volume sold on the same day. Price flexibilities for the important size grades were also significantly differ-

H **Morwong: average daily demand, Sydney Fish Market, by grade**



ent, depending on the volumes sold. Price flexibilities for large morwong (the most common grade) ranged from –0.21 for low volume days through to –0.3 for high volume days. As with small redfish, price flexibilities for either small or ungraded morwong were based on only product traded on previous days, so prices were highly inflexible with high standard errors resulting from the low volumes sold.

Strong seasonality in the landings of morwong was reflected in the price flexibilities. The overall flexibility for morwong was –0.17, but an increase in the volume sold in the low volume period from May to July had two and a half times the price impact (–0.24) of the same volume increase in the high volume period from February to April (when the flexibility for an average sale was –0.1).

Most factors influencing morwong prices were similar to those influencing flathead prices. However, many of these influences were weaker, with reduced impacts of earlier sales, the total supplies of morwong, and of the number of buyers. Rubberlip morwong was nominated as a substitute but had a weak complementary relationship. There was a discount for sales on Monday and, for large and medium grades, on Tuesdays; however, again this was much weaker than that found to exist for flathead.

Silver trevally

Silver trevally was one species for which the model fitted the data in aggregate better than by individual grades. This mainly reflected the highly fluctuating volume of sales. The limited volume sold for many grades prevented

the robust specification of the price–quantity relationship, particularly on low volume days. Moreover, there were few differences in prices or price flexibilities across the three largest categories (large, medium, and undefined), suggesting that buyers do not differentiate between these sizes.

The individual grades were also broken into seasons and the form in which they were sold (in aggregate or chilled in ice slurry), but these measures did not result in an improved fit. While price flexibilities were calculated for all grades except small, they were generally associated with relatively low volumes traded. Prices for small silver trevally were mainly determined by the volume of other grades available on the day, by availability on previous days and by supplies of luderick, rather than by their own volume.

School whiting

There was also a reduction in fit linked with disaggregation of school whiting into grades. There were reasonable relationships identified between prices and volume sold for large and extra large grades. The total volumes of large and medium grades were relatively similar in importance (with 38 per cent and 31 per cent respectively of the Sydney Fish Market sales), although medium sized fish was sold less frequently but in larger daily volumes.

Price flexibilities varied little across the different grades. However, the flexibilities for large whiting were consistently higher than for medium whiting on low, average and high throughput days, despite similar sales volumes.

Ling and gemfish

Modeling the individual grades significantly improved the fit between price and volume for both ling and gemfish. The main improvements for both occurred in the definition of the price–quantity relationships for the large grade, and resulted in an acceptable fit of around 0.4 for gemfish and 0.5 for ling. Price flexibilities for both species were similar at around –0.1. While the standard errors associated with the price flexibility estimates were above those of the high volume species, the estimates nonetheless appear feasible.

The remaining species which showed a poor aggregate relationship between price and volume factors (blue warehou, ocean perch and mirror dory) were disaggregated into size grades and processes. This allowed some estimates of price flexibilities for large ocean perch and mirror dory, but failed to provide any reliable estimates for blue eye, blue warehou or john dory which

could be used for management decisions. It would be necessary to examine the marketing arrangements for these species in more detail, and to extend the model to include these arrangements.

Discussion

Marketing issues have been given only limited attention in fisheries management issues, with the major focus on biological yields of fish stocks and the costs of fishing. However, without considering the market relationships, fisheries management decisions may result in suboptimal outcomes.

Studies of fisheries management issues, such as establishing optimal catch levels, often assume that prices are set independently of the level of output in the fishery (see, for example, DPIE 1989). The optimal catch is based on the biological yield of the fishery and on likely industry costs in different levels of catch. If price is assumed to be independent of catches, the industry total revenue at each output level is determined by multiplying the expected yield by price. The economic optimal catch is that which maximises the difference between industry revenue and costs. This is usually less than the fishery's maximum sustainable yield.

If prices are determined by the level of output, then the total revenue relationship needs to reflect the biological yield of the fishery and the demand relationship for the output. The economic optimum catch levels will be lower when prices are responsive to the level of catch than when constant prices are assumed.

This study has found that prices for major species caught in the inshore and Danish seine sectors of the south east fishery are responsive to changes in the volume sold, and that those relationships for some species will have a large impact on industry total revenue. Consequently, to assess the impact on industry revenue of any management decisions affecting catch levels, it is necessary to examine the likely impact of changes in those catch levels on prices.

The major high volume species caught in the inshore sector of the fishery (redfish, red spot whiting, silver trevally and tiger flathead) exhibited relatively similar price responses to a change in the volume marketed. These responses were quite high, at around 0.6 per cent for each 1 per cent increase in the volume sold. Higher prices would partly compensate for the impact on industry revenue of any reduction in catches. Conversely, the existing

market demand would likely be a key constraint to expanding catches. Thus, lower prices substantially offset the marginal impact on total industry revenue of any sustained expansion of catches.

Prices received for several quota species from the south east fishery were relatively unaffected by the level of catch. A sustained increase of 10 per cent in catches of ling, for example, would result in only minor price falls (around 1 per cent). Market factors would be unlikely to constrain expanding production; conversely, prices would be unlikely to rise in response to reduced catches. John dory and blue warehou are other species for which an increase in supplies would be unlikely to result in any large fall in prices.

The likely price response of most other quota species to a change in volume would probably fall between these extremes, with price flexibilities found to range from –0.4 for silver warehou and –0.3 for morwong to around –0.15 for ocean perch. Several of the species examined (including john dory, blue eye, blue warehou, ocean perch, gemfish and mirror dory) exhibited only a weak aggregate relationship between average daily price and volume.

Despite the volume of the species for sale being the most important influence on prices, other factors also had a significant impact — for example, the volume sold on the previous day, the total volume of all fish on the market, the size grade of the fish, the number of buyers and the day of the week.

Removing the impact of changes in size grade composition (by examining each grade separately) improved the definition of the price and quantity relationships for mirror dory, gemfish, ocean perch and john dory. These analyses found large differences in the demand relationships across different size grades for a number of the species. Prices for the most supplied size grade were usually more responsive to volume changes than were the other grades. The demand for small fish (in most species) was highly unresponsive to changes in the volume of small fish, and prices were strongly influenced by the availability of larger sized fish of the same species.

The relationships between markets is important in establishing price flexibilities. It is likely that prices of a number of the south east fishery species are influenced by important factors outside of the Sydney Fish Market, such that the prices on the market are not influenced by the volume sold. Such possibilities include the increasing sales through wholesalers, imports from New Zealand and the impact of interstate markets. Thus, the price flexibil-

ities derived from sales on the Sydney Market may not be representative of price– volume relationships facing all sectors.

If the Sydney Fish Market is the major market for a species, then estimates of price flexibilities based on sales on that market are likely to provide a reasonable estimate of those applying to all suppliers of that species (such as for redfish). If the Sydney Fish Market is the marginal market (where some other markets are supplied first because they offer higher net returns to operators), such as for blue eye and john dory, then the estimates will provide a robust estimate of demand conditions prevailing at the margin.

Most management decisions relate to marginal changes in production, so the estimates derived here are still relevant. However, the allocation of product between markets may involve significant differences in quality, and it may not be appropriate to extend demand inferences to fish that differ in quality from those traded in the Sydney Fish Market.

Structural changes with the introduction of individual transferable quotas and possibly in the regulatory requirements for seafood marketing in New South Wales may have influenced the supply relationships in the south east fishery and the Sydney Fish Market. There is some evidence that short term changes from the introduction of quotas may have influenced the supply and demand relationships. Caution should be taken in extending the results to management decisions that would lead to significant structural changes. The examination of price–volume relationships to assess quality differences (chapter 5) found problems both with changes in the form of the relationship and in the intercept term between years. Both problems are consistent with structural change.

5 *Impact of quality factors on price*

The importance of *volume* factors in establishing prices for different seafood species is examined in previous chapters. However, *quality* influences are also likely to affect price setting, and to be a source of variability in prices received. In this chapter the possible influences of quality factors on prices paid for seafood at the Sydney Fish Market are examined.

The existence of relationships between different quality characteristics and prices is a prerequisite to making the seafood industry more quality focused. Unless suppliers to the market are aware of the impact of different factors on their returns, they are unlikely to adapt their fishing and handling practices to address quality issues. However, it is often difficult to ascertain the premiums and discounts involved with different levels of quality because a large number of factors simultaneously influence prices.

If the premiums or discounts for important quality factors are not apparent, there may be a case for developing a framework to incorporate those factors into domestic fisheries trade. Such a framework, if established correctly, could result in closer relationships between buyers' quality requirements and prices (Smith 1992). However, identifying the feasibility of developing and implementing such a framework depends on a number of conditions. It is important, for example, to establish consumers' quality preferences and their willingness to pay for product with the identified characteristics.

The industry payoffs from introducing standard product descriptions include the potential savings in trading costs and higher returns. An earlier study (Smith, Tran and Ruello 1995) established that the majority of buyers like to inspect the seafood before they buy or take delivery because there are no accepted product standards on the domestic market. There is much potential for savings through more direct trading, given the high costs of buyers having to search for product and attend markets to screen product before purchase (as opposed to being able to inspect product on delivery).

A further potential benefit is that fishing operators may receive higher prices for graded over ungraded product. This depends on consumers valuing seafood with certain attributes more highly than ungraded product, and being willing to pay for these quality preferences. The net benefits to suppliers

depend on the size of these premiums and on the costs of grading and maintaining the separate grades through the marketing chain.

The value of quality attributes to consumers is often difficult to ascertain. Observed prices for a commodity sold under one method of selling may not directly indicate the price that buyers are willing to pay for the information provided under another method. It is often difficult to distinguish the price differential owing to grading from those stemming from the value of the commodity (Gleeson, Lubulwa and Beare 1993).

The returns from grading will vary between species and not all products are amenable to grading. Moreover, seafood quality has many dimensions which are often difficult to assess. These dimensions include size, appearance, flavor, texture, smell, color, and freshness, as well as other less obvious characteristics such as safety and trueness to label. Moreover, the importance of quality attributes depends on the assessor and the values that he ascribed to the different product characteristics. Quality is ultimately dictated by the consumer of the product, but in the auction market environment, the buyers interpret consumer preferences for species, size and other attributes and apply them to the market through their willingness to pay for a product.

The objective in this chapter is to examine the relationships between prices paid for seafood and various quality factors, to establish the extent to which differences in quality factors of different lots explain the differences in prices received by fishing operators.

Approach

Examining the price–quality relationship requires a means of assessing the differences in the quality of product. A range of objective methods exists, including measurement of the physical product (such as use of a Torrymeter, which measures changes in dielectric properties of the fish), chemical analysis and measurement of bacterial spoilage. However, most assessments made are based on sensory criteria and are generally subjective. All assessments at the Sydney Fish Market, as elsewhere in the domestic seafood industry, subjectively describe the characteristics of the products sold (except the description of the lot weight).

Following interviews with a range of buyers, an assessment system was developed to reflect characteristics important for a selection of seafood species. The study team determined the seafood quality factors important to

seafood buyers and developed a means of scoring each factor. This system (appendix A) combines generic factors — such as the trueness to the size grade definitions set by the Sydney Fish Market, and the icing of the fish — with the specific factors that buyers prefer in different species. Factors affecting snapper purchases, for example, included the color of the fish, while purchasers of cooked king prawns looked for the absence of melanosis (black spot) and the looseness of heads.

The species chosen for assessment were:

- tiger flathead
- redfish
- john dory
- morwong
- ling
- snapper
- mullet
- yellowfin tuna
- cooked king prawns.

The species were selected to overlap with the south east fishery quota species analysed in earlier sections of this report, but also to provide information on price–quality relationships for a wider range of species, to establish whether different relationships were apparent. Some features of the other species assessed but not discussed in earlier sections are outlined below.

Yellowfin tuna is sold either in a designated sashimi bay or on the market floor. In the sashimi bay, whole fish are usually sold by voice auction to assembled buyers. Sales of yellowfin tuna on the Sydney Fish Market were 292 tonnes in 1995-96, at an average price of $6.73 a kilogram.

Most yellowfin tuna sold is caught in the east coast tuna fishery, which is a Commonwealth managed fishery that produced around 1300 tonnes in 1995-96 and markets its catches either in Japan or on the domestic market. The marketing decision is largely based on the size and condition of the fish. Returns from the Japanese market can be significantly higher than from the domestic market, but greater marketing risks are involved because there are higher costs in airfreighting the product to Japan. Consequently, most tuna unsuited to the Japanese market (usually on the basis of their smaller size or some small quality defect) are sold domestically.

Snapper is one of the better known and highly valued table fish, widely used in the restaurant sector as well as for the retail trade and for export. Total sales in 1995-96 were 312 tonnes at an average price of $8.84 a kilogram. Snapper sold at the Sydney Fish Market come from a range of sources, including Western Australia, New Zealand and the inshore sectors of New South Wales and Victoria. A large volume is also sold through Sydney wholesalers.

Sea or bully mullet are a lower priced fish mainly sold for the retail trade. In 1995-96, 673 tonnes were sold on the Sydney Fish Market at an average price of $1.58 a kilogram. Given the limited popularity of mullet and its low price (and therefore low profit margin) wholesalers do not sell the product.

Cooked king prawns are the most common species of prawns sold in the Sydney Fish Market. The majority of king prawns sold come from the New South Wales north coast fishery, with some supplies from Queensland and South Australia. In 1995-96, 404 tonnes were sold at an average of $14.36 a kilogram. The prawn market is highly competitive, with many types of prawns (including wild caught and farmed prawns from both domestic and imported sources) sold both in the market and through Sydney wholesalers. Most buyers at the market purchase a part of their prawn supplies from other sources (Smith, Tran and Ruello 1995).

Collection of quality information

The relevant quality criteria for individual lots of each target species (selected by a predetermined sampling plan) were assessed on the market floor of the Sydney Fish Market over the period September 1995 to November 1996. An overlap period was required to test the methods and the sampling plan before applying both for a full twelve months. Observations were based on assessments on alternate weeks for the survey period. The quality criteria used for each species are outlined in appendix A.

The sampling plan was based on randomised assessments of boxes of the target species on the market floor to ensure that the information on quality was representative of all lots of those species. The plan was to set the minimum number of observations for each species, based on the expected number of lots on the day. A prespecified gap was set between the lots to be assessed on a computer, which then generated the lot numbers to be examined. The gap between assessments needed to achieve the minimum number of assessments specified for each day was greater for a high volume day than for a small trading day. The set minimum number of lots assessed could be supplemented by additional lots selected by the researcher. The assessments were made before the sales on each of the days surveyed, so the prices had no impact on the choice of lots for quality assessment.

While the Sydney Fish Market sales records have a range of information on the individual lots sold, the quality characteristics of the product are not routinely assessed. The only 'quality' information provided to buyers related

to the size grade (information provided by the seller), the form of the product and information on the supplier of that lot (although the catcher is not known for product supplied through cooperatives). Buyers undertake all other quality assessments, and may inspect product before purchase. Auctioneers may also comment on quality characteristics of specific lots during sales.

The information collected in the quality survey was subsequently matched with the Sydney Fish Market sales information on the surveyed lots, to provide the complete data set for analysis. This process also necessitated the deletion of some observations from the analysis, given problems in matching data records. More than 10 000 quality observations were included in the final data set for analysis, representing more than 16 per cent of the sales on the days when sampling took place. Nearly 7 per cent of all sales of the selected species sold during the survey period were assessed (table 10).

Given that the measures used to assess quality are subjective, steps were taken to ensure consistency in their application over the survey. The one researcher assessed all lots over the full survey to provide some assurance of consistency. Some education effect (the increased experience of the researcher influencing the assessments) was unavoidable, but:

- an electronic data recording system was developed to provide the exact criteria and definitions to be used for each consignment; and

10 Quality survey characteristics

	Days sampled	Lots	Lots sold on days sampled	Proportion of these sales sampled	Proportion of all sales
	no.	no.	no.	%	%
John dory	121	1 000	3 835	26.1	11.3
Tiger flathead	126	1 127	8 460	13.3	5.54
Ling	119	1 087	5 397	20.1	8.25
Morwong	124	854	4 692	18.4	8.73
Mullet	142	1 438	7 434	19.3	6.05
Prawns	105	872	5 253	16.6	5.46
Redfish	120	1 078	7 965	13.5	7.85
Snapper	121	1 100	8 695	12.7	7.81
Tuna	118	1 605	11 534	13.9	5.62
Total	274	10 086	146 621	16.08	6.87

- observations made in the first month of the trial were excluded from the analysis and the survey was extended by a month to ensure that a full year was monitored.

Quality survey results

Despite the relatively large number of quality assessments made, the majority of observations fell within a restricted number of the possible scores. This was not unexpected, given the large number of possible permutations (approximately 5^7) and the limited likelihood of obtaining a significant number of scores for poor quality combinations in routine surveying.

The Sydney Fish Market has been required to accept a wide range of product that meets basic statutory requirements of being wholesome and fit for human consumption, although some quality control is achieved through the links with fishing cooperatives and by fishing operators. Sydney Fish Market management has done much to educate suppliers and buyers about product quality and grading. The market developed and introduced grading criteria for product, for example, and has been influential in the adoption of better icing practices in the domestic industry. However, significant variation in product quality was identified in the products covered by the survey. The dispersion of scores for each characteristic assessed is shown in table 11.

Size grading

There are no regulations on grading or handling practices in the domestic seafood industry, except for those on minimum sizes (set and enforced by fisheries management authorities in various states) and those on suitability for human consumption (set by health departments). However, the grades used by the Sydney Fish Market are generally used as a guide in the fishing industry in New South Wales.

The Sydney Fish Market grading standards were met by around 73 per cent of all product assessed during the trial, with a further 25 per cent of product showing greater than 80 per cent grading accuracy. This lack of compliance to the Sydney Fish Market grade standards must introduce increased uncertainty to buyers, given that these include provision for ungraded product — to account for lots where highly variable size may create problems to suppliers.

11 Quality survey assessments, by species and criterion
South east fishery species a

	Score				
	1	2	3	4	5
	%	%	%	%	%
John dory					
Sizing	0	2	6	19	73
Icing	0	1	10	54	35
Eyes		1	52	47	0
Color	0	1	63	35	1
Flesh		1	42	57	0
Gut	0	1	22	77	0
Smell		1	1	98	
Tiger flathead					
Sizing	0	1	5	24	70
Icing	0	0	12	71	16
Eyes		2	35	63	0
Color		3	68	29	0
Flesh		2	53	45	
Gut		1	23	76	
Smell		1	0	99	
Ling					
Sizing	0	0	2	19	79
Icing	0	0	11	71	18
Eyes		1	50	48	1
Color		3	54	41	2
Flesh		0	7	92	1
Gut		0	5	94	1
Smell		0	1	99	
Morwong					
Sizing		0	2	24	74
Icing		0	13	76	11
Eyes	0	2	38	59	1
Color	0	1	46	52	1
Flesh					
Gut					
Smell		1	1	98	
Scales	0	3	42	55	0
Redfish					
Sizing	0	2	5	25	68
Icing		0	22	60	18
Eyes		2	30	65	3
Color		3	39	54	4
Flesh		1	42	56	1
Gut		0	8	92	0
Smell		0	1	99	0
Scales		0	16	83	1

Continued ⇨

11 Quality survey assessments, by species and criterion *continued*

Other species a

	Score				
	1	2	3	4	5
	%	%	%	%	%
Mullet					
Sizing		0	6	28	66
Icing	0	3	26	47	24
Eyes		0	25	74	1
Scales		1	25	74	0
Color		1	44	53	2
Flesh		1	39	60	0
Gut		0	15	85	0
Smell		0	100	0	
King prawns					
Sizing	0	0	2	13	85
Icing		1	21	49	29
Color		0	3	47	50
Clean	0	3	23	64	10
Mosis			0	2	98
Robust	0	1	4	56	39
Smell		0	0	100	0
Snapper					
Sizing	0	0	1	7	92
Icing		0	8	20	72
Eyes		1	41	57	1
Color	0	4	57	36	3
Flesh	0	0	31	68	1
Gut		0	8	91	1
Smell			0	100	
Scales	0	1	34	63	2
Yellowfin tuna					
Bruising	0	1	11	20	68
Color	0	1	32	65	2
bites	1	0	1	4	94
Eyes	0	3	35	58	4
Flesh	0	2	27	67	4
Gut	0	2	8	90	0

a See appendix A for definitions of criteria and scores. 0 = less than 0.5 per cent of scores in the category.

From the limited number of species assessed, there appeared to be a positive relationship between the application of Sydney Fish Market grading categories and price, because both redfish and mullet (the two cheapest species) had higher proportions of product out of grade. Most of this product was in the medium grade product (small fish graded as medium), but there was misgrading across all size grades. The accuracy of application in the grades did not vary significantly over the year, with the exception of the grading of mullet.

Icing practices

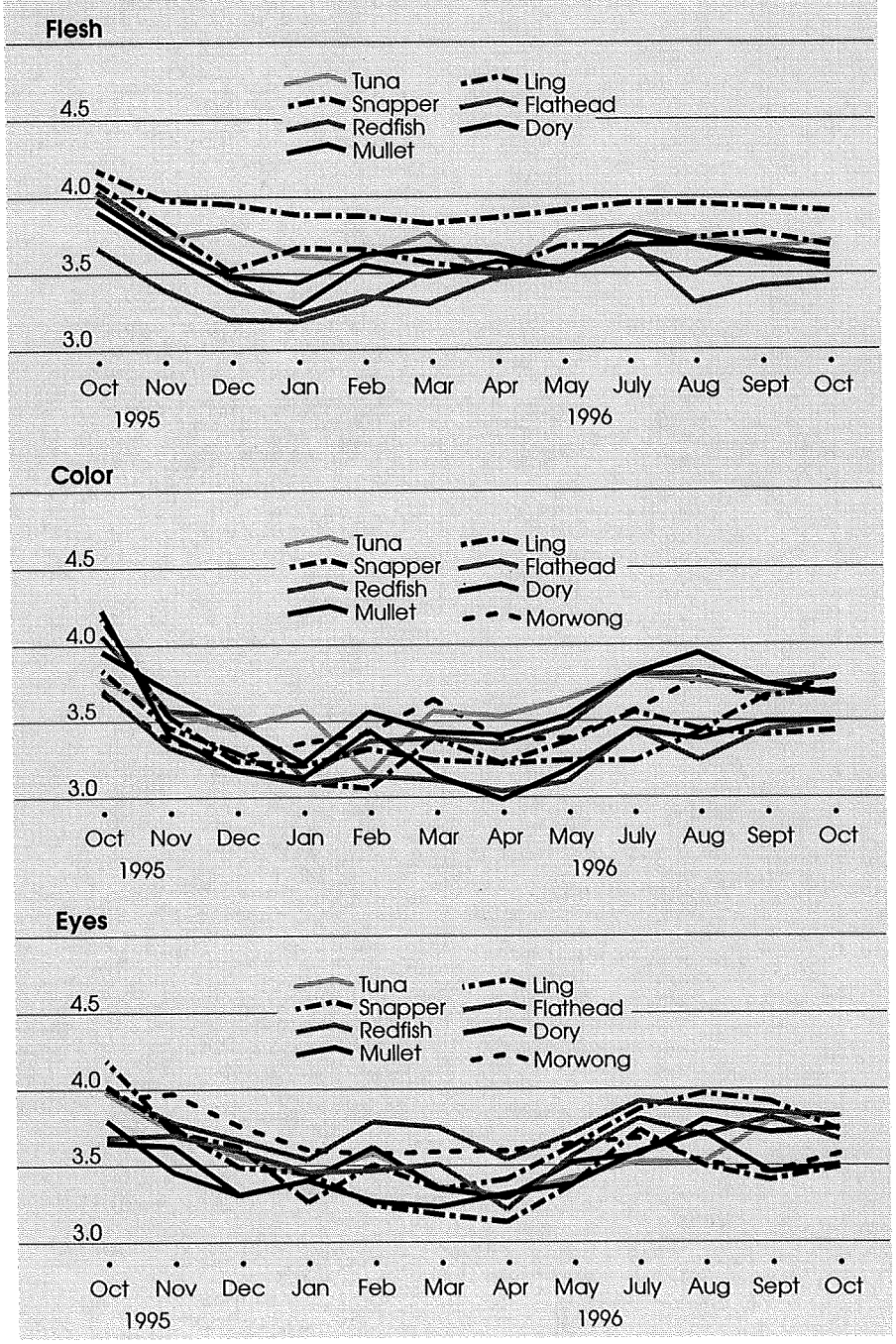
While the majority of product (76 per cent of all product assessed) had full ice covering, there was often a problem in its distribution throughout the product in the box. Over 40 per cent of product did not have ice distributed through the fish. The most obvious result of insufficient mixing of the ice with the fish is that a solid slab of ice forms above the fish. When ample ice is added to the top of a box of fish and not mixed in, the ice immediately in contact with the fish quickly melts away, leaving a small air pocket between the fish and the ice. The ice above the pocket then fuses into a slab and slowly melts, leading to minimal cooling and washing of the underlying fish. These problems were mainly apparent in the south east fishery species, but were also a problem with mullet and prawns.

The effectiveness of icing (the distribution of ice in a box) in maintaining product quality varied over the year. The scores were associated with month for all species assessed (significance tested using chi square test at 99.9 per cent confidence level). The results suggest that reduced effectiveness of icing resulted from the alterations in icing practices to meet changing weather conditions. All species examined received lower scores in May and June, indicating that operators may have underestimated the amount of ice required in winter. All species except prawns also scored lower in November and December, suggesting that operators may have failed to adequately compensate for the onset of warmer weather.

Lower scores were also most prevalent on Mondays and Tuesdays for all species except snapper and morwong, suggesting that fishing operators increased their use of ice when the product was likely to be held longer, but did not distribute ice effectively.

Insufficient use of ice (a score of 3 or less) was found in around 26 per cent of mullet and 22 per cent of redfish (the two cheapest species) and 20 per

I **Average quality scores, by month**



cent of prawns assessed (the most expensive species). For other species, around 10 per cent of product was insufficiently iced. Less than 1 per cent of the product sampled had no ice. Inadequate icing was more apparent in warmer months and also for product sold on Tuesdays.

Other quality indicators

Product quality could be expected to vary with a wide range of factors, including natural factors affecting fish condition (such as with changes in climatic conditions, feeding and spawning) as well as by product handling, fishing techniques and subsequent treatment of the product in the marketing chain. Buyers have available to them a limited number of indicators of quality differences, including changes in the color, flesh and eyes of the fish.

Average scores for color, flesh and eyes of all fish species assessed showed significant variation over the year (figure J), generally in inverse relation to seasonal temperatures. Quality scores fell as temperatures rose in spring and summer, and rose as temperatures fell. A possible explanation is that handling practices may not take sufficient account of seasonal climate variations and their impact on quality. Such variations may also indicate the influence of natural factors in determining seafood quality.

Handling factors influenced quality in the survey period. While there was monthly variation in scores for eyes and color, consistent with seasonal changes in fish quality, scores for both eyes and color were consistently lower on sales conducted on Mondays and Tuesdays. This may reflect the increased elapsed time between catching and sale because the market does not operate on weekends (that is, product caught late in the week and on the weekend may not be sold until Monday or Tuesday).

Relationships between quality factors and price

It was not possible to observe all possible quality characteristics in sufficient numbers to fully analyse the range of premiums and discounts for each quality characteristic. However, there were sufficient numbers of observations to analyse the price differences for scores of 3, 4 and 5 for each of the quality factors assessed in the survey.

Analytical approach

The relationships between prices and product characteristics can be analysed through the use of hedonic pricing models. These models usually take the form of a regression model:

$$p_i = \sum b_j x_{ij} + e_i$$

where p_i is the price of lot i of the commodity; b_j is a coefficient for characteristic j; x_{ij} is a measure of characteristic j of lot i; and e_i is an error term. The coefficients b are interpreted as the change in the price of the commodity per unit change in a quality characteristic.

Hedonic pricing models have been used to evaluate the relationships between quality characteristics and price for a range of commodities. In the wool industry there has been extensive research into the relationships between wool quality characteristics (such as staple measurements, length and strength) and the value of this information (Gleeson, Lubulwa and Beare 1993). The method has also been previously applied to overseas seafood markets, to identify the impact of quality factors influencing the prices paid for cod at the Portland, Maine, fish auction (Ty and Gates 1994) and prices for tuna in Hawaii (McConnell, Strand and Curtis 1998).

The quality factors at the Portland fish auction and the methods used to assess those quality factors were similar to the factors and approach used in this study. The sensory characteristics assessed in the Portland study included appearance, texture, color and odor of the cod. The assessments were based on similar criteria — such as the appearance of eyes, loss of scales, smell and flesh color — although each part of the fish was assessed on a 4 point scale with the scores averaged. A panel of six buyers made the assessments over a three week period in June 1990 and covered 440 lots. The data were combined with other detail, such as the size grade of the fish, size of the lot being sold, gear type and fishing ground, and total quantity of fish consigned to the market. The analysis showed that size related premiums had the largest influence on the prices paid but that all quality factors had a significant impact on prices received.

The most important potential source of estimation error in hedonic pricing models is the impact of omitted factors on the estimates of the quality coefficients. If factors that influence prices are omitted from the model, the estimates of the coefficients will be biased because they pick up the impact of

the excluded variable. If only quality variables are used to explain prices of seafood and the volume of product is a major determinant of prices but omitted from the model, for example, then the impact of volume will be incorrectly associated with the quality premiums.

To identify whether premiums or discounts were associated with the assessed quality attributes, the 'expected' price for the species was identified for each of the days sampled (based on the volume factors modeled earlier). The difference between the expected price and the actual price on the day provided the data for the analysis. If the model adequately specified market behaviour, then any divergence between actual and expected prices could be attributed to quality factors, structural changes or random variation.

The parameters derived from the stage 1 analysis were used to establish the expected daily prices for all species. The parameter estimates and expected prices were developed on the basis of sales on the market over the period coinciding with quality survey (October 1995 to October 1996). (The form of the models used and the estimates obtained for the non south east trawl species are shown in appendix B.)

The model used in quantifying typical quality premiums/discounts was:

$$\ln(P_{id}) - Expected[\ln(P_d)] = \sum_{\substack{quality\ characteristics \\ q}} \sum_{\substack{quality \\ level \\ l}} \alpha_{ql}$$

Expected $[\ln(P_d)]$ is the expected value of (P_d) for day d based on factors of the sale pertinent to the market factors model discussed in chapter 4 (factors such as species, size grade, process, season, day of week, volume sold). To enable statistical estimation of the parameters α_{ql} they were restricted so that there was a reference quality level (for each characteristic) for which α_{ql} was zero. The reference quality level for sizing and icing was 5; for all other characteristics it was 4. An estimate of the average percentage increase/decrease in price of product for which quality characteristic q is at level l when compared to product of reference level quality is given by $(e^{\alpha_{ql}} - 1)*100$.

On any given day, it is assumed that market factors likely to affect the price received (such as the number of buyers and suppliers attending, and the volume and quality of alternative product available) are constant for all sales. To the extent that the quality factors are associated with the variables used in stage 1 of the analysis, the impact of the quality factors on prices will be

underestimated. Scores for both color and eyes were both consistently lower on Mondays and Tuesdays, for example. Any price depressing effect of these lower scores would have been reflected in lower 'expected' prices for sales on those days. Thus, estimates of price impacts of these two quality factors would be underestimated in this second stage.

Alternative model specifications were also investigated to test the robustness of the analysis results. In all cases the qualitative outcomes from the alternative analyses were the same as those obtained for the analysis presented here.

Results

The quality factors assessed during the trial explained some differences between the actual prices received and the expected prices based on the volume on the day. However, the influence of quality factors was not particularly strong. There were some common factors, but no one set of factors was found to influence prices across all the assessed species. Table 12 shows the impact of quality factors on price.

For those species which are sold whole, the color factors had a strong impact on prices received. For example, prices for john dory with above average color (score 5) were 13.8 per cent higher than for the reference group (score 4), while those scoring 3 had a discount of 3.2 per cent. Snapper had similar pricing, with a high premium (of nearly 15 per cent) for well colored gilled and gutted fish, but only a weak discount for score 3 fish. However, for whole snapper, there was a discount of 7 per cent for weaker colored (score 3) fish. A similar discount was associated with poorly colored morwong.

The strongest impact of the quality factors was found for whole snapper and yellowfin tuna, where the model fitted accounted for 30 per cent and 14 per cent respectively of the difference between the actual and expected values. (The values reported are the logs of the ratios of actual and expected daily price for each species.) Prices received for yellowfin tuna showed the strongest influence of quality factors, with bruising, flesh, eyes and color all significant factors in explaining variation in prices on the day. This is not surprising, given the wider dispersion of quality scores recorded (shown in table 11) and a wider variation in daily prices than shown by the other species assessed. Moreover, tuna in the sashimi bay are sold separately and inspected by buyers before sale, so buyers are more aware of defects when bidding.

12 Impact of quality factors on price, by species

	Season	Number in group	Quality characteristic	Score/ base	Price premium	Std error	Significance a
					%		
John dory	Peak	933	color	3/4	–3.2	0.016	**
				5/4	+13.8	0.101	**
			gut	3/4	+4.8	0.019	**
			icing	4/5	+4.9	0.016	***
			sizing	3/5	–8.2	0.031	***
Flathead	Peak	1 036	gut	3/4	+7.1	0.024	***
			sizing	3/5	–11.4	0.046	**
				4/5	–6.9	0.023	***
Ling	Peak	495	flesh	3/4	–7.9	0.042	*
	Offpeak	355	eyes	3/4	–3.6	0.015	**
Morwong	Peak	129	sizing	4/5	–12.8	0.050	**
	Offpeak	164	icing	4/5	–8.7	0.039	**
			sizing	4/5	–7.9	0.044	*
	All	480	color	3/4	–6.4	0.033	*
			scale	3/4	+8.4	0.033	**
Redfish	Peak	342	sizing	3/5	–11.8	0.048	**
				4/5	–7.4	0.028	***
Mullet	Peak	1 139	icing	4/5	–6.0	0.020	***
			sizing	3/5	–10.7	0.034	***
				4/5	–3.7	0.018	**
Prawns	Peak	817	clean	3/4	+4.2	0.013	***
				5/4	–4.3	0.018	**
			icing	4/5	–2.7	0.012	**
			smell	5/4	–15.5	0.076	**
Snapper gilled/gutted	Peak	644	color	3/4	–0.1	0.014	*
				5/4	+14.9	0.042	***
Snapper whole	Peak	86	icing	4/5	–15.6	0.033	***
			flesh	3/4	+10.2	0.038	***
			color	3/4	–7.9	0.032	**
			gut	3/4	+9.1	0.045	**
Tuna	Peak	1419	bruise	3/5	–20.5	0.042	***
				4/5	–20.5	0.029	**
			flesh	3/4	–15.9	0.029	***
			eyes	3/4	–11.4	0.026	***
				5/4	–12.2	0.074	*
			color	5/4	+17.1	0.087	**

a Significance: 95 per cent significant ***, 90 per cent significant **, 85 per cent significant.

Probably more importantly, these are aspects of quality that are much more important for fish intended to be served raw than for fish that is cooked.

Snapper and john dory (the higher priced fish assessed) also had strong relationships between quality factors and prices, each with four factors having significant relationships with prices. The relationship between the quality factors and price was weakest for prawns, where two of the three factors found to have significant relationships were of the wrong sign in relation to expectations.

Other inconsistencies occurred in the relationships found between the factors. Other apparently inconsistent relationships included premiums associated with lower icing scores for john dory and snapper, and greater discounts associated with icing score 4 than with score 3 for prawns, mullet and snapper. There is the possibility that the measures used may not be the most appropriate measures of quality as assessed by buyers. Assessment of the impact of gut condition on price, for example, revealed inconsistencies between scores. Lots scored at 3, which would be expected to show a discount compared with the price of those scoring 5, actually attracted a premium in the four species for which gut condition was assessed.

The impact of quality factors on average prices is shown in table 13, which highlights the average price difference between the score for quality attributes and the benchmark score. For example, lots of john dory which had all product correctly graded received prices 2 per cent higher than those for lots in which more than 80 per cent of product was true to its size grade. However, there was a 6 per cent penalty when size grading was only 50–80 per cent accurate.

Penalties for inaccurate size grading existed for six of the eight species assessed. The remaining two — snapper and king prawns — had higher compliance with the size grading standards, with 92 per cent and 85 per cent correctly graded. All price penalties showed the expected relativities (with a penalty for a score of 3 and a premium for a score of 5).

The inconsistencies between scores for icing and the associated premiums or discounts become more apparent when expressed in relation to average premiums and discounts. Only one of the five species for which icing was significant (morwong) had the right signs and relativities, while a further three had discounts for inadequate icing but greater penalties for inadequate

13 Impact of quality factors on price, by quality factor

			Quality score a	
			3	5
			Price differential	Price differential
			%	%
Size grading	John dory		–6.1	+1.9
	Flathead		–4.3	+7.2
	Ling		–3.9	+3.3
	Morwong	peak		+13.3
		offpeak		+8.2
	Mullet		–9.3	+3.8
	Redfish	peak	–4.3	+7.6
		offpeak	–5.9	+10.6
Icing	John dory		–1.0	–4.8
	Morwong	offpeak	–3.5	+9.1
	Mullet		+3.0	+6.2
	Prawns		+1.2	+2.7
	Snapper gilled/gutted		+5.4	+1.9
	Snapper whole		+7.1	+17.0
Color	John dory		–3.1	+14.8
	Morwong		–6.2	+19.3
	Snapper gilled/gutted		–0.1	+16.0
	Snapper whole		–7.6	
	Tuna		–3.7	+18.7
Eyes	Ling		–3.6	+11.0
	Tuna		–10.8	–11.5
Flesh	Ling		–7.6	–8.8
	Snapper whole		+10.7	
	Tuna		–14.7	+2.6
Gut	John dory		+4.9	
	Flathead		+7.4	
	Redfish		+19.1	
	Snapper whole		+9.5	
Clean	Prawns		+4.3	–4.2
Bruising	Tuna		–18.5	+22.7

a Price differentials shown are those against a benchmark score of 4.

mixing of the ice than for inadequate *use* of ice. This could be expected, because of the hazards associated with ice crusts forming above the fish.

There were also inconsistencies between the scores for gut and their pricing relativities. Premiums occurred for low scores for all four species for which this factor was found to be significant. This suggests a positive relationship with another factor (not included in the analysis) that was negatively related to the gut assessments.

There were large premiums for prominent color in those fish for which appearance is important, with john dory, morwong, snapper and tuna all receiving a premium of 15 per cent or more for strongly colored fish.

Many factors are likely to have influenced the analysis results. Volume factors have only a limited influence on prices received, such that the expected price (which was based on volume) used in the quality analysis was not a standardised benchmark for a number of the species analysed. Moreover, in analysing price differences for individual sales within a day, there were likely to be many additional factors (such as the sequence of sales within a sale, and the composition of supplies) that would influence prices.

It is noteworthy that snapper, the species with the strongest correlation between quality and price at the Sydney Fish Market, is also the species for which buyers at the auction and retail consumers can easily recognise and judge its one striking characteristic — its color. Tuna also has a strong correlation between quality characteristics and price because the buyers can inspect the individual fish as it is being sold through voice auction. By contrast, the species which had a low correlation between quality and price (morwong, ling and flathead) are sold through electronic auction, generally in large lots. Most are retailed in fillet form where the appearance of the whole fish — the most easily assessed quality parameter — is less critical.

6 Implications

Under the current individual transferable quota management regime in the south east fishery, fisheries managers set the total allowable catches and the management rules in the fishery. The operators holding catch quota are left to organise their operations most efficiently within those parameters. Marketing issues have generally remained outside the role of fisheries management.

Management in the fishery under individual transferable quotas has been focused on setting total catches and enforcing catch restrictions to ensure sustainable fishing. Factors related to effective enforcement — such as operating adjacent fisheries under different management regimes and matching quota held with catches — have all been major management priorities. Avoidance issues have also been addressed, including discarding of catches, recording of catches as originating in other fisheries or as other species, and nonrecording of catches (Baulch and Pascoe 1992).

To meet the economic objective of maximising the value of production over time, marketing considerations become an important component of any management program. To illustrate, it has generally been assumed that the revenue changes from a change in total allowable catches are solely a function of the change in volume. This research has demonstrated that the effects of changes in supplies on prices are significant for many of the quota species in the south east fishery, particularly for species sold in relatively higher volumes. As a result, the impact on total industry revenue of any change in catches would be partly offset by price changes as markets adapt to the new production level.

The expected impact of any change in catch levels on prices will also depend on factors such as the size composition of catches and their timing. Both factors have a significant effect on prices and industry revenue. Conversely, increased management focus on the size composition (directly related to age cohorts) of the catch rather than on total allowable catches may be a more effective means of achieving management goals.

Operators have less incentive to use quota to maximise their share of available catches during periods of high natural abundance because there is potential for market prices to fall significantly in response to high daily supplies.

Operators holding quota have to determine the relative net benefits of taking fish during periods of high natural abundance (and low fishing costs) or in periods when fish may be scarcer (and fishing costs higher) but market returns are improved. This analysis of price–quantity relationships will assist operators in making this tradeoff.

Given that a significant part of the discarding problem is market related, it is necessary to incorporate marketing considerations in fisheries management plans. This can be illustrated with the high rates of trashing of redfish catches. Without viable markets, small redfish caught are discarded. Based on information from the scientific monitoring program undertaken in New South Wales, the discard rate for redfish varied from 47 per cent in 1993, to 54 per cent in 1994, to 56 per cent in 1995, to 24 per cent in 1996. Moreover, there has been a shift in the size distribution, with the mean size falling from around 24 centimetre fork length in 1980 to 20 centimetres in 1995, and with the proportion of small fish increasing. The discard rate was also higher in the Eden area than in the Ulladulla area, reflecting the higher marketing costs of the former (which is more distant from Sydney).

The large difference in prices received for different size grades and the low prices received for small redfish provide little incentive to retain small redfish catches. There is no separate market demand for small redfish because their prices are set only by the availability of other grades. However, there are significant costs involved in catching small redfish, mainly in forgone revenue from failing to allow the fish to grow to sizes preferred by the market. There are stronger demand and higher prices for larger fish (figure E) and possibly better returns from meeting the size and seasonal requirements of markets (figure F).

If it is not possible to develop individual transferable quotas for the fishery that allow managers to provide effective property rights, then it may be necessary to more directly address the issue of discarding through measures which address the common property aspects of fishing (which remain even after the introduction of a quota system). This may require the combination of output controls with input controls to achieve the gear selectivity required to minimise the taking of small fish, such as through introducing minimum mesh sizes and net design. If output controls are to continue as the main management tool then the issues associated with the wide value of quota entitlements will need to be addressed, through greater emphasis on the size composition of catches, rather than the aggregate catches of quota species.

Pricing efficiency issues

Prices on the Sydney Fish Market (a fresh fish market) could be expected to be volatile, given the market's limited potential to carry over stock on demand and the impact of short term factors (such as weather conditions) on supply. This study has found that most of the south east fishery species show a large variation in prices received which is not related to either volume changes on the Sydney Fish Market or quality factors. Potential sources of price variation that were not assessed by this study include the impact of trading by wholesalers outside the Sydney Fish Market, interstate and international factors, and demand relationships between different species. Even taking these factors into account, a significant proportion of the variation in prices paid for fish is likely to remain unexplained.

Over the four years examined, the relationships between prices and volumes were changing. This suggests that structural changes were likely to have been an important influence on the results. However, given that major structural changes were occurring in the fishery (following the introduction of individual transferable quotas) and in the Sydney Fish Market (following its privatisation), this could be expected. Several other factors emerged from the study, including the changing importance of the Sydney Fish Market as an outlet for south east trawl species.

The large amount of 'noise' in prices (apparent random price variation not associated with either volume or quality factors) indicates that marketing represents a significant source of risk in fishing operations. Even if operators completely addressed all other factors in selling their fish they would have a significant variation in fishing returns. Thus, the price mechanism may not clearly indicate to operators the benefits and costs of different quality practices on the prices likely to be received.

Ensuring that the prices paid to fishing operators reflect the factors that are important to consumers is fundamental to the efficiency of the industry. The results in this study indicate that some characteristics are reflected in prices, while others exhibit less conclusive relationships. It is likely that a larger trial, in which a greater range of product characteristics are likely to be encountered, would confirm further relationships with prices.

There has been considerable focus on attempting to improve seafood quality standards. However, what are appropriate standards? The answer will depend on consumers' willingness to pay; industry is more likely to address

the demand for specific characteristics (including quality) that are explicitly identified through price differences. Further, how can such standards be introduced? Implementation relies on ensuring that consumer requirements are transmitted to producers through price differentials.

One means of ensuring this is through standardised product descriptions. Such descriptions exist on export markets, but the case for developing standardised product descriptions as the basis for domestic seafood trade depends on several factors. First, the current trade framework may not allow buyers to adequately specify their quality requirements. Second, it would be necessary to establish that there are net benefits to the industry and consumers from developing and introducing an improved framework for domestic seafood trading. This would require establishing the costs of inadequate trade descriptions and of developing and implementing a more suitable alternative.

Many of the operational costs associated with inadequate trade descriptions have already been established in an earlier study (Smith, Tran and Ruello 1995) which examined the costs of current trading systems and their alternatives. The costs to both buyers and sellers were significant. The absence of a framework for trade was the key constraint to developing marketing alternatives that reduced the need for visual inspection. Further, a standardised framework for trade in seafood would improve the information flow between consumers and producers. The costs may also include the impacts on demand if consumers cannot adequately express their preferences and the impact on industry revenues if fishing operators fail to focus on those product characteristics in highest demand.

The development of national standard product descriptions for the seafood industry is likely to be a major undertaking. There has been a large amount of work to standardise marketing names and to introduce these into trading (DPIE 1995), but the trade is yet to adopt many. Similar problems are likely to occur with uniform grade standards.

Developing and introducing uniform standards for other important trading characteristics such as size grading and icing are also likely to be difficult. However, such work is required if quality issues are to be addressed. The framework for trade has a major impact on the characteristics of the product traded. This project developed a simple product description system and applied it to a limited range of species. It is equally feasible to develop similar descriptions with buyers for other species, and to apply these to domestically traded product.

A Appendix

Assessment of product quality

The system was developed using a combination of generic and specific criteria. These criteria were applied on a 5 point scale with the use of an overall demerit system to take account of those factors which had an overriding influence on marketability.

Generic criteria

1. Size grading (The grading of all products were assessed against Sydney Fish Market size grades.)

5 100 per cent correct and uniform

4 > 80 per cent correct

3 50–80 per cent correct

2 > 50 per cent one grade out

1 >50 per cent two grades out

2. Icing (all products except tuna)

5 full ice covering and mixed in

4 full ice covering but not mixed in (ineffective icing)

3 inadequate icing

2 no ice but fish still cold

1 no ice and fish warm

3. Appearance/quality

Separate criteria were developed according to the species being assessed. The appearance criteria used for each of the target species were as follows, again ranging between scores of 1 and 5.

	Score 5	Score 1
Yellowfin tuna		
Color	Brilliant colour and sheen	No sheen, color completely faded
Eyes	Eyes clean and bulging; strong black pupil color	Cloudy and sunken
Gutting	Gill cavity and belly clean	Gill/belly cavity dark
Flesh	Prerigor/early rigor – very firm	Post rigor – very soft
Defects		
bites	None	Major or more than three small ones
bruising	None	Large, obvious skin damage
Cooked king prawns		
Color	Strong red with shine	Pale, no shine
Robust	Tails firm to head	More than 15 per cent loose heads
Clean	No brown heads	More than 15 per cent brown heads
Melanosis	None	More than 15 per cent black spots
Defects		
smell	None	Unpleasant, unnatural
Flathead (ungutted)		
Color	Brilliant color and sheen	No sheen, color gone
Eyes	Eyes clean and bulging; strong black pupil color	Cloudy and sunken
Gut	Belly firm, clean	Belly stained, ruptured
Flesh	Prerigor/early rigor – very firm	Soft
Defects		
smell	None	Unpleasant, unnatural
Morwong (ungutted)		
Color	Brilliant color and sheen	No sheen, color gone
Eyes	Eyes clean and bulging; strong black pupil color	Cloudy and sunken
Scale loss	Negligible	More than 50 per cent scale loss
Defects		
smell	None	Unpleasant, unnatural
Ling (ungutted)		
Color	Bright pink	Pink gone, now ivory
Eyes	Eyes clean and bulging; strong black pupil color	Cloudy and sunken
Gut	Belly firm, clean	More than 15 per cent belly ruptured
Flesh	Early rigor – very firm	Soft
Defects		
smell	None	Unpleasant, unnatural

	Score 5	Score 1
Mullet (usually ungutted)		
Color	Brilliant color and sheen	No sheen, color gone
Eyes	Eyes clean and bulging; strong black pupil color	Cloudy and sunken
Scale loss	Negligible	More than 25 per cent scale loss
Gut	Belly firm, clean	More than 15 per cent belly ruptured
Flesh	Early rigor – very firm	Soft
Defects		
smell	None	Unpleasant, unnatural
Redfish (ungutted)		
Color	Brilliant color and sheen	Pink color gone, now grey
Eyes	Eyes clean and bulging; strong black pupil color	Cloudy and sunken
Scale loss	Negligible	More than 25 per cent scale loss
Gut	Belly firm, clean	More than 15 per cent belly ruptured
Flesh	Early rigor – very firm	Soft
Defects		
smell	None	Unpleasant, unnatural
Snapper (gutted or ungutted, *iki jime*)		
Color	Brilliant color and sheen; blue spots prominent	Pink color gone, now grey; spots gone
Eyes	Eyes clean and bulging; strong black pupil color	Cloudy and sunken
Scale loss	Negligible	More than 25 per cent scale loss
Gut	Belly firm, clean (ungutted) Belly cleaned and clean (gutted)	More than 15 per cent belly ruptured Unclean and/or dark
Flesh	Pre or early rigor – very firm	Soft
Defects		
smell	None	Unpleasant, unnatural
John dory (usually ungutted)		
Color	Bright color and sheen	drab color
Eyes	Eyes clean and bulging; strong black pupil color	Cloudy and sunken
Gut	Belly firm, clean	More than 15 per cent belly ruptured
Flesh	Pre or early rigor – very firm	Soft
Defects		
smell	None	Unpleasant, unnatural

Price–volume relationships – tiger flathead

	Ungraded			Large			Medium			Small			Unspecified			Extra large		
	Estimate	SE	Sig	Estimate	SE	Sig	Estimate	SE	Sig	Estimate	SE	Sig	Estimate	SE	Sig	Estimate	SE	Sig
Intercept	2.110	0.23	****	2.464	0.21	****	3.343	0.124	****	2.292	0.33	****	2.297	0.11	****	2.390	0.156	****
Log (wgt tiger flathead)	0.176	0.08	**	0.233	0.065	****				0.180	0.103	*				0.192	0.044	****
Log (wgt tiger flathead)^2	–0.032	0.01	****	–0.028	0.005	****	–0.016	0.002	****	–0.031	0.011	***	–0.021	0	****	–0.031	0.003	****
Log (wgt lagged 1 day)	–0.035	0.01	****	–0.070	0.009	****	–0.059	0.011	****	–0.031	0.009	***	–0.061	0.01	****	–0.064	0.006	****
Log (wgt lagged 2 days)				–0.062	0.009	****	–0.071	0.012	****				–0.043	0.01	****	–0.048	0.007	****
Log (wgt other size flathead)	–0.202	0.02	****	–0.154	0.01	****	–0.022	0.014	****	–0.266	0.027	****	–0.119	0.01	****	–0.104	0.009	****
Log (number of buyers)	0.152	0.04	****	0.069	0.028	**	0.255	0.029	****	0.296	0.043	****	0.338	0.03	****	0.175	0.024	****
Log (wgt sand flathead)	–0.058	0.01	****	–0.028	0.005	****	–0.053	0.006	****	–0.055	0.013	****	–0.057	0.01	****	–0.024	0.004	****
Log (wgt of latchet)	0.056	0.01	****	0.038	0.006	****	0.018	0.008	**	0.064	0.015	****	0.024	0.01	***	0.015	0.005	***
Log (wgt red gurnard)				0.007	0.004	*												
Monday				–0.686	0.074	****	–0.623	0.096	****				–0.506	0.08	****	–0.627	0.062	****
Tuesday				–0.371	0.062	****	–0.424	0.079	****				–0.212	0.07	***	–0.290	0.053	****
Thursday																–0.051	0.02	**
Friday																–0.039	0.02	*
R^2	0.236			0.383			0.388			0.383			0.353			0.478		
No. of observations	819			1 119			1 113			379			1 115			1 109		

Significance: **** 99.99 per cent; *** 99 per cent; ** 95 per cent; * 90 per cent.

Price–volume relationships – gemfish (gutted and headed)

	Large			Medium			Unspecified		
	Estimate	**SE**	**Sig**	**Estimate**	**SE**	**Sig**	**Estimate**	**SE**	**Sig**
Intercept	1.905	0.112	****	2.330	0.088	****	1.848	0.04	****
Log (wgt gemfish)	0.122	0.044	***	–0.014	0.004	***			
Log (wgt gemfish)^2	–0.015	0.004	****	–0.037	0.009	****			
Log (wgt lagged 1 day)	–0.011	0.004	***						
Log (wgt other processed gemfish)	–0.045	0.005	****	–0.063	0.01	**	–0.031	0.01	****
Log (wgt other size gutted and headed gemfish)				–0.023	0.009	****			
Log (number of buyers)				0.112	0.056	**			
Log (wgt blue grenadier)	–0.011	0.003	***						
Thursday				0.125	0.046	***			
R^2	0.387			0.307			0.04		
No. of observations	295			194			428		

Significance: **** 99.99 per cent; *** 99 per cent; ** 95 per cent; * 90 per cent.

Price–volume relationships – gemfish (whole)

	Large			Medium			Small			Unspecified		
	Estimate	**SE**	**Sig**	**Estimate**	**SE**	**Sig**	**Estimate**	**SE**	**Sig**	**Estimate**	**SE**	**Sig**
Intercept	1.718	0.07	****	1.785	0.052	****	0.796	0.119	****	1.049	0.13	****
Log (wgt gemfish)	0.097	0.024	****							0.216	0.05	****
Log (wgt gemfish)^2	–0.019	0.002	****	–0.011	0.003	****	–0.006	0.003	*	–0.0367	0.01	****
Log (wgt lagged 1 day)	–0.031	0.006	****	–0.016	0.006	***	–0.030	0.016	*			
Log (total wgt other processed gemfish)												
Log (wgt other size gemfish)	–0.024	0.004	****	–0.055	0.006	****	0.038	0.015	**	–0.0217	0.01	****
Log (number of buyers)	0.084	0.021	****	0.110	0.037	***				0.231	0.04	****
Log (wgt of blue grenadier)	0.006	0.003	**	–0.012	0.005	***	–0.033	0.012	***	–0.01	0.01	**
Monday	–0.124	0.034	****									
R^2	0.405			0.206			0.060			0.115		
No. of observations	473			455			246			785		

Significance: **** 99.99 per cent; *** 99 per cent; ** 95 per cent; * 90 per cent.

Price–volume relationships – morwong

	Ungraded			Large			Medium			Small			Unspecified			Extra large		
	Estimate	SE	Sig	Estimate	SE	Sig	Estimate	SE	Sig	Estimate	SE	Sig	Estimate	SE	Sig	Estimate	SE	Sig
Intercept	1.784	0.15	****	0.170	0.136	****	2.071	0.227	****	1.825	0.27	****	1.711	0.11	****	1.837	0.127	****
Log (wgt morwong)				0.136	0.041	****	0.200	0.076	***				–0.074	0.04	*	0.096	0.4	**
Log (wgt morwong)^2				–0.024	0.003	****	–0.032	0.007	****				–0.016	0	****	–0.020	0.003	****
Log (wgt lagged 1 day)				–0.051	0.006	****	–0.046	0.012	****				–0.023	0	****	–0.038	0.006	****
Log (wgt lagged 2 days)	–0.040	0.01	***	0.036	0.006	****	–0.059	0.013	****							–0.024	0.006	****
Log (wgt other size morwong)	–0.102	0.02		–0.052	0.006	****	–0.13	0.014	****	–0.165	0.036	****	–0.055	0.01	****	–0.071	0.008	****
Log (number of buyers)				0.092	0.021	****	0.143	0.028	****				0.282	0.03	****	0.111	0.021	****
Log(wgt rubberlip morwong)				0.027	0.006	****							0.015	0.01	*	0.019	0.007	***
Monday				–0.440	0.053	****	–0.446	0.096	****	0.246	0.078	***				–0.252	0.051	****
Tuesday	–0.153	0.08	*	–0.190	0.044	****	–0.298	0.080	****							–0.110	0.044	**
R^2	0.130			0.428			0.319			0.168			0.341			0.399		
No. of observations	243			1 010			532			124			1 084			754		

Significance: **** 99.99 per cent; *** 99 per cent; ** 95 per cent; * 90 per cent.

Price–volume relationships – john dory

	Ungraded			Large			Medium			Small			Unspecified			Extra large		
	Estimate	SE	Sig	Estimate	SE	Sig	Estimate	SE	Sig	Estimate	SE	Sig	Estimate	SE	Sig	Estimate	SE	Sig
Intercept	2.825	0.120	****	2.054	0.102	****	1.753	0.129	****	2.449	0.220	****	3.30	0.12	****	2.676	0.064	****
Log (wgt john dory)				0.374	0.034	****	0.378	0.048	****	0.400	0.083	****				0.041	0.012	****
Log (wgt john dory)^2	0.015	0.005	***	–0.026	0.003	****	–0.036	0.005	****	–0.054	0.010	****	–0.01	0.00	***			
Log (wgt lagged 1 day)	–0.038	0.009	****	–0.045	0.006	****	–0.081	0.010	****	–0.109	0.018	****	–0.10	0.01	****			
Log (wgt lagged 2 days)				–0.041	0.007	****	–0.050	0.010	****	–0.086	0.020	****	–0.12	0.02	****			
Log (wgt other size john dory)	–0.194	0.017	****	–0.049	0.009	****				–0.178	0.022	****	–0.12	0.02	****	–0.110	0.008	****
Log (number of buyers)	–0.160	0.044	****	–0.212	0.020	****	–0.212	0.026	****				–0.07	0.04	*	–0.031	0.018	*
Log(wgt of mirror dory)	0.023	0.008	***	–0.011	0.003	****							0.01	0.01	*	–0.011	0.004	***
Monday				–0.461	0.048	****	–0.578	0.063	****	–0.661	0.104	****	–0.82	0.08	****			
Tuesday				–0.256	0.043	****	–0.218	0.057	****	–0.333	0.094	****	–0.43	0.07	****	–0.037	0.017	**
Thursday	0.075	0.037	**															
Friday	0.094	0.036	***	0.039	0.015	***	0.056	0.022	**							0.037	0.016	**
R^2	0.168			0.433			0.431			0.189			0.313			0.210		
No. of observations	917			1137			1114			971			1038			930		

Significance: **** 99.99 per cent; *** 99 per cent; ** 95 per cent; * 90 per cent.

Price–volume relationships – mirror dory

	Ungraded			Large			Medium			Small			Unspecified			Extra large		
	Estimate	SE	Sig	Estimate	SE	Sig	Estimate	SE	Sig	Estimate	SE	Sig	Estimate	SE	Sig	Estimate	SE	Sig
Intercept	1.206	0.087	****	0.922	0.069	****	1.121	0.070	****	0.650	0.160	****	0.906	0.185	****	2.320	0.090	****
Log (wgt mirror dory)				0.263	0.022	****							–0.178	0.081	**			
Log (wgt mirror dory)^2				–0.026	0.002	****	0.008	0.003	***				0.026	0.009	***			
Log (wgt lagged 1 day)				–0.037	0.005	****	–0.017	0.006	***	–0.028	0.015	*				–0.027	0.007	****
Log (wgt lagged 2 days)				–0.015	0.005	***												
Log (wgt other size mirror dory)	–0.094	0.013	****				–0.088	0.010	****	–0.066	0.021	***	–0.041	0.009	****	–0.017	0.013	****
Log (number of buyers)				–0.073	0.017	****	–0.169	0.035	****									
Monday	0.144	0.052	***	–0.230	0.039	****							0.125	0.045	***			
Tuesday				–0.061	0.035	*	–0.089	0.036	**									
Thursday																–0.062	0.037	*
Friday	0.134	0.055	**															
R^2	0.149			0.488			0.174			0.046			0.053			0.469		
No. of observations	339			945			836			235			907			229		

Significance: **** 99.99 per cent; *** 99 per cent; ** 95 per cent; * 90 per cent.

Price–volume relationships – ling

	Ungraded			Large			Medium			Small			Unspecified			Extra large		
	Estimate	SE	Sig	Estimate	SE	Sig	Estimate	SE	Sig	Estimate	SE	Sig	Estimate	SE	Sig	Estimate	SE	Sig
Intercept	1.562	0.110	****	1.754	0.075	****	1.967	0.081	****	1.233	0.125	****	1.524	0.081	****	2.267	0.094	****
Log (wgt ling)	0.048	0.020	**	0.169	0.025	****	0.089	0.026	****	0.281	0.051	****	0.145	0.030	****	0.101	0.035	***
Log (wgt ling)^2				–0.017	0.002	****	–0.010	0.002	****	–0.029	0.006	****	–0.017	0.003	****	–0.014	0.004	****
Log (wgt lagged 1 day)				–0.051	0.004	****	–0.044	0.005	****	–0.024	0.005	****	–0.039	0.007	****	–0.048	0.006	****
Log (wgt lagged 2 days)				–0.027	0.004	****	–0.023	0.005	****				–0.021	0.007	***	–0.033	0.006	****
Log (wgt other size ling)	–0.066	0.012	****	–0.016	0.005	****	–0.065	0.007	****	–0.098	0.010	****	–0.049	0.006	****	–0.081	0.006	****
Log (number of buyers)					–0.049	0.014	****											
Monday	0.093	0.044	**	–0.037	0.034	****	–0.307	0.038	****				–0.239	0.048	****	–0.317	0.039	****
Tuesday				–0.128	0.029	****	–0.100	0.033	***				–0.114	0.044	**	–0.142	0.035	****
Friday	–0.077	0.036	**							–0.073	0.028	***	–0.042	0.021	**			
R^2	0.138			0.477			0.368			0.217			0.233			0.440		
No. of observations	271			1010			988			507			973			667		

Significance: **** 99.99 per cent; *** 99 per cent; ** 95 per cent; * 90 per cent.

Price–volume relationships – ocean perch

	Ungraded			Large			Medium			Small			Unspecified			Extra large		
	Estimate	SE	Sig	Estimate	SE	Sig	Estimate	SE	Sig	Estimate	SE	Sig	Estimate	SE	Sig	Estimate	SE	Sig
Intercept	1.618	0.108	****	1.753	0.098	****	1.558	0.167	****	0.277	0.264		1.280	0.093	****	2.050	0.142	****
Log (wgt ocean perch)				0.198	0.035	****	0.225	0.061	****	0.361	0.118	***				0.118	0.053	**
Log (wgt ocean perch)^2				–0.024	0.003	****	–0.017	0.006	***	–0.031	0.015	**	0.004	0.002	**	–0.019	0.005	****
Log (wgt lagged 1 day)	–0.036	0.013	***	–0.071	0.006	****	–0.073	0.010	****				–0.020	0.010	**	–0.039	0.007	****
Log (wgt lagged 2 days)				–0.036	0.006	****	–0.049	0.011	****				–0.022	0.009	**			
Log (wgt other size ocean perch)	–0.103	0.014	****	–0.033	0.006	****	–0.114	0.013	****	–0.117	0.021	****	–0.096	0.013	****	–0.092	0.008	****
Number of buyers							–0.058	0.028	**	–0.186	0.054	****				0.065	0.023	***
Monday				–0.525	0.045	****	–0.536	0.071	****							–0.116	0.042	***
Tuesday	–0.108	0.053	**	–0.167	0.039	****	–0.220	0.061	****									
Thursday							–0.060	0.024	**									
Friday				0.054	0.015	****										0.061	0.018	****
R^2	0.117			0.407			0.231			0.099			0.073			0.248		
No. of observations	454			1053			990			564			890			891		

Significance: **** 99.99 per cent; *** 99 per cent; ** 95 per cent; * 90 per cent.

Price–volume relationships – silver warehou

	Ungraded			Large			Medium			Small			Unspecified			Extra large		
	Estimate	SE	Sig	Estimate	SE	Sig	Estimate	SE	Sig	Estimate	SE	Sig	Estimate	SE	Sig	Estimate	SE	Sig
Intercept	1.021	0.130	****	1.151	0.185	****	1.672	0.103	****	0.706	0.072	****	1.267	0.069	****	2.018	0.254	****
Log (wgt silver warehou)				0.133	0.064	**										–0.091	0.023	****
Log (wgt silver warehou)^2				–0.020	0.006	****	–0.012	0.003	****	–0.020	0.010	**	–0.024	0.002	****			
Log (wgt lagged 1 day)				–0.054	0.010	****	–0.046	0.011	****				–0.031	0.009	****	–0.033	0.010	***
Log (wgt lagged 2 days)							–0.050	0.013	****				–0.016	0.009	*			
Log (wgt other size silver warehou)	–0.087	0.018	****	–0.038	0.005	****	–0.047	0.005	****	–0.050	0.010	****	–0.040	0.008	****	–0.108	0.028	****
Log (number of buyers)							0.086	0.036	**				0.313	0.087	****			
Log (wgt blue warehou)	–0.035	0.017	*	–0.036	0.004	****	–0.034	0.005	****	–0.037	0.009	****	–0.053	0.007	****	–0.035	0.011	***
Monday				–0.129	0.069	*	–0.428	0.102	****									
Tuesday							–0.258	0.086	***									
R^2	0.46			0.416			0.362			0.212			0.4			0.305		
No. of observations	38			560			603			189			389			128		

Significance: **** 99.99 per cent; *** 99 per cent; ** 95 per cent; * 90 per cent.

Price–volume relationships – redspot whiting

	Ungraded			Large			Medium			Small			Unspecified			Extra large		
	Estimate	SE	Sig	Estimate	SE	Sig	Estimate	SE	Sig	Estimate	SE	Sig	Estimate	SE	Sig	Estimate	SE	Sig
Intercept	1.937	0.275	****	1.470	0.153	****	1.528	0.072	****	1.289	0.217	****	1.106	0.171	****	1.670	0.154	****
Log (wgt redspot whiting)	–0.209	0.039	****	0.153	0.057	***							0.113	0.060	*	0.357	0.055	****
Log (wgt redspot whiting)^2				–0.040	0.005	****	–0.021	0.002	****				–0.037	0.006	****	–0.061	0.006	****
Log (wgt redspot whiting lagged 1 day)				–0.044	0.009	****	–0.009	0.005	*				–0.083	0.010	****	–0.015	0.005	***
Log (wgt other size redspot whiting)	–0.064	0.032	**	–0.058	0.009	****	–0.123	0.009	****	–0.176	0.030	****	–0.034	0.007	****	–0.144	0.014	****
Log (number of buyers)	0.216	0.061	****	0.166	0.030	****	0.230	0.026	****				0.234	0.274	****	0.112	0.028	****
Log (wgt of trumpeter whiting)	–0.044	0.024	*				–0.014	0.008	*				0.014	0.008	*			
Monday				–0.096	0.053	*							–0.412	0.065	****			
Tuesday										–0.139	0.055	**						
Friday				0.071	0.024	***	0.087	0.028	***				0.076	0.028	***	0.122	0.023	****
R^2	0.252			0.37			0.272			0.117			0.254			0.375		
No. of observations	134			1062			941			282			1044			673		

Significance: **** 99.99 per cent; *** 99 per cent; ** 95 per cent; * 90 per cent.

Price–volume relationships – redfish (overall)

	Ungraded			Large			Medium			Small			Unspecified			Extra large		
	Estimate	SE	Sig	Estimate	SE	Sig	Estimate	SE	Sig	Estimate	SE	Sig	Estimate	SE	Sig	Estimate	SE	Sig
Intercept	2.175	0.128	****	1.909	0.099	****	2.067	0.182	****	1.313	0.199	****	1.727	0.154	****	2.389	0.088	****
Log (wgt redfish)				0.103	0.030	****	0.246	0.049	****				–0.110	0.044	**			
Log (wgt redfish)^2	–0.008	0.002	****	–0.026	0.002	****	–0.033	0.004	****				–0.009	0.004	**	–0.019	0.002	****
Log (wgt redfish lagged 1 day)	–0.023	0.005	****	–0.071	0.005	****	–0.080	0.008	****	–0.038	0.011	****	–0.024	0.008	***	–0.053	0.007	****
Log (wgt redfish lagged 2 days)				–0.053	0.005	****	–0.063	0.008	****				–0.030	0.009	****	–0.007	0.004	*
Log (wgt other size redfish)	–0.181	0.012	****	–0.024	0.006	****	–0.107	0.009	****	–0.128	0.016	****	–0.098	0.008	****	–0.085	0.009	****
Log (number of buyers)	0.058	0.031	*	0.121	0.023	****	0.146	0.029	*****				0.314	0.019	****	0.161	0.248	****
Log (wgt luderick)	–0.036	0.013	***	–0.034	0.006	****	–0.059	0.009	****	–0.053	0.023	**	–0.030	0.011	***	–0.051	0.008	****
Monday				–0.676	0.043	****	–0.932	0.077	****				–0.306	0.076	****	–0.185	0.043	****
Tuesday				–0.299	0.038	****	–0.432	0.066	****				–0.175	0.063	***			
Friday				0.048	0.015	***										0.062	0.021	***
R^2	0.331			0.679			0.501			0.234			0.405			0.400		
No. of observations	713			1094			1078			259			1089			817		

Significance: **** 99.99 per cent; *** 99 per cent; ** 95 per cent; * 90 per cent.

Price–volume relationships – redfish (peak Aug, Sept, Oct, Nov)

	Ungraded			Large			Medium			Small			Unspecified			Extra large		
	Estimate	SE	Sig	Estimate	SE	Sig	Estimate	SE	Sig	Estimate	SE	Sig	Estimate	SE	Sig	Estimate	SE	Sig
Intercept	1.542	0.155	****	1.857	0.175	****	2.214	0.298	****	1.359	0.326	****	0.714	0.085	****	2.682	0.218	****
Log (wgt redfish)				0.108	0.061	*	0.174	0.082	**	–0.072	0.034	**				–0.155	0.062	**
Log (wgt redfish)^2	–0.005	0.001	****	–0.030	0.004	****	–0.042	0.006	****				–0.019	0.002	****	–0.011	0.006	*
Log (wgt redfish lagged 1 day)				–0.072	0.007	****	–0.075	0.011	****							–0.050	0.011	****
Log (wgt redfish lagged 2 day)				–0.045	0.008	****	–0.050	0.013	****									
Log (wgt other size redfish)	–0.153	0.018	****	–0.027	0.010	***	–0.120	0.015	****	–0.063	0.025	**	–0.066	0.011	****	–0.080	0.015	****
Log (number of buyer)				0.202	0.035	****	0.453	0.049	****				0.278	0.032	****	0.255	0.042	****
Log (wgt luderick)				–0.033	0.010	****	–0.066	0.016	****	–0.127	0.046	***				–0.050	0.015	***
Monday	0.139	0.046	***	–0.674	0.067	****	–0.870	0.132	****							–0.161	0.061	***
Tuesday				–0.265	0.060	****	–0.339	0.107	***	–0.170	0.089	*						
Friday				0.072	0.022	***										0.061	0.032	*
R^2	0.293			0.740			0.566			0.233			0.323			0.430		
No. of observations	252			384			375			105			383			282		

Significance: **** 99.99 per cent; *** 99 per cent; ** 95 per cent; * 90 per cent.

Price–volume relationships – redfish (offpeak season)

	Ungraded			Large			Medium			Small			Unspecified			Extra large		
	Estimate	SE	Sig	Estimate	SE	Sig	Estimate	SE	Sig	Estimate	SE	Sig	Estimate	SE	Sig	Estimate	SE	Sig
Intercept	2.456	0.157	****	1.948	0.128	****	2.095	0.216	****	1.639	0.252	****	2.082	0.185	****	2.425	0.107	****
Log (wgt redfish				0.107	0.037	***	0.240	0.057	****				–0.108	0.054	**			
Log (wgt redfish)^2	–0.002	0.001	**	–0.023	0.003	****	–0.025	0.004	****				–0.008	0.004	*	–0.017	0.002	****
Log (wgt redfish lagged 1 day)	–0.022	0.007	***	–0.070	0.006	****	–0.075	0.010	****	–0.037	0.014	***	–0.035	0.010	****	–0.059	0.009	****
Log (wgt redfish lagged 2 days)				–0.060	0.007	****	–0.069	0.010	****				–0.041	0.011	****	–0.008	0.005	*
Log (wgt other size redfish)	–0.199	0.015	****	–0.023	0.008	***	–0.090	0.011	****	–0.156	0.022	****	–0.113	0.009	****	–0.078	0.011	****
Log (number of buyers)				0.074	0.030	**							0.316	0.023	****	0.128	0.031	****
Log (wgt luderick)	–0.065	0.016	****	–0.034	0.008	****	–0.076	0.012	****	–0.063	0.027	**	–0.051	0.013	****	–0.061	0.010	****
Monday				–0.712	0.055	****	–0.901	0.094	****				–0.409	0.091	****	–0.213	0.056	****
Tuesday				–0.352	0.048	****	–0.479	0.082	****				–0.232	0.078	***			
Thursday				–0.044	0.020	**												
Friday																0.068	0.027	**
R^2	0.332			0.658			0.497			0.295			0.464			0.403		
No. of observations	461			710			703			154			706			535		

Significance: **** 99.99 per cent; *** 99 per cent; ** 95 per cent; * 90 per cent.

Price–volume relationships – silver trevally (unprocessed)

	Ungraded			Large			Medium			Small			Unspecified			Extra large		
	Estimate	SE	Sig	Estimate	SE	Sig	Estimate	SE	Sig	Estimate	SE	Sig	Estimate	SE	Sig	Estimate	SE	Sig
Intercept	2.438	0.13	****	2.180	0.167	****	2.117	0.111	****	1.897	0.149	****	2.000	0.08	****	1.348	0.262	****
Log (wgt silver trevally)				0.089	0.05	*												
Log (wgt silver trevally)^2	–0.016	0	****	–0.029	0.005	****	–0.018	0.002	****				–0.024	0	****	–0.008	0.003	***
Log (wgt silver trevally lagged 1 day)	–0.026	0.01	***	–0.041	0.009	****	–0.031	0.008	****	–0.026	0.007	****	–0.073	0.01	****	–0.031	0.016	*
Log (wgt silver trevally lagged 2 days)													–0.054	0.01	****			
Log (wgt other size unprocessed silver trevally)	–0.223	0.02	****	–0.151	0.013	****	–0.141	0.011	****	–0.180	0.016	****	–0.051	0.01	****	–0.084	0.035	**
Log (wgt other processed silver trevally)	–0.015	0.01	**	–0.026	0.005	****	–0.021	0.004	****	–0.015	0.006	**	–0.022	0	****	–0.027	0.015	*
Log (number of buyers)	0.15	0.04	****	0.178	0.027	****	0.171	0.028	****				0.229	0.03	****			
Log (wgt luderick)				–0.028	0.011	***	–0.026	0.011	**	–0.047	0.014	****						
Monday				–0.197	0.054	****	–0.114	0.055	**				–0.665	0.08	****			
Tuesday													–0.321	0.07	****			
Thursday	–0.094	0.05	*															
Friday	0.147	0.04	****	0.135	0.028	****	0.134	0.027	****	0.181	0.034	****	0.132	0.03	****	0.209	0.075	***
R^2	0.327			0.343			0.295			0.197			0.441			0.245		
No. of observations	529			868			1 011			629			1 148			99		

Significance: **** 99.99 per cent; *** 99 per cent; ** 95 per cent; * 90 per cent.

Price–volume relationships – blue warehou

	Ungraded			Large			Medium			Small			Unspecified		
	Estimate	**SE**	**Sig**	**Estimate**	**SE**	**Sig**	**Estimate**	**SE**	**Sig**	**Estimate**	**SE**	**Sig**	**Estimate**	**SE**	**Sig**
Intercept	0.663	0.051	****	1.321	0.049	****	1.006	0.241	****	0.801	0.110	****	0.921	0.109	****
Log (wgt blue warehou)							0.169	0.090	*						
Log (wgt blue warehou)^2							–0.038	0.009	****						
Log (wgt blue warehou lagged 1 day)							–0.012	0.007	*				–0.027	0.013	**
Log (wgt other size blue warehou)				–0.021	0.006	****	–0.018	0.008	**				–0.027	0.010	***
Log (number of buyers)				–0.049	0.015	***	0.238	0.052	****						
Log (wgt of silver warehou)				–0.042	0.007	****	–0.043	0.008	****	–0.094	0.017	****	–0.048	0.014	****
Monday				0.128	0.037	****				0.207	0.079	***			
Friday							–0.108	0.044	**						
R^2	0			0.192			0.3			0.190			0.107		
No. of observations	40			345			268			148			238		

Significance: **** 99.99 per cent; *** 99 per cent; ** 95 per cent; * 90 per cent.

Price–volume relationships – blueye (gutted and headed)

	Large			Medium			Small			Unspecified		
	Estimate	SE	Sig	Estimate	SE	Sig	Estimate	SE	Sig	Estimate	SE	Sig
Intercept	2.233	0.045	****	2.299	0.060	****	2.342	0.133	****	2.121	0.097	****
Log (wgt blueye)										0.091	0.034	***
Log (wgt blueye)^2	–0.002	0.001	**	–0.005	0.002	***				–0.013	0.003	****
Log (wgt blueye lagged 1 day)										–0.007	0.002	***
Log (wgt other size blueye)	–0.022	0.007	***	–0.029	0.010	***	–0.053	0.021	**			
Log (wgt hapuka)										–0.005	0.003	*
Log (wgt blue warehou)				0.010	0.004	**	0.012	0.006	*			
Log (wgt jewfish)										–0.024	0.006	****
Friday										0.027	0.015	*
R^2	0.085			0.219			0.099			0.117		
No. of observations	188			101			78			911		

Significance: **** 99.99 per cent; *** 99 per cent; ** 95 per cent; * 90 per cent.

Price–volume relationships – blueye (whole)

	Large			Medium			Small			Unspecified		
	Estimate	**SE**	**Sig**	**Estimate**	**SE**	**Sig**	**Estimate**	**SE**	**Sig**	**Estimate**	**SE**	**Sig**
Intercept	2.244	0.079	****	2.121	0.073	****	2.031	0.066	****	2.103	0.048	****
Log (wgt blueye)^2							–0.006	0.002	***	–0.003	0.001	****
Log (wgt other processed blueye)	–0.045	0.012	****	–0.026	0.010	***	–0.021	0.009	**	–0.030	0.004	****
Log (wgt other size whole blueye)	–0.043	0.013	****	–0.039	0.010	****	–0.020	0.010	*	0.010	0.004	***
Log (wgt jewfish)										–0.027	0.008	****
Log (wgt blue warehou)							0.010	0.005	**			
R^2	0.277			0.192			0.180			0.129		
No. of observations	101			106			138			712		

Significance: **** 99.99 per cent; *** 99 per cent; ** 95 per cent ; * 90 per cent.

Price–volume relationships – snapper (gilled and gutted)

	Unspecified			Large			Medium			Small			Ungraded		
	Estimate	SE	Sig	Estimate	SE	Sig	Estimate	SE	Sig	Estimate	SE	Sig	Estimate	SE	Sig
Intercept	2.973	0.08	****	3.050	0.09	****	3.227	0.09	****	2.704	0.085	****	3.450	0.08	****
Log (wgt snapper)	0.056	0.02	**	0.063	0.03	**	0.079	0.03	***	0.235	0.022	****			
Log (wgt snapper)^2	–0.019	0	****	–0.011	0	****	–0.017	0	****	–0.0325	0	****	–0.008	0.00	****
Log (wgt lagged 1 day)	–0.015	0	****	–0.030	0.01	****	–0.028	0.01	****	–0.043	0.005	****	–0.012	0.00	****
Log (wgt lagged 2 days)				–0.024	0.01	****	–0.022	0.01	****	–0.037	0.005	****			
Log (wgt other processed snapper)	–0.063	0.01	****	–0.030	0	****	–0.023	0	****	–0.014	0.002	****	–0.019	0.00	****
Log (wgt other size snapper)	–0.022	0	****	–0.0503	0.01	****	–0.063	0.01	****	0.021	0.007	***	–0.122	0.01	****
Log (number of buyers)	0.073	0.02	****				0.073	0.02	****				0.062	0.02	***
Log (wgt silver bream)	–0.037	0.01	****	–0.035	0.01	****	–0.052	0.01	****	–0.036	0.006	****	–0.049	0.01	****
Log (wgt redspot whiting)										0.006	0.004	*	0.012	0.01	**
Log (wgt silver bluefin tuna)	–0.011	0	***	–0.007	0	**	–0.004	0	*	–0.005	0.003	*	–0.007	0.00	**
Monday				–0.218	0.04	****	–0.212	0.04	****	–0.434	0.039	****			
Tuesday				–0.122	0.03	****	–0.116	0.03	****	–0.221	0.037	****			
Thursday							–0.217	0.01	*	–0.051	0.012	****			
Friday	0.105	0.01		0.085	0.1	****	0.085	0.01	****	0.054	0.013	****	0.102	0.01	****
R^2	0.279			0.397			0.463			0.6230			0.373		
No. of observations	1 039			1 109			1 117			1 136			929		

Significance: **** 99.99 per cent; *** 99 per cent; ** 95 per cent; * 90 per cent.

Price–volume relationships – snapper (whole)

	Unspecified			Large			Medium			Small			Ungraded			Extra large		
	Estimate	SE	Sig	Estimate	SE	Sig	Estimate	SE	Sig	Estimate	SE	Sig	Estimate	SE	Sig	Estimate	SE	Sig
Intercept	3.189	0.11	****	2.685	0.11	****	3.185	0.173	****	2.887	0.127	****	3.97	0.25		2.21	0.12	****
Log (wgt snapper)	–0.094	0.01	****	0.062	0.01	****	–0.116	0.023	****									
Log (wgt snapper)^2										–0.009	0.001	****				–0.006	0	*
Log (wgt lagged 1 day)	–0.017	0.01	****							–0.011	0.005	*						
Log (total wgt other processed snapper)	–0.057	0.01	****	–0.078	0.01	****	–0.059	0.014	****	–0.041	0.011	****	–0.25	0.04				
Log (wgt other size snapper)							–0.023	0.007	***				–0.048	0.01		–0.03	0.02	*
Log (number of buyers)	0.057	0.02	***				0.097	0.029	****									
Log(wgt silver bream)	–0.062	0.01	****				–0.047	0.018	**	–0.041	0.014	***						
Monday	0.072	0.03	**													0.256	0.11	**
Tuesday																		
Friday	0.079	0.02	****	0.104	0.04	***	0.064	0.034	*	0.089	0.027	***						
R^2	0.377			0.258			0.349			0.385			0.707			0.237		
No. of observations	492			169			193			231			31			37		

Significance: **** 99.99 per cent; *** 99 per cent; ** 95 per cent; * 90 per cent.

Price–volume relationships – yellowfin tuna

	Unspecified		
	Estimate	**SE**	**Sig**
Intercept	1.571	0.26	****
Log(wgt yellowfin)	0.883	0.08	****
Log (wgt yellowfin)^2	–0.069	0.01	****
Log (wgt lagged 1 day)	–0.013	0.01	****
Log (wgt lagged 2 days)	–0.080	0.01	****
Log (number of buyers)	–0.357	0.03	***
Log(wgt southern bluefin)	–0.023	0.01	****
Monday	–1.227	0.10	****
Tuesday	–0.480	0.09	****
Friday	0.113	0.03	****
R^2	0.5901		
No. of observations	1 097		

Significance: **** 99.99 per cent; *** 99 per cent; ** 95 per cent; * 90 per cent.

Price–volume relationships – bully mullet

	Ungraded			Large			Medium			Small			Unspecified			Extra large		
	Estimate	SE	Sig	Estimate	SE	Sig	Estimate	SE	Sig	Estimate	SE	Sig	Estimate	SE	Sig	Estimate	SE	Sig
Intercept	2.877	0.147	****	2.163	0.070	****	2.940	0.181	****	2.378	0.54	****	1.652	0.22	****	2.143	0.134	****
Log (wgt mullet)							–0.096	0.056	*				0.189	0.07	***	0.130	0.043	***
Log (wgt mullet)^2	–0.021	0.002	****	–0.026	0.002	****	–0.012	0.005	**	–0.042	0.02	*	–0.042	0.01	****	–0.026	0.005	****
Log (wgt lagged 1 day)	–0.022	0.006	****	–0.067	0.008	****	–0.058	0.009	****				–0.086	0.01	****	–0.023	0.003	****
Log (wgt lagged 2 days)	–0.013	0.006	**				–0.042	0.010	****									
Log (wgt other size mullet)	–0.284	0.019	****	–0.128	0.009	****	–0.203	0.014	****	–0.296	0.07	****	–0.145	0.01	****	–0.184	0.011	****
Log (number of buyers)	0.185	0.032	****	0.316	0.026	****	0.177	0.027	****				0.271	0.03	****	0.101	0.022	****
Log (wgt sea mullet)	–0.021	0.004	****	–0.028	0.002	****	–0.033	0.003	****				–0.022	0.00	****	–0.025	0.003	****
Log (wgt fantail mullet)				0.022	0.003	****	0.023	0.004	****				0.014	0.00	***	0.022	0.003	****
Monday				–0.339	0.052	****	–0.421	0.070	****				–0.429	0.07	****			
Tuesday							–0.229	0.060	****									
Friday	0.117	0.031	****	0.073	0.017	****	0.093	0.025	****				0.075	0.03	****	0.114	0.018	****
R^2	0.349			0.568			0.489			0.32			0.453			0.476		
No. of observations	783			1 148			1 031			45			1 138			949		

Significance: **** 99.99 per cent; *** 99 per cent; ** 95 per cent; * 90 per cent.

Price–volume relationships – cooked king prawn

	Ungraded			Large			Medium			Small			Unspecified			Extra large		
	Estimate	SE	Sig	Estimate	SE	Sig	Estimate	SE	Sig	Estimate	SE	Sig	Estimate	SE	Sig	Estimate	SE	Sig
Intercept	3.068	0.171	****	2.971	0.076	****	2.734	0.098	****	2.552	0.062	****	2.410	0.06	****	3.120	0.077	****
Log (wgt king prawn)	0.135	0.071	*	0.097	0.029	***	0.226	0.030	****							–0.055	0.016	****
Log (wgt king prawn)^2	–0.022	0.008	***	–0.009	0.003	***	–0.024	0.003	****									
Log (wgt lagged 1 day)	–0.017	0.007	**	–0.022	0.005	****	–0.021	0.007	***				–0.039	0.02	**			
Log (wgt lagged 2 days)							–0.026	0.007	****									
Log (wgt other size k prawn)	–0.085	0.013	****	–0.029	0.003	****										–0.020	0.011	*
Log (wgt other prawns)							–0.027	0.005	****	–0.039	0.008	****						
Log (number of buyers)	0.053	0.030	*	–0.027	0.015	*										0.045	0.025	*
Monday				–0.108	0.032	****	–0.253	0.050	****									
Tuesday							–0.148	0.045	***									
Thursday				–0.032	0.018	*												
Friday	0.069	0.031	**	0.068	0.016	****	0.084	0.018	****	0.068	0.021	***	0.110	0.06	*	0.062	0.024	**
R^2	0.226			0.171			0.234			0.048			0.033			0.170		
No. of observations	336			937			968			592			206			164		

Aggregate of all other prawn species sold. a Estimates are significant at the 99.99 per cent level of confidence unless shown otherwise.
Significance: *** = 99 per cent. ** = 95 per cent. * = 90 per cent.

Appendix C

Price flexibilities, by species and grade – high, average and low volume sales

		Not defined	Large	Medium	Small	Not graded	Extra large	All
Tiger flathead								
Average sale	kg/day	632	613	592	103	106	736	3 337
Expected price	$/kg	1.77	2.98	1.99	1.61	1.8	3.14	2.6
Price flexibility	a	–0.38	–0.26	–0.33	–0.14	–0.16	–0.33	–0.52
rse	%	10	30	10	70	50	10	0
Low sale	kg/day	290	322	282	40	44	354	1 803
Expected price	$/kg	2.14	3.24	2.42	1.41	1.98	3.66	2.74
Price flexibility	a	–0.34	–0.22	–0.31	–0.08	–0.1	–0.29	–0.49
rse	%	10	30	10	120	80	20	0
High sale	kg/day	1 195	1 059	1 046	256	271	1 454	5 374
Expected price	$/kg	1.51	2.76	1.96	1.34	1.86	3.21	2.29
Price flexibility	a	–0.4	–0.29	–0.35	–0.2	–0.22	–0.38	–0.54
rse	%	10	20	10	60	40	10	0
Redfish								
Average sale	kg/day	702	684	1 882	62	122	128	4 324
Expected price	$/kg	0.84	2.01	1.32	0.73	1.38	2.55	1.34
Price flexibility	a	–0.28	–0.36	–0.39	–0.04	–0.1	–0.24	–0.61
rse	%	20	10	10	30	20	10	0
Low sale	kg/day	202	250	762	26	39	49	1 918
Expected price	$/kg	1.13	2.35	1.63	0.85	1.24	2.47	1.8
Price flexibility	a	–0.26	–0.3	–0.33	–0.04	–0.08	–0.21	–0.56
rse	%	20	10	20	30	20	10	0
High sale	kg/day	1 697	1 400	3913	159	514	291	7 636
Expected price	$/kg	0.82	1.67	1.13	0.8	1.13	2.2	1.15
Price flexibility	a	–0.3	–0.39	–0.44	–0.04	–0.12	–0.28	–0.64
rse	%	20	10	10	30	20	10	0
Morwong								
Average sale	kg/day	338	602	227	42	31	397	1 730
Expected price	$/kg	2.53	3.04	2.38	2.39	2.51	3.27	2.94
Price flexibility	a	–0.28	–0.26	–0.25	–0.07	–0.04	–0.21	–0.31
rse	%	10	20	30	30	40	20	10
Low sale	kg/day	136	214	83	20	21	109	594
Expected price	$/kg	3.01	3.38	2.86	1.83	2.97	3.56	3.26
Price flexibility	a	–0.26	–0.21	–0.19	–0.07	–0.04	–0.16	–0.26
rse	%	20	30	40	30	40	20	10
High sale	kg/day	858	1 384	544	105	63	1 088	3 445
Expected price	$/kg	2.27	2.73	2.25	1.86	2.62	2.68	2.75
Price flexibility	a	–0.31	–0.3	–0.31	–0.07	–0.04	–0.25	–0.33
rse	%	10	20	30	30	40	20	10

Continued ⇨

Price flexibilities, by species and grade – high, average and low volume sales
Continued

		Not defined	Large	Medium	Small	Not graded	Extra large	All
Silver trevally								
Average sale	kg/day	654	148	347	64	56	79	1 498
Expected price	$/kg	1.6	1.81	1.59	1.3	2.01	1.44	1.59
Price flexibility	a	–0.43	–0.242	–0.24	–0.026	–0.15	–0.1	–0.57
rse	%	10	20	10	30	20	30	0
Low sale	kg/day	298	48	122	26	25	24	809
Expected price	$/kg	2.04	2.11	1.88	1.21	1.95	1.94	1.96
Price flexibility	a	–0.4	–0.18	–0.2	–0.03	–0.13	–0.08	–0.54
rse	%	10	30	10	30	20	30	0
High sale	kg/day	1 219	363	822	147	127	346	2 449
Expected price	$/kg	1.46	1.64	1.59	1.09	1.69	1.23	1.47
Price flexibility	a	–0.46	–0.29	–0.27	–0.03	–0.18	–0.12	–6
rse	%	10	20	10	30	20	30	10
Ling								
Average sale	kg/day	173	311	374	76	32	127	1 001
Expected price	$/kg	3.24	4.82	3.87	3.18	3.96	4.7	4.13
Price flexibility	a	–0.09	–0.11	–0.09	0.01	0.05	–0.11	–0.1
rse	%	40	20	30	530	40	30	30
Low sale	kg/day	57	124	148	25	20	47	394
Expected price	$/kg	3.59	4.98	4.2	3.01	3.75	4.78	4.52
Price flexibility	a	–0.05	–0.08	–0.08	0.06	0.05	–0.09	–0.06
rse	%	60	30	40	70	40	40	40
High sale	kg/day	445	686	794	192	55	306	2 186
Expected price	$/kg	3.11	4.15	3.65	3.05	3.65	4.12	3.8
Price flexibility	a	–0.12	–0.14	–0.11	–0.04	0.05	–0.14	–0.12
rse	%	30	20	30	130	40	30	20
Gemfish (whole)								
Average sale	kg/day	200	159	83	40			348
Expected price	$/kg	4.48	4.72	3.68	2.72			4.69
Price flexibility	a	–0.17	–0.13	–0.11	–0.07			–0.23
rse	%	30	20	20	40			20
Low sale	kg/day	67	45	32	25			124
Expected price	$/kg	4.27	5.1	4.05	2.7			4.52
Price flexibility	a	–0.09	–0.08	–0.09	–0.07			–0.16
rse	%	60	30	20	40			30
High sale	kg/day	477	505	197	100			787
Expected price	$/kg	4.65	4.3	3.58	2.16			4.31
Price flexibility	a	–0.24	–0.17	–0.13	–0.08			–0.29
rse	%	30	20	30	40			20

Continued ⇨

Price flexibilities, by species and grade – high, average and low volume sales
Continued

		Not defined	Large	Medium	Small	Not graded	Extra large	All
John dory								
Average sale	kg/day	77	352	167	66	39	83	870
Expected price	$/kg	4.19	7.85	5.58	3.81	5.71	7.98	6.93
Price flexibility	a	–0.29	–0.02	–0.12	–0.25	0.07	0.04	0.1
rse	%	10	180	40	40	50	30	90
Low sale	kg/day	33	181	81	30	20	37	459
Expected price	$/kg	5.76	8.35	6.13	3.9	5.82	7.15	7.51
Price flexibility	a	–0.27	0.14	–0.07	–0.16	0.05	0.04	0.15
rse	%	10	250	70	50	60	30	50
High sale	kg/day	165	618	352	131	69	172	1 431
Expected price	$/kg	3.88	7.44	4.97	3.01	5.88	7.37	5.96
Price flexibility	a	–0.3	–0.05	–0.175	–0.32	0.09	0.04	0.03
rse	%	10	80	30	30	50	30	260
Mirror dory								
Average sale	kg/day	113	289	136	37		55	578
Expected price	$/kg	1.54	3.39	1.54	1.12		3.43	2.86
Price flexibility	a	0.07	–0.08	0.06	–0.03		–0.03	–0.04
rse	%	120	30	50	50		30	30
Low sale	kg/day	39	95	59	21		26	211
Expected price	$/kg	1.64	3.37	1.86	1.04		3.39	2.62
Price flexibility	a	0.01	–0.03	0.05	–0.03		–0.04	–0.04
rse	%	590	100	50	50		30	30
High sale	kg/day	260	907	282	92		138	1 320
Expected price	$/kg	1.93	2.88	1.51	0.93		2.82	2.68
Price flexibility	a	0.11	–0.14	0.07	–0.03		–0.03	–0.04
rse	%	80	20	40	50		30	30
Red spot whiting								
Average sale	kg/day	378	266	234		60	78	1 058
Expected price	$/kg	1.65	2.65	1.76		1.8	3.52	1.9
Price flexibility	a	–0.4	–0.34	–0.23		–0.21	–0.188	–0.608
rse	%	20	20	10		20	30	0
Low sale	kg/day	158	109	95		20	37	556
Expected price	$/kg	1.62	2.8	1.66		1.93	3.54	2.19
Price flexibility	a	–0.34	–0.27	–0.197		–0.21	–0.1	–0.56
rse	%	20	20	10		20	60	0
High sale	kg/day	768	543	463		193	160	1659
Expected price	$/kg	1.46	2.21	1.49		1.59	2.91	1.74
Price flexibility	a	–0.46	–0.398	–0.26		–0.21	–0.27	–0.638
rse	%	20	20	10		20	20	0

Continued ⇨

Price flexibilities, by species and grade – high, average and low volume sales
Continued

		Not defined	Large	Medium	Small	Not graded	Extra large	All
Ocean perch								
Average sale	kg/day	70	296	180	53	31	211	803
Expected price	$/kg	1.99	4.05	2.43	1.21	2.62	4.75	3.6
Price flexibility	a	–0.007	–0.177	–0.07	0.11	–0.036	–0.12	–0.1546
rse	%	310	20	90	110	40	50	30
Low sale	kg/day	31	126	81	27	21	90	344
Expected price	$/kg	1.99	4.24	2.43	1.52	2.47	4.94	3.72
Price flexibility	a	–0.013	–0.136	–0.045	0.15	–0.036	–0.09	–0.113
rse	%	130	30	130	70	40	60	40
High sale	kg/day	142	632	333	114	52	438	1 491
Expected price	$/kg	1.71	3.44	2.23	1.43	2.37	4.5	3.43
Price flexibility	a		–0.212	–0.094	0.06	–0.036	–0.147	–0.185
rse	%	2 530	20	80	210	40	40	30
Silver warehou								
Average sale	kg/day	159	384	514	160		559	960
Expected price	$/kg	1.37	1.85	1.75	1.25		1.5	2.02
Price flexibility	a	–0.287	–0.16	–0.25	–0.02		–0.12	–0.41
rse	%	10	40	10	50		20	20
Low sale	kg/day	36	105	157	53		192	220
Expected price	$/kg	1.72	2.03	1.76	1.64		1.15	2.27
Price flexibility	a	–0.216	–0.11	–0.22	–0.02		–0.12	–0.29
rse	%	10	60	10	50		50	20
High sale	kg/day	761	1 038	1 280	504		1 187	2 372
Expected price	$/kg	1.37	1.64	1.36	1.36		1.27	1.34
Price flexibility	a	–0.36	–0.2	–0.27	–0.02		–0.12	–0.48
rse	%	10	40	20	50		50	10
Blue warehou								
Average sale	kg/day			225				365
Expected price	$/kg			1.87				2.01
Price flexibility	a			–0.25				–0.036
rse	%			40				20
Low sale	kg/day			64				94
Expected price	$/kg			2.27				2.16
Price flexibility	a			–0.155				–0.036
rse	%			60				20
High sale	kg/day			673				1005
Expected price	$/kg			1.93				2.13
Price flexibility	a			–0.33				–0.036
rse	%			30				20

a The price flexibilities shown are the change in price associated with a 1 per cent change in quantity sold.

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Final Report
FRDC Project no 95/118

FISHERIES RESEARCH & DEVELOPMENT CORPORATION

Evaluation of factors influencing prices of domestic seafoods

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ii. Summary

The relationships between prices play an important role in efficient resource use. Prices provide signals to fishing operators in relation to what is required, when, in what volumes, and with what characteristics. The objective in this study was to examine these relationships, to identify the links between volume supplied and the quality characteristics of that volume with price.

For this study, an analysis was undertaken of prices formed at the Sydney Fish Market, Australia's largest fresh fish auction, for product landed from the south east fishery, Australia's major producer of fresh fish for domestic consumption. This fishery supplies a range of different markets with fourteen key species of fish and is managed under an individual tradeable quota system, based on setting of total allowable catches to restrict the commercial harvest.

The relationship between the quantity of fish sold and prices received is key management information, needed to establish the impact of changes in catch levels on total industry revenue. The likely impact on revenue of management decisions need to be known to establish the benefits and costs of the available management options. If prices are responsive to changes in volume then the impact of a reduction in total allowable catches on revenue will be reduced by higher prices.

This study has found that prices for the major south east fishery species sold at the Sydney Fish Market are responsive to changes in the volume sold, with this response ranging from around -0.6 per cent for redfish and red spot whiting, silver trevally and tiger flathead down to -0.1 for ling. For a number of the species examined, the results were not sufficiently conclusive, suggesting that prices formed were significantly influenced by other markets. For other species, such as orange roughy and blue grenadier, an insufficient proportion of catches were sold at the Sydney Fish Market for the price-quantity relationship to be estimated.

The price-quantity relationships between different size grades of the same species were also examined to isolate the impact of fish size on prices received. These analyses found large differences in both the prices and the quantity relationships between different size grades. In particular the demand for small fish from a number of the species were strongly dependent on the availability of larger sized fish of the same species.

Prices were found to be influenced by a range of other factors apart from the volume sold. These included the total volume of all fish on the market, the size grade of the fish,

the number of buyers and the day of the week. However, even with these factors incorporated, a large proportion of the variation in average daily prices remained unexplained. Some of this variation may be due to the interaction of prices for the species assessed with other fish sold on the market, the specific auction conditions, and the impact of price influences outside the market, such as the availability of product from wholesalers and importers.

To identify the impact of quality differences on price, a separate study of was conducted based on a quality assessment of 10 000 lots of nine species sampled over a twelve month period. This assessment was conducted using visual assessment of the accuracy of grading, icing, and six appearance/quality characteristics set according to species. The characteristics used were selected in consultation with buyers at the Market.

A range of quality differences were identified in the fish sampled in the survey. A number of these were associated with the impact of seasonal variations, such as inadequate icing during warmer weather. The grades set by the Sydney Fish Market were met by 73 per cent of all product assessed, while 76 per cent of the product had sufficient ice, the distribution of ice was a problem in 40 per cent of product sampled.

In general, the relationships between prices received and quality depended on the characteristic and the species. The quality factors assessed during the trial did explain some of the variation between the actual prices received and the expected prices calculated on the basis of the volume on the day. However, the influence of quality factors was not particularly strong. The strongest impact of the quality factors used was in relation to whole snapper and yellowfin tuna, where they accounted for 30 and 14 per cent, respectively, of the total variation in prices. However, for most species assessed, quality factors only explained a relatively small proportion of the daily variation in prices over the period, ranging from around 5 per cent for morwong to around 2 per cent of ling and flathead.

iii. Background

The initial focus of the project was to examine the relationships between prices received by fishing operators and quality factors, to identify whether these factors were reflected in prices at auction. In a previous study of marketing in the south east fishery (Smith, Tran and Ruello, 1995), a key factor found to influence the seafood handling practices of a group of fishing operators was the widely held perception that differences in product quality were not reflected in the prices they received.

At the request of the Fisheries Research and Development Corporation, the project was expanded to examine volume–price relationships for major species from the south east fishery in addition to those species targeted for the quality study.

The study was undertaken on sales made at the Sydney Fish Market because of its importance as an outlet for fish from the south east fishery, its role in establishing domestic seafood prices and because both the marketing and accounting systems used were suited to collecting the detailed information necessary to undertake an analysis of the impact of volume and quality factors on seafood prices.

iv. Need

Analysis of the relationships between prices received and quantity supplied at the wholesale level is needed to help establish the likely revenue implications of any decisions by fisheries managers in setting desired catch levels for target species. The analysis is also relevant to the management of by-catch and in resolving resource access issues. Such analysis also provides some guidance to fishing operators to target particular species or size of fish, in marketing of catches.

Price analysis is also useful in addressing a range of marketing efficiency issues in the fishing industry as it allows the impact of different marketing practices on prices to be established. The main marketing efficiency issue addressed in this project is whether prices established at markets convey effective price signals in relation to consumer requirements to the catching sector. Very often, it is difficult for fishing operators to ascertain the premiums and discounts involved with different practices because of the large number of factors which may simultaneously influence the prices they receive. Unless fishermen supplying the market are aware of the effects of different factors on their returns they are unlikely to adapt their fishing and handling practices to meet consumer requirements.

v. Objectives

The objective of the project was to establish the relative importance of different factors on prices paid at auction for selected species on the Sydney Fish Market. These included:

- the influence of handling and quality attributes of products; and
- the impact of volume changes.

vi. Methods

The range of methods were used in the project and are outlined in detail in the attached report. These included the use of separate ordinary least squares regressions to establish the impact of volume factors on average daily prices received for south east trawl quota species for the period April 1992 to March 1996.

The analysis of quality was undertaken using a hedonic pricing model to establish the impact of various aspects of fish quality assessed over a twelve month period. This model attempts to identify the impact of different factors in explaining the difference between the expected price for the species, based on the supplies to the market and the actual price received.

vii. Detailed results

See attached draft report

viii. Benefits

The major benefit of the project accrues to the industry and consumers. The project provides baseline information fundamental to addressing both marketing and quality issues in the industry. Generating estimates of price flexibilities for major south east fishery species can be expected to have a major impact on management of that fishery and contribute to resolving many of the problems faced.

The project results may also contribute to standardisation of product descriptions in the industry. Many of the issues involved with the development of standardised grades are addressed in the project and a simple grading system used in the project has potential for wider application in the industry.

ix. Intellectual property

Not applicable

x. Further development

The research covered in the project has wide application and can be further developed in a range of areas. The research could be extended to establish the relationships between markets. This would require identifying the pricing links between the Sydney Fish Market and other channels used to market south east trawl fish (Melbourne fish market and processing) and between the domestic market and imports.

The research does not establish conclusively the market links between different types of seafood sold on the Sydney Fish Market. While this was attempted in the project using several different techniques it was not generally possible to usefully identify causal relationships in demand for different species. One technique not used was cointegration which has been successfully applied in overseas studies but would need to incorporate the large number of species involved in the trade. This provides a large number of possible permutations which would need to be examined. The major advantage is that the approach would further improve the accuracy of price-quantity definitions.

One major application will be in incorporating marketing considerations in fisheries management decision making. For example, problems of high grading in the fishery are partly due to inadequate specification of quota property rights in relation to market demand. A high proportion of total redfish caught is discarded because there is not the same market demand for small redfish as for other grades. The costs associated with this practice can be established through the use of the price flexibility analysis in this report.

The analysis will assist the industry in defining the marketing options available to it. Definition of the price flexibilities has identified the key factors influencing the price which can be expected from selling on the Sydney Fish Market.

The report provides a basis for examining strategies for improving quality of seafood on the domestic market. For industry to address quality issues it is necessary that markets reflect the value differences which are important to consumers. The results of this report suggests that price premiums for the quality factors assessed do not come through strongly. Provided that the characteristics used are an accurate reflection of consumer preferences, it may be desirable to develop measures to strengthen these relationships. The most obvious of the options is development of standardised product descriptions.

The development of standardised quality descriptions is becoming a priority area for development in the seafood industry because it is essential for electronic marketing and in the development of quality assurance programs. The independent development of such descriptions is not only more expensive in aggregate to develop, it has major ongoing transaction costs to the industry.

The report raises the issue of the benefits and costs of introducing improvements in fish product description and provides an outline of a simple quality grading system which could be used to develop an effective means of developing standardised product descriptions for domestic seafood. The analysis also provides some insight into the demand differences involved with different grades and highlights instances (such as

with flathead where there are no benefits in maintaining some of the existing size grades – such as between large and extra large flathead – because there is no difference in demand.

The analysis can be used to highlight the potential to develop some measures specific to the Sydney Fish Market. One such example is the possible impact of the speed of the auction on quality assessments by buyers. The key quality measures which had an impact were those which can be assessed quickly by buyers (such as colour of snapper) or for those fish inspected by buyers (such as yellowfin tuna sold in the sashimi bay). If the speed of the auction is a problem (as would appear to be the case), one option may be to use video cameras to highlight the quality of the fish under auction. There may be others.

A further option which may be more effective is to develop training programs for both buyers and sellers on fish quality and its impact. Such programs may address various problems highlighted in the report, such as those associated with inadequate distribution of ice.

xi. Staff

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xiii Distribution

The attached draft report will be professionally edited and published as an ABARE Research Report. It may also be desirable to undertake some direct extension work with both industry and buyers to effectively communicate the results of the research. This possibility has been discussed with FRDC.

Summaries of the research will also be provided for publication in relevant industry magazines.