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AUSTRALIAN fisheries surveys report 2003

Economic performance of selected fisheries in 2000-01 and 2001-02

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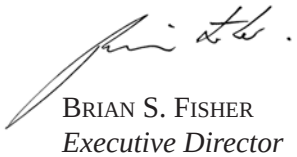
ABARE is a professionally independent government economic research agency.

ABARE project 2866

foreword

Estimates of the economic performance of operators in the northern prawn, Torres Strait prawn, south east trawl, and southern and western tuna and billfish fisheries — which were surveyed by ABARE in 2003 — are given in this report.

ABARE survey information is used by fisheries policy makers, managers, researchers and the fishing industry. For instance, the Australian Government Department of Agriculture, Fisheries and Forestry uses the information to assess the Australian Fisheries Management Authority's performance in managing Commonwealth fisheries. As the information is made available publicly, those in the fishing industry can also independently assess the performance of fisheries and the impacts of management policies.



BRIAN S. FISHER
Executive Director

February 2004

acknowledgments

ABARE's fisheries surveys program involves a cooperative effort among industry, fisheries management and research agencies, and ABARE staff.

Industry

ABARE surveys are voluntary. The participation of fishing operators and their accountants in providing data is essential for the success of the fisheries surveys. Without this assistance the surveys would not be possible. The advice and comments on a draft of the report provided by industry representatives and representatives of relevant Management Advisory Committees are also greatly appreciated.

Management and research agencies

The Australian Fisheries Management Authority (AFMA) provided the logbook information necessary to select a sample and provide relevant population statistics and information on fishery management costs. In particular, Thim Skousen and Andrew Kettle provided valuable assistance. Assistance was also provided by Ian Towers, Matt Barwick, Steve Bolton and Ryan Murphy from AFMA, John Kung from the Queensland Fisheries Service, and Greg Anderson from the Torres Strait Prawn Entitlement Holders Association.

ABARE staff

David Galeano and Dana Langenkamp of the Fisheries Economics Section undertook the analyses and compiled the report. Peter Gooday, Graham Love and Fiona Alexander provided comments on the report. Sample design and estimation was undertaken by Walter Shafron and Caroline Levantis of the Survey Data Analysis Section. Data were collected, entered and edited by Ron Godenzi, Richard Paton, David Galeano, Lou Sissian and Bob Hill of the Data Management and Collection Section. Laurie Cannon, Tony Wain, Bruce McConnell and Paul Phillips of the Data Management and Collection Section carried out survey administration and questionnaire design. Programming and computer systems support was provided by Shona Lambert, Xue Huynh and Ken Colbert of the Data Management and Collection Section.

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contents

ABARE fishery surveys 1

Economic surveys 1
The 2003 surveys 2

northern prawn fishery 3

The fishery 3
Biological status of the fishery 5
Management of the fishery 6
Boats surveyed 7
Financial performance of boats 7
Economic performance of the fishery 11

figures

A Northern prawn fishery management areas 4
B Northern prawn fishery: catch 4
C Northern prawn fishery: real GVP 4
D Effort creep in the northern prawn fishery 13

tables

1 Financial performance of boats operating in the northern prawn fishery 8
2 Net returns in the northern prawn fishery 12

Torres Strait prawn fishery 15

The fishery 15
Biological status of the fishery 17
Management of the fishery 17
Boats surveyed 19
Financial performance of boats 20
Economic performance of the fishery 22

figures

A Torres Strait prawn fishery management areas 16
B Torres Strait prawn fishery: catch 16
C Torres Strait prawn fishery: real gross value of production 16
D Torres Strait prawn fishery: real unit values 21

tables

1 Estimated financial performance of boats operating in the Torres Strait prawn fishery 20
2 Net returns to the Torres Strait prawn fishery 23

south east trawl fishery 26
The fishery 26
Biological status of the fishery 28
Management of the fishery 28
Boats surveyed 30
Financial performance of boats 31
Economic performance of the fishery 34

figures

A Map of the south east trawl fishery 27
B South east trawl fishery: catch 27
C South east trawl fishery: real gross value of production 28
D Percentage of actual TAC caught in the south east trawl fishery in 2002 38

tables

1 Status of species caught in the south east trawl fishery 28
2 Estimated financial performance of boats operating in the south east trawl fishery 32
3 Estimated financial performance of boats operating in the south east trawl fishery, by triptile 34
4 Net returns to the south east trawl fishery 37

southern and western tuna and billfish fishery 39
The fishery 39
Biological status of the fishery 41
Management of the fishery 43
Boats surveyed 44
Financial performance of boats 44
Economic performance of the fishery 46

figures
A Management areas of the southern and western tuna and billfish fisheries 39
B Southern and western tuna and billfish fishery: longline production 40
C Southern and western tuna and billfish fisheries: real value of production in 2000-01 41

tables
1 Effort in the domestic longline southern and western tuna and billfish fishery 40
2 Permits in the southern and western tuna and billfish fishery – 2002 43
3 Estimated financial performance of longline boats that caught greater than 26 tonnes of tuna and billfish in the southern and western tuna and billfish fishery in 2001-02 45
4 Net returns to the longline southern and western tuna and billfish fishery 47

appendix
A Survey methods and definitions 49

references 54

previous fisheries surveys reports 56

ABARE fishery surveys

Economic surveys

ABARE has been undertaking economic surveys of selected Commonwealth fisheries since the early 1980s and on a regular basis for particular fisheries since 1992. The current fisheries survey program involves surveying major Commonwealth fisheries every few years, or more frequently where the fishery is undergoing major changes and monitoring is particularly important. The aim is to develop a consistent time series of economic information for each fishery. Such a database, in conjunction with scientific assessments of each fishery, is vital for assessing the economic performance of fisheries.

The surveys provide a broad range of information on the physical characteristics and financial performance of boats that operate in each fishery. For details on survey methods used and definitions of physical and financial characteristics discussed in the report, see appendix A.

Information from the surveys is made publicly available so the performance of fisheries and the impact of management policies can be independently assessed.

Based on logbook and boat registry information collected from licensed fishing operations in Commonwealth fisheries and supplied by the Australian Fisheries Management Authority (AFMA) and the Queensland Fisheries Management Authority, a representative sample of Commonwealth endorsed boats is selected in each fishery.

In practice this sample is seldom fully realised. Nonresponse is relatively high across fishery surveys, reflecting the difficulty in contacting some operators and a reluctance of others to participate. Sample design and weighting systems have been developed that reduce the impact of nonresponse.

Between February and June an ABARE officer visits the owner of each boat selected in the sample and interviews the boat owner to obtain physical and financial details of the fishing business for the survey years. In a number of instances the skipper of the boat is also interviewed. Further information is subsequently obtained from accountants, selling agents and marketing organisations on the signed authority of the survey respondents.

The information obtained from various sources is reconciled to produce the most accurate description possible of the physical and financial characteristics of each sample boat.

The 2003 surveys

ABARE surveyed four individual Commonwealth fisheries in 2003 — the northern prawn fishery, the Torres Strait prawn fishery, the south east trawl fishery, and the southern and western tuna and billfish fishery. This is the second time that ABARE has surveyed the southern and western tuna and billfish fishery, but the first time that results have been published. This is due to low participation in the first survey in 2001.

northern prawn fishery

- The real (2002-03 dollars) gross value of production of the northern prawn fishery reached a record $175 million in 2000-01 before falling to $140 million in 2001-02 and to under $83 million in 2002-03.
- Average per boat prawn receipts fell by 21 per cent in 2001-02 to $1.17 million. This partly reflected lower catches.
- The fall in average per boat prawn receipts was slightly greater for small boats and, while there were some cost reductions across the fleet, profit at full equity for all boats fell on average by 35 per cent to around $305 000 per boat.
- On large boats, cost reductions were not as large and profit at full equity fell by 44 per cent to an average of around $337 000 per boat in 2001-02.
- Estimated real net returns (including management costs) to the northern prawn fishery resource have fluctuated substantially since 1990-91, averaging around $29.4 million (in 2002-03 dollars) over that period. Net returns (assuming constant stocks) were an estimated $61.4 million in 2000-01 and $33.0 million in 2001-02.

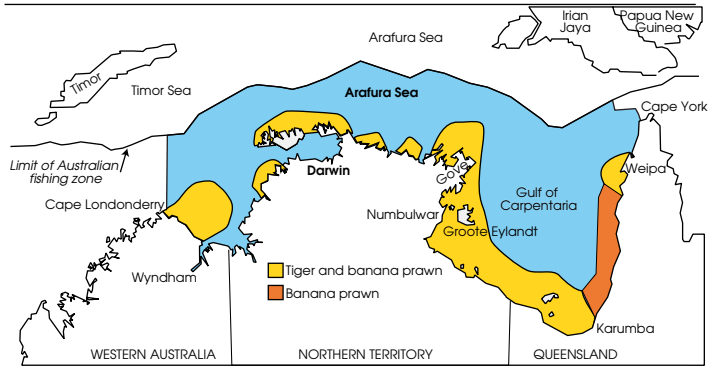
The fishery

The northern prawn fishery is located off Australia's northern coast. Bordered in the east by Cape York in Queensland and in the west by Cape Londonderry in Western Australia, it extends from the low water mark to the outer edge of the Australian Fishing Zone (AFZ) (figure A).

Although it is one of the largest defined fishing areas in Australia, only 27 per cent of the area is subject to fishing. This is a result of the large area closure enforced in the fishery, and the inshore nature of prawn fishing (AFMA 2001a). The fishery targets nine commercial species of prawns, including white banana (*Penaeus merguiensis*), redlegged banana (*P. indicus*), brown tiger (*P. esculentus*), grooved tiger (*P. semisulcatus*), blue endeavour (*Metapenaeus endeavouri*) and red endeavour (*M. ensis*). Squid is also taken as an opportunistic target species along with scallops and bugs.

On average, banana and tiger prawns accounted for 84 per cent of the prawn catch in the fishery between 1992-93 and 2002-03 (figure B). Together with prawn catches, a considerable amount of predominantly unused bycatch has traditionally been taken in the fishery but this has been reduced since the introduction of bycatch reduction devices (BRDs) (T. Stone, AFMA, personal communication, November 2001). Most bycatch species have no or an

A **Northern prawn fishery management areas**

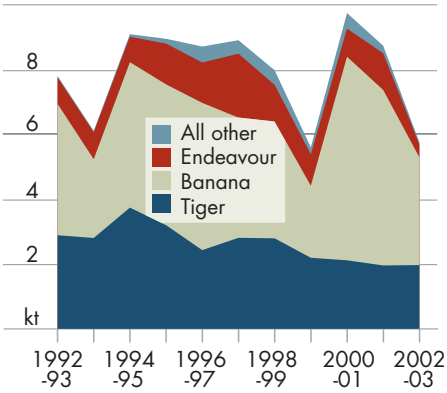


extremely low value and are discarded. The byproduct species that have commercial value (for example, bugs and squid) are retained.

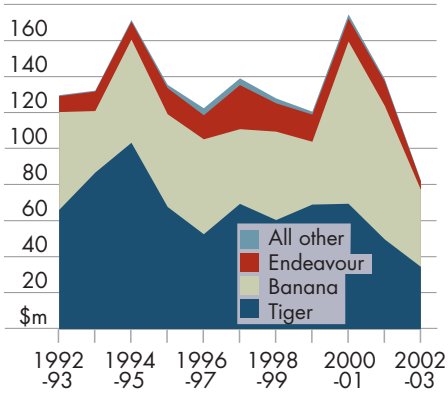
The gross value of catch in the northern prawn fishery is the highest of any of the Commonwealth fisheries. In 2002-03 the northern prawn fishery accounted for around 20 per cent of the gross value of production (GVP) from Commonwealth fisheries. This is despite significant falls in both 2001-02 and 2002-03. In 2002-03 the real GVP was around $82.5 million (in 2002-03 dollars), compared with a high of around $175 million in 2000-01 (figure C). The variation in value displayed in figure C is caused mainly by the fluctuating catch of banana prawns (figure B). Over the past decade, catches of banana prawns have ranged from 2222 tonnes in 1999-2000 to 6286 tonnes in 2000-01.

Since the majority of the catch is exported to Japan and other parts of Asia, exchange rate movements have had a relatively large impact on the value of the fishery. The Australian dollar prices received for all three key prawn species fell in 2002-03, in part because of the appreciation of the Australian dollar.

B **Northern prawn fishery: catch**



C **Northern prawn fishery: real GVP** In 2002-03 dollars



Biological status of the fishery

The Northern Prawn Fishery Assessment Group (NPFAG) assesses the biological status of the northern prawn fishery on a regular basis and detailed summaries of the biological status of prawns in the northern prawn fishery have been published in Caton (2003).

The commercial prawn species of the northern prawn fishery have a lifespan of up to two years. Most species are sexually mature at six months of age, and at twelve months of age a female prawn can produce hundreds of thousands of eggs at a single spawning and may spawn more than once a season. However, fewer than 1 per cent of these offspring survive the two to four week planktonic larvae stage (Caton 2003).

Banana prawns

Banana prawn catches in the northern prawn fishery are made up of white banana prawns and red legged banana prawns. The sustainable long term average annual catch for both species of banana prawns in the northern prawn fishery is thought to be around 4000 tonnes, approximately the average annual catch of the past ten years (Caton 2003). The catch of banana prawns from the northern pawn fishery is considered to be probably sustainable, but the reliability of the assessment is moderate (Caton 2003).

The annual productivity of banana prawns has been linked to rainfall levels. Expected catches based on rainfall levels are compared with observed catches to give an assessment of the banana prawn fishery (Caton 2003). In recent years, however, actual catches have not matched predictions well. For example, the catch in 2000 was close to the lowest on record despite good rainfall before the season and the catch in 2001 was considerably higher than expected. Preliminary results from an age structure model indicate that at least in certain areas, there may be a relationship between stock size and subsequent recruitment for white banana prawns (Caton 2003). The relationship between stock size, fishing effort and environmental factors will be the subject of further research.

Tiger prawns

In 2001, AFMA contracted Dr Rick Deriso, an independent expert, to review the 1999 tiger prawn assessment. Dr Deriso supported the assessment's conclusion that brown tiger prawn stocks were at 42–54 per cent and grooved tiger prawn stocks were at 66–86 per cent of target levels in 2001 and that tiger prawn stocks were overfished. He also suggested that the levels of effort were too high to promote recovery (Caton 2003).

The model used to assess the status of tiger prawns has been updated in recent years (Dichmont et al. 2001 and Dichmont et al. 2003 as in Caton 2003). The assessments still show brown tiger prawns as being overfished. However, effort levels in 2002 are thought to have been below the level needed to achieve the stock associated with maximum sustainable yield and projections suggest that rebuilding of the target spawning stock size will occur within a couple of years if 2002 effort levels are maintained (Caton 2003).

The assessment indicated that increased recruitment in recent years has meant that the grooved tiger prawn stock is not considered to be overexploited, and has recovered to a biomass level that corresponds with that associated with the 'maximum sustainable yield'. The stock is fully exploited and is projected to remain at this level based on the assumption that current effort levels (2002) are maintained and are not increased.

A major program of surveys to collect data has been initiated to resolve some of the uncertainties in the assessments of the fishery (Caton 2003).

Management of the fishery

From the mid-1960s until the late 1980s the northern prawn fishery was managed under a variety of arrangements by the Queensland, Western Australian, Northern Territory and Australian Governments. In 1988 the Australian Government accepted responsibility for the fishery under the terms of an Offshore Constitutional Settlement Agreement (OCS). Under this agreement, the Commonwealth has jurisdiction for the target species of prawns, bugs, scallops, scampi and squid where taken by prawn trawl gear. The Commonwealth also has jurisdiction over any bycatch, such as turtles, taken along with target species.

The fishery has historically been managed using input controls. Controls have included limited entry, seasonal closures, restrictions on the amount of gear and restrictions on the below deck boat volume and engine capacity. Also, voluntary and compulsory vessel buybacks have been used in an attempt to control effort.

Since the release of a 1985 study by CSIRO indicating the existence of recruitment overfishing for tiger prawns, biological overfishing has been considered an issue in the northern prawn fishery (Taylor and Die 1999). Despite the introduction of a voluntary buyback scheme in the early 1990s, a compulsory surrender scheme in 1993, and continued restrictions on boat numbers, the northern prawn fishery was still assessed as being overfished in the late 1990s. The Senate Rural and Regional Affairs and Transport Legislation Committee (2000) indicated that attempts to reduce effort in the fishery had been undermined by persistent effort creep.

In November 1997, the Northern Prawn Fishery Management Advisory Committee suggested the introduction of gear based management as the most flexible means of controlling fishing effort. Consequently, on 24 July 2000, the limits on boat and engine sizes (class A statutory fishing rights) were replaced with gear SFRs (AFMA 2001b). Gear SFRs regulate the length of headrope and thereby the size of the net that may be towed by vessels. AFMA anticipated that reducing the length of headrope used in the industry would reduce fishing effort.

The translation of class A SFRs to gear SFRs was agreed to on a one to one basis of 10 centimetres of headrope for each class A SFR. This resulted in a reduction in total gear towed by the fleet by around 15 per cent to 5384 metres (Senate Rural and Regional Affairs and Transport Legislation Committee 2000). On the argument that the new arrangements might potentially disadvantage the fishery's smaller (less than 300 class A SFRs) vessels,

these smaller vessels were granted 'top up' gear SFRs for two years (Senate Rural and Regional Affairs and Transport Legislation Committee 2000).

In 2002, measures to reduce effort directed at tiger prawns were introduced. The season was shortened and from 24 August 2002 the value of an SFR was reduced by a further 25 per cent. This resulted in a reduction in the number of class B SFRs from 119 to 102 (AFMA 2003a).

In 2002, the fleet started fishing for banana prawns on 1 April and fished until 13 May. Tiger prawn fishing ran from 1 September until 1 December 2002 (Caton 2003).

Turtle excluder devices (TEDs) and bycatch reduction devices (BRDs) became compulsory in the fishery in April 2000. These devices had been trialed in the fishery on a voluntary basis for several years.

Boats surveyed

The target population for the survey was defined as boats that held a Commonwealth northern prawn endorsement and fished during 2001-02. For the purposes of the survey, the northern prawn fishery was divided into two groups based on the number of net units attached to each boat. A sample of boats from each group was then surveyed. The two groups were: less than 470 net units (small boats) and greater than or equal to 470 net units (large boats). This is different to previous ABARE surveys of the fishery that divided the population based on the number of class A SFRs. In July 2000, net units replaced class A SFRs at the rate of 10 centimetres of headrope (one net unit) for each SFR.

According to AFMA logbook data there were 118 eligible boats in both 2000-01 and 2001-02, of which 55 and 57 were surveyed respectively. In 2000-01, 14 of 51 small boats were surveyed and 41 of 67 large boats were surveyed. In 2001-02, 17 of 56 small boats and 40 of 62 large boats were surveyed.

Financial performance of boats

The major measures of the financial performance for boats in the northern prawn fishery in 2000-01 and 2001-02 are shown in table 1. The estimates in the table also include costs and earnings from other fisheries such as the Torres Strait prawn fishery, Kimberley prawn fishery and Queensland east coast prawn fishery.

There are a number of external factors that affected the performance of operators in the fishery over the survey period. With around 90 per cent of the product from the northern prawn fishery being exported, market conditions overseas and exchange rate conditions have had a major bearing on returns. In addition, environmental factors such as monsoonal rains also have an influence on the availability of prawns for harvesting, particularly banana prawns.

As financial years are used for reporting revenue and cost information, the figures contained in this report are not directly comparable with those for the fishing season.

Receipts

Average cash receipts per boat are estimated to have fallen from $1.54 million in 2000-01 to around $1.22 million in 2001-02, a decline of around 21 per cent (table 1). The cash receipts of both boat size categories fell between 2000-01 and 2001-02, with the percentage fall being slightly greater for small boats.

Prawn receipts are estimated to have contributed 95–97 per cent of total cash receipts in both years and size categories. Other fishing receipts are estimated to have been relatively small in both years and size categories. Other fishing receipts comprise mainly crustaceans caught while operating in other state and Commonwealth fisheries.

Nonfishing receipts include items such as endorsements leased out, and rebates and refunds. These are estimated to have averaged around $28 600 per boat in 2001-02, a 7 per cent increase from 2000-01.

1 Financial performance of boats operating in the northern prawn fishery

		Less than 470 units				Greater than 470 units			
		2000-01		2001-02		2000-01		2001-02	
Prawn receipts	$	1 277 238	(4)	999 052	(4)	1 645 742	(2)	1 319 925	(2)
Other fishing receipts	$	3 790	(34)	9 567	(29)	38 757	(21)	39 629	(28)
Nonfishing receipts	$	45 217	(22)	41 684	(18)	12 587	(30)	16 854	(20)
Total cash receipts	$	1 326 245	(4)	1 050 303	(3)	1 697 085	(2)	1 376 409	(2)
Administration	$	15 735	(10)	13 018	(15)	20 491	(6)	17 973	(5)
Crew costs	$	350 694	(4)	277 388	(3)	397 446	(2)	326 504	(2)
Freight and marketing expenses	$	33 410	(9)	23 271	(12)	36 817	(4)	32 256	(4)
Fuel	$	178 286	(5)	166 981	(4)	218 819	(2)	201 023	(2)
Insurance	$	23 882	(10)	25 869	(5)	47 655	(8)	49 039	(6)
Interest paid	$	13 015	(37)	17 194	(36)	16 635	(16)	12 058	(19)
Leasing	$	52 913	(56)	36 865	(34)	457	(45)	100	(60)
Licence fees and levies	$	22 495	(5)	21 574	(12)	24 948	(2)	36 947	(5)
Packaging	$	6 964	(28)	10 328	(19)	19 185	(4)	20 971	(5)
Repairs and maintenance	$	158 889	(12)	140 431	(7)	211 783	(4)	239 859	(4)
Other costs	$	43 199	(13)	38 671	(11)	65 848	(5)	60 250	(5)
Total cash costs	$	899 482	(4)	771 589	(3)	1 060 083	(2)	996 979	(2)
Boat cash income	$	426 763	(13)	278 714	(10)	637 002	(5)	379 430	(6)
less depreciation **a**	$	24 873	(12)	28 228	(20)	56 119	(9)	55 206	(7)
Boat business profit	$	401 890	(14)	250 486	(12)	580 883	(6)	324 223	(8)
plus interest, leasing and rent	$	67 141	(48)	54 790	(24)	17 414	(15)	12 306	(19)
Profit at full equity	$	469 031	(9)	305 277	(8)	598 297	(5)	336 529	(7)
Capital									
– excluding quota and licences	$	846 909	(8)	867 099	(6)	1 345 362	(4)	1 313 819	(3)
– including quota and licences	$	na		4 164 874	(3)	na		4 893 791	(2)
Rate of return to boat capital **b**	%	55.4	(12)	35.2	(9)	44.5	(8)	25.6	(9)
Rate of return to full equity **c**	%	na		7.3	(7)	na		6.9	(8)

Continued

Costs

For the fleet overall, average per boat cash costs are estimated to have fallen from around $991 000 in 2000-01 to $890 000 in 2001-02 (table 1). As expected, large boats incurred the largest cash costs in the fishery, reflecting higher fuel, crew and repairs and maintenance costs relative to the small boats group. Average per boat cash costs for large boats fell by around 6 per cent to around $997 000 in 2001-02, while those for small boats fell by 14 per cent to around $772 000.

Fuel, crew and repairs and maintenance costs together accounted for around three-quarters of total cash costs for the fleet in 2001-02.

Crew costs for the fleet as a whole are estimated to have fallen by 20 per cent over the survey period to an average of $303 000. This fall was consistent across both size groups. As the skipper and crew are generally paid a share of the fishing receipts, the decrease in crew

1 Financial performance of boats operating in the northern prawn fishery *continued*

		All boats			
		2000-01		**2001-02**	
Prawn receipts	$	1 486 473	(2)	1 167 646	(2)
Other fishing receipts	$	23 644	(20)	25 363	(24)
Nonfishing receipt	$	26 689	(18)	28 638	(14)
Total cash receipts	$	1 536 807	(2)	1 221 647	(2)
Administration	$	18 435	(5)	15 621	(7)
Crew costs	$	377 240	(2)	303 194	(2)
Freight and marketing expenses	$	35 344	(4)	27 992	(5)
Fuel	$	201 300	(2)	184 868	(2)
Insurance	$	37 380	(6)	38 043	(4)
Interest paid	$	15 070	(17)	14 495	(22)
Leasing	$	23 129	(56)	17 548	(34)
Licence fees and levies	$	23 887	(2)	29 651	(5)
Packaging	$	13 903	(7)	15 920	(7))
Repairs and maintenance	$	188 922	(5)	192 673	(4)
Other costs	$	56 059	(5)	50 009	(5)
Total cash costs	$	990 671	(2)	890 014	(2)
Boat cash income	$	546 136	(5)	331 633	(6)
less depreciation **a**	$	42 614	(7)	42 403	(8)
Boat business profit	$	503 521	(6)	289 230	(7)
plus interest, leasing and rent	$	38 906	(36)	32 468	(19)
Profit at full equity	$	542 428	(5)	321 698	(5)
Capital					
– excluding quota and licences	$	1 129 929	(4)	1 101 816	(3)
– including quota and licences	$	na		4 547 864	(2)
Rate of return to boat capital **b**	%	48.0	(7)	29.2	(7)
Rate of return to full equity **c**	%	na		7.1	(5)

a Depreciation adjusted for profit or loss on capital items sold. **b** Excluding value of quota and licences. **c** Including value of quota and licences. **na** Not applicable.
Note: Figures in parentheses are relative standard errors. A guide to interpreting these is included in appendix A.

payments is consistent with the fall in receipts between 2000-01 and 2001-02. It is important to note that crew costs include the estimated cost of replacing owner operator and family labor. The reason for this is that on many boats where owner skippers are involved or family labor is involved, the labor payments can be low or even nil. To reflect the true market value of the labor, operators are asked to estimate what it would cost to replace owner operator and family labor with paid crew and staff. This is likely to more accurately reflect the true market value of the labor used in the fishing operation.

Fuel costs fell by around 8 per cent over the survey period to an average of around $185 000 per boat in 2001-02. This fall was again consistent across both size groups and may partly reflect the increasing trend of fishers to purchase fuel net of the diesel fuel rebate, rather than paying full price at point of sale and claiming the rebate later.

Across the fleet, repairs and maintenance costs are estimated to have remained relatively steady between 2000-01 and 2001-02 at around $193 000. However, repairs and maintenance costs for the small boat category are estimated to have fallen by 12 per cent to an average of around $140 000 per boat in 2001-02 while they rose by 13 per cent to an average of almost $240 000 per boat in 2001-02 in the large boat category.

Boat cash income and profit

Estimated boat cash income provides an indication of the ability of the operator to remain in the fishery in the short to medium term without the need for recourse to additional finance. Changes in this measure simply reflect changes in receipts and costs.

On average, estimated boat cash income for the fleet was around $332 000, a fall of around 39 per cent from the previous year (table 1). This fall was felt slightly more heavily in the large boats category where boat cash income is estimated to have fallen by 40 per cent over the survey period to around $379 000 per boat compared with a fall of 35 per cent to just under $279 000 in the small boat category.

Boat business profit is boat cash income less depreciation on capital items. As depreciation remained relatively stable over the survey period in both size categories, the change in boat business profit estimated for the northern prawn fishery fleet closely reflected the increase in boat cash income. For the fleet as a whole, boat business profit was estimated at $289 000 per boat in 2001-02, a fall from over $503 000 in 2000-01.

Profit at full equity is estimated by adding leasing costs, interest charges and rent payments to boat business profit. It represents the average return that would have been earned by the business unit had the boat and capital (including quota and licences) been fully owned by the operator. While these costs affect the financial position of the operator, they represent some profits that have been redistributed to other investors in the fishery. For the fleet as a whole, average profit at full equity is estimated to have fallen by 41 per cent to under $322 000 per boat in 2001-02.

Rates of return

The rate of return to boat capital is calculated on total capital (excluding the value of quota and licences) as if the proprietors wholly owned all assets so that the financial performance of all boats can be compared regardless of the proprietors' equity in the business. The estimated average rate of return to boat capital (excluding the value of quota and licences) fell from 48 per cent in 2000-01 to 29 per cent in 2001-02. While the rate of return fell in both size categories, the rate of return to boat capital is estimated to have been higher in the small boat category at 35 per cent in 2001-02, compared with under 26 per cent in the large boat category. This reflects the much higher level of boat capital invested in the large boat size category.

The rate of return to full equity (including quota and licences) provides an indication of the return to total capital invested in the business unit. This measure includes changes in the value of quota and licences, and boat capital as well as changes in the profitability of the fishing operation — that is, the profit from fishing that accrues to the owners of the capital.

The estimated value of licences attached to each boat operating in the northern prawn fishery was around $3.45 million in 2001-02. This includes the value of licences for other fisheries in which the boats are endorsed to fish, such as the Torres Strait prawn fishery, and state managed fisheries of Western Australia and Queensland. Given this large value of licences, the rate of return to full equity (including quota and licences) was much lower than the rate of return to boat capital. For the fleet as a whole, it was an estimated 7.1 per cent in 2001-02. For the large and small boat size categories, the value of licences was estimated to be $3.58 million and $3.30 million respectively resulting in profit at full equity estimates of 7.3 per cent and 6.9 per cent for small and large boats respectively.

Economic performance of the fishery

While the measures of financial performance in table 1 provide an indication of the financial health of fishing operators in the northern prawn fishery, they do not provide an indication of AFMA's performance against their legislated objectives of maximising economic efficiency and providing efficient and cost effective management. This is because the figures in table 1 include costs, receipts and capital from fisheries other than the northern prawn fishery.

Maximising economic efficiency in a fishery involves maximising economic rent. The term 'economic rent' is used to describe the part of the return from the use of a natural resource that stems from the scarcity of that resource. The concept of economic rent arose in the early nineteenth century from the realisation that rent for land was not set by the owners of the land but rather by the potential profitability that users could reap from using the land (Barlowe 1958). In a fishery, economic rent is the long run surplus income after all other costs have been met, such as fuel, bait, labor, repairs and the necessary return on capital to justify any investment. Any resource rent in fisheries is commonly accrued by fishing operators.

As an indicator of economic rent, ABARE has calculated net returns to the northern prawn fishery using survey data. However, net returns in a given year may differ from the long run economic rent for a number of reasons. Of particular importance are the condition of the

fish stock, capital structure and market conditions. For example, if the fish stock is being fished down then net returns in that year will include revenue from selling off part of the fish stock that will not be available over the long term. Consequently the calculated net returns will overestimate the long term economic rent available from the fishery. More detail can be found in Rose et al. (2000).

Net returns in the northern prawn fishery and assessment of fishery management

The measure of net return to the fishery includes only those receipts and costs that are attributable to the northern prawn fishery. As a result, the estimated receipts and costs in table 2 will differ from those in table 1 which include all receipts and costs of boats operating in the fishery, including those incurred while fishing in other fisheries such as the Torres Strait prawn and Queensland east coast trawl fisheries.

The real net returns to the northern prawn fishery for the period 1990-91 to 2001-02 are presented in table 2, which shows that real net returns to the fishery (including management costs) averaged around $30 million a year (in 2002-03 dollars) over the period. In 2000-01 and 2001-02 real net returns were estimated at $61.4 million and $33.0 million respectively. The estimate for 2000-01 coincides with the record harvests of banana prawns in that year as well as high prawn prices.

There are two main steps involved in assessing the economic efficiency of fishery management arrangements. First, it needs to be determined what type of management regime is likely to allow for economic returns to be maximised (including the cost of management).

2 Net returns in the northern prawn fishery
In 2002-03 dollars

	Revenue a	Operating costs a,b	Capital a,c	Net returns (excl. management costs) d	Management costs e	Net returns (incl. management costs)	Number of vessels
	$m	$m	$m	$m	$m	$m	no.
1990-91	149.4 (3)	110.7 (3)	98.1 (1)	22.3 (12)	na	22.3	169
1991-92	115.8 (4)	94.5 (3)	80.3 (2)	10.0 (22)	na	10.0	160
1992-93	128.6 (10)	99.1 (10)	68.5 (11)	21.3 (15)	na	21.3	129
1993-94	140.8 (9)	108.0 (12)	59.7 (11)	21.9 (8)	na	21.9	132
1994-95	173.8 (8)	116.6 (6)	77.8 (6)	44.0 (16)	na	44.0	133
1995-96	147.7 (3)	111.1 (3)	92.3 (7)	21.1 (17)	1.6	19.5	134
1996-97	139.1 (3)	101.3 (3)	80.6 (7)	24.1 (14)	1.9	22.2	128
1997-98	167.4 (2)	109.5 (2)	77.1 (6)	43.8 (5)	1.7	42.1	130
1998-99	153.0 (3)	105.0 (3)	73.2 (8)	35.6 (7)	1.4	34.2	133
1999-2000	121.9 (4)	89.2 (4)	58.3 (8)	22.1 (16)	1.1	21.0	130
2000-01	185.7 (3)	114.3 (2)	52.7 (9)	62.4 (6)	1.0	61.4	118
2001-02	139.3 (3)	97.1 (3)	45.4 (9)	34.0 (7)	1.1	33.0	118

a Amount attributable to the fishery. **b** Cash costs include imputed operator and family labor costs but exclude licence and levy payments and interest payments. **c** Replacement capital (depreciated capital). **d** Excludes management costs. Calculated as per the definition in this report. **e** AFMA management costs (A. Kettle, AFMA, personal communication, 4 September 2002). **na** Not applicable.
Note: Figures in parentheses are relative standard errors. A guide to interpreting these is included in appendix A.

Once this is established, the level of catch/effort required to achieve maximum returns needs to be determined. Setting catch/effort too high will result in the dissipation of economic returns, while setting it too low will result in missed profitable opportunities.

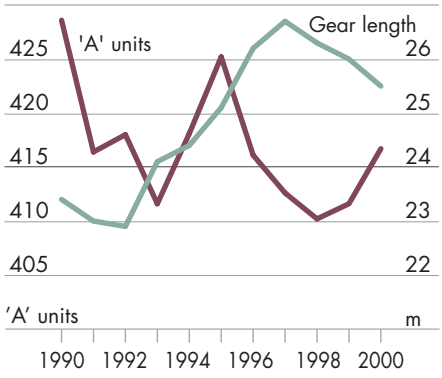
As described above, input controls have been the primary management tools used in the northern prawn fishery. One of the main problems with input controls is that ownership of fish is by capture. Therefore individuals have a strong incentive to compete to maximises their catch — race to fish — which results in overcapacity and reduction in overall net returns. A second, although related problem is effort creep. This is where fishers substitute unrestricted inputs for restricted inputs in an attempt to increase their relative fishing power. In the case of the northern prawn fishery, this is illustrated in figure D, where fishers substituted gear length for 'A' units in the 1990s when the fishery was managed with a limit on 'A' units.

The result is that individual fishers end up using a combination of inputs that do not minimise costs for the level of catch and consequently net returns to the entire fishery are not maximised. Evidence of this effect in the northern prawn fishery is illustrated in Kompas and Che (2002). These authors found that changes to the input control system introduced in the fishery in the early 1990s resulted in a drop in technical efficiency and considerable effort creep. They also found that the new set of controls introduced in 2000 are likely to increase technical efficiency, but not to constrain effort as fishers are likely to substitute unrestricted inputs for the restricted input (gear length).

Where effort creep occurs, it is likely that input controls will need to be tightened frequently to ensure that fishing mortality is in line with management targets. As Rose (2002) explains, each set of rule changes can be expensive as they generally make some boats and gear redundant. As well, the process of researching, designing and negotiating changes in management regimes can be costly for both fishers and managers. In estimating the long run net returns to the fishery, both sets of periodic costs — those of research and negotiation and those of reinvestment — should be set against any apparent net returns in the years between changes in management regime.

Detailed analysis of the relative costs and benefits of alternative management arrangements in the northern prawn fishery has not been undertaken. However, the obvious alternative to gear controls would be a system of individual transferable quotas (ITQs) and a total allowable catch. This form of management would avoid the problems associated with effort creep. However, ITQs have other potential problems. The potential for ITQs to encourage discarding and difficulties in setting an optimal total allowable catch in fisheries with unpredictable abundance have long been recognised (Rose 2002).

D Effort creep in the northern prawn fishery



Given the problems associated with implementing ITQs in the northern prawn fishery, it is not clear whether or not the net benefits of ITQ management would outweigh the net benefits of the current gear controls. In comparing the net benefits of gear controls and ITQs it is important that the full costs associated with each regime are accounted for. For example, the periodic costs involved in the development of new sets of rules under an input controlled fishery to correct for effort creep should be taken into account. Similarly, the potential loss of profitable opportunities under an ITQ regime in years of high abundance needs to be considered. Currently ABARE is conducting a project on the management options under uncertainty for the tiger prawn fishery in the northern prawn fishery. The aim in this project is to determine whether input or output controls are the most suitable management tool for the fishery in terms of maximising net returns given variability in stocks and catch per unit effort. Results from this research are expected early in 2004.

Torres Strait prawn fishery

- Despite a relatively stable harvest of prawns between 2000-01 and 2001-02, average per boat prawn receipts for the fleet as a whole are estimated to have fallen by 15 per cent in the second year to $671 000. At around $557 000 in 2001-02, average per boat prawn receipts for specialist Torres Strait prawn boats fell by only 3.5 per cent.
- Fuel costs and crew costs were the main contributors to an estimated 9 per cent fall in costs across the fleet between 2000-01 and 2001-02. Costs are estimated to have fallen only slightly for the specialist fleet.
- Boat cash income across the fleet fell by an estimated 45 per cent between 2000-01 and 2001-02, while for the specialists it fell by an estimated 17 per cent.
- Net returns (including management costs and assuming constant stocks) to the fishery are estimated to have fallen in real terms from $4.8 million in 2000-01 to $2.8 million in 2001-02.

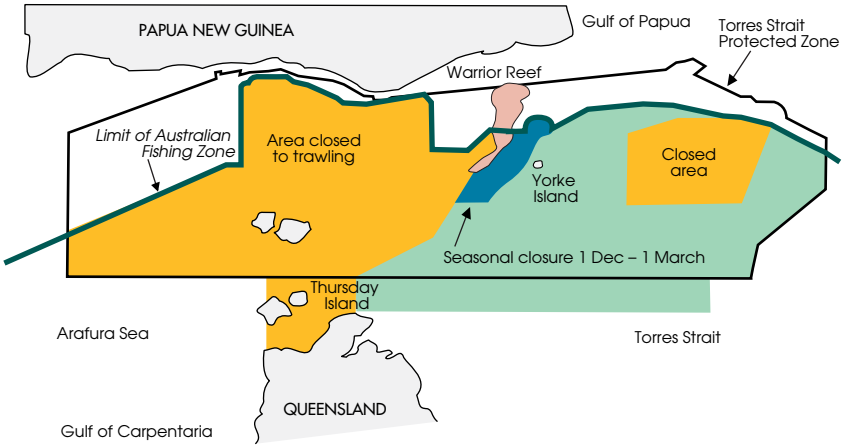
The fishery

The Torres Strait prawn fishery is located between the tip of the Cape York Peninsula and the south coast of Papua New Guinea and is bordered in the west by the Arafura Sea and in the east by the Coral Sea. The main prawn fishing ground in the Torres Strait is east of the Warrior Reef complex, with a focus around Yorke Island, which is the main anchorage for the fleet (figure A).

Operators in the fishery target tiger and endeavour prawns. Tiger prawns usually account for between 30 and 40 per cent of the prawn catch and endeavour prawns for around 60 per cent (figure B). King prawns usually account for the most of the remaining prawn catch.

The real gross value of production (in 2002-03 dollars) from the Torres Strait prawn fishery has fluctuated over the past decade, from a low of $17.0 million in 1992-93 to a high of $31.3 million in 1998-99 and back to around $19.2 million in 2002-03. Since 1998-99, harvests have fallen each year, contributing to the fall in the real gross value of the fishery (figure C). Endeavour and tiger prawns have accounted for around 90 per cent of the real gross value of prawn production from the Torres Strait prawn fishery since 1992-93. In 2001-02 and 2002-03 the value share of endeavour and tiger prawns decreased slightly with increased harvests of king prawns. Morton bay bugs, scallops and squid make up the most of the remaining 10 per cent of real GVP.

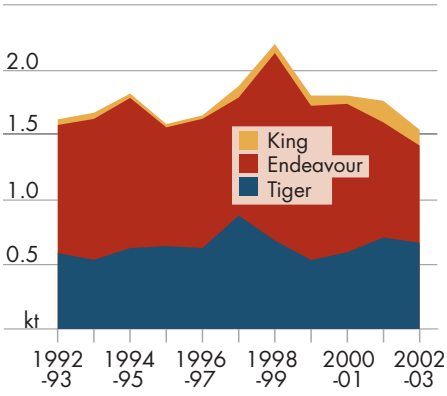
A Torres Strait prawn fishery management areas



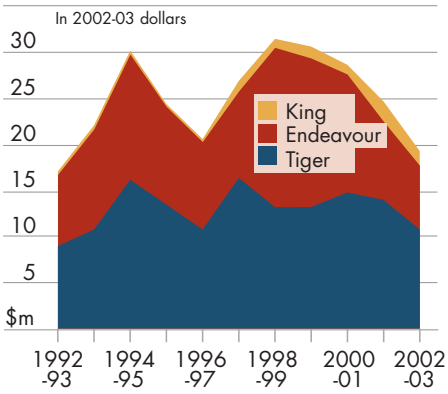
Fishing in the Torres Strait prawn fishery is carried out at night using otter trawls up to 20 metres long, with two pairs of nets with a combined maximum headrope and footrope length of 80 metres (reduced in 2002 from the previous 88 metres) and a mesh size of 45 millimetres (Kung, Turnbull and Murphy 2003).

Few vessels fish exclusively in the Torres Strait area and most move between the Queensland east coast trawl fishery and the northern prawn fishery. The fishing season in the Torres Strait prawn fishery is March–December. As financial years (July–June) are used for reporting revenue and cost information, the figures contained in this report overlap fishing seasons. For example the March–June period of the 2001 fishing season is included in the 2000-01 financial year, while the July–December period of the 2001 season is included in the 2001-02 financial year.

B Torres Strait prawn fishery: catch



C Torres Strait prawn fishery: real gross value of production



Biological status of the fishery

Brown tiger prawns and blue endeavour prawns are both endemic to tropical and subtropical Australia. Both these species are highly fecund, fast growing, short lived and reach sexual maturity by six months of age (Caton 2003).

The first formal assessment of the fishery was conducted in 1991 and updated in 1994. Currently a new tiger prawn stock assessment is being undertaken for the fishery. From the earlier assessments the long term biologically sustainable yield was estimated to be around 1900 tonnes, consisting of 680 tonnes of tiger prawns, 1035 tonnes of endeavour prawns and 185 tonnes of king prawns. Preliminary results from the current stock assessment indicate that the biological sustainable yield for tiger prawns, using standardised data, is similar to previous studies at about 665 tonnes (within a range of 629–711 tonnes). According to the most recent assessment, the biological status of the three major prawn species is fully fished (Caton 2003). The effort required to achieve this biologically sustainable harvest is 10 300 days (with a range of 9131–13 256 days) (Caton 2003). This effort includes the combined catch of tiger, endeavour and king prawns as single species cannot be targeted (personal communication, Clive Turnbull, 14 November 2003).

Both tiger and endeavour prawns are caught using trawlers, which sweep a large area of seabed to catch relatively sparsely distributed prawns. Consequently, a wide range of non-targeted commercial species such as bugs, scallops, squid, finfish and sharks are taken as bycatch. A 1998 study revealed that commercial prawn catch accounts for only 4–11 per cent of total catches, of which target species accounted for about 60 per cent. Noncommercial species such as marine reptiles, mainly turtles and sea snakes, are also taken as bycatch. The use of turtle excluding devices became mandatory at the beginning of the 2002 fishing season.

Management of the fishery

In 1985, with the ratification of the Torres Strait Treaty, the Torres Strait fishery became a separately managed fishery. Previously the fishery was jointly managed with the northern prawn fishery and the Queensland east coast otter trawl fishery. Approximately 500 boats took out a licence to fish in the fishery at this time.

The Protected Zone Joint Authority (PZJA) is responsible for monitoring the condition of the Torres Strait prawn fishery and for formulating policies and plans for its management. The PZJA is comprised of the Commonwealth and Queensland ministers responsible for fisheries. The fishery is managed under the provisions of the Commonwealth *Torres Strait Fisheries Act 1984*. Management, licensing, enforcement and research activities are carried out on behalf of the PZJA by the Australian Fisheries Management Authority, the Queensland Fisheries Service, the Queensland Boating and Fisheries Patrol, and the Queensland Department of Primary Industries.

The major objectives of management in the Torres Strait prawn fishery are to conserve the prawn stocks while allowing their optimum utilisation and maximising opportunities for traditional inhabitants to participate in the fishery. In 1987, among other restrictions, limited entry management of the prawn fishery was introduced to reduce latent effort and to prepare

for the catch sharing provisions of the treaty. This management arrangement effectively reduced the number of vessels holding a licence to operate in the Torres Strait prawn fishery to 150. In 1989 a freeze was implemented on the transfer of licences, and by June 1992 around 110 vessels were licensed to operate in the fishery.

In 1993, interim management provisions were introduced in an attempt to cap effort. Each vessel was allocated a number of fishing days in which it could operate in the Torres Strait prawn fishery. The allocation was based on the greatest number of days that the vessel had fished in the Torres Strait in a financial year over the period 1988-89 to 1991-92, with an additional allocation for nonfishing time and breakdowns.

In 1994, interim management provisions were approved under which fishing access (in blocks) was made transferable across operators in the fishery. Under these arrangements, operators selling fishing access are prevented from operating in the fishery in the next year. In October 2001 the PZJA approved a boat replacement policy. When smaller boats are replaced by larger boats there is a 20 per cent reduction in fishing day entitlements held.

Together with these controls, restrictions apply on sizes of boat and gear used in the fishery. Prawn trawl boats used in the Torres Strait prawn fishery are not to exceed a maximum length of 20 metres. The maximum length of nets towed from the prawn trawlers (single and combined) is 80 metres, reduced in the 2002 season from the previous 88 metres. Mesh size is also restricted to no larger than 45 millimetres.

Seasonal and area closures of the prawn fishery are an important management tool, keeping sensitive areas free from trawling and allowing protection for areas at important times — such as during recruitment of small prawns to the fishery. The Torres Strait prawn fishing grounds west of Warrior Reef are permanently closed while the grounds east of Warrior Reef are closed between 1 December and 1 March each year.

By February 1999 the fleet comprised 82 licensed vessels assigned 13 570 fishing days (Jackson, Gaffney and Turnbull 1999). By 2002 the fleet had fallen to 77 licensed vessels of which 75 fished in the 2002 season. A majority of the vessels licensed to fish the Torres Strait prawn fishery also hold endorsement to the Queensland east coast trawl fishery and some to the Commonwealth's northern prawn fishery.

Despite the fall in boat numbers since the effort quota was introduced in 1993, the current 77 fishing vessels are still capable of expanding fishing effort to the maximum effort quota of 13 532 fishing days. There is general agreement that the current cap of 13 532 quota days for the Australian commercial operators is too high and that a significant amount of latent effort exists in the fishery (Caton 2003). The PZJA is currently exploring ways to reduce total effort further by removing the latent effort that has existed in the fishery since the advent of the time quota system.

The bycatch action plan for the Torres Strait prawn fishery has included the compulsory introduction in 2002 of turtle excluding devices (TEDs) to all trawling nets. Additional bycatch reduction devises (BRDs) were adopted from the east coast trawl fishery and introduction and research of BRDs is continuing. New shark bycatch limits were introduced in

the 2002 season, with operators permitted to retain up to five shark trunks, to a maximum of 30 kilograms, onboard at any time. In addition, an overall ban on shark finning in the prawn fishery began in the 2002 season.

Future management in the Torres Strait prawn fishery will include the discussion of methods to further reduce latent effort. How this effort reduction is achieved among all users of the fishery, including the Australian commercial fleet, traditional inhabitants of the Torres Strait and Papua New Guinea is the subject of current debate at management meetings.

Other users

Other users of the Torres Strait fishery include residents of Papua New Guinea and the indigenous population of Torres Strait Islanders. Among the management objectives of the Protected Zone Joint Authority is the provision for catch sharing between Australia and Papua New Guinea, as well as to encourage Islander participation.

The Torres Strait Treaty recognises the right of Australia and Papua New Guinea to share the commercial fisheries of the Torres Strait Protected Zone. The treaty contains catch sharing provisions to this end. The commercial fishing grounds in the protected zone lie in both Australian and PNG waters. The sharing scheme in place requires each country to nominate the number of vessels that will operate in the other county's jurisdiction. Australia has agreed to not fish in PNG waters. Currently, seven PNG vessels are endorsed to fish in the Australian jurisdiction, but as yet there has been minimal participation. These vessels are subject to the same restrictions and requirements as the Australian commercial vessels.

To encourage Torres Strait Islander participation in the fishery, three licences are reserved exclusively for Islander participation. These licences are subject to the same operating restrictions as other commercial vessels. To date, the licences are not active, but the Islander Coordinating Council has called for expressions of interest from potential Islander operators.

The quota fishing days held by the Papua New Guinea and Torres Strait Islander fishers are in addition to the 13 532 fishing days held by the Australian commercial fleet.

Boats surveyed

The population of boats operating in the Torres Strait prawn fishery was defined as boats that held a Commonwealth endorsement for the fishery and caught prawns in the survey years. Based on logbook data there were 78 active boats in the Torres Strait prawn fishery in 2000-01 and 75 boats in 2001-02. Of these, 18 were surveyed in 2000-01 and 28 in 2001-02.

For a majority of the boats operating in the Torres Strait prawn fishery, a large proportion of their fishing receipts are derived from operations in the Queensland east coast trawl fishery and the northern prawn fishery. Therefore the financial performance of these boats may not necessarily give an indication of the performance of boats that solely operate in the Torres Strait prawn fishery. For this reason, a group of specialist boats has also been identified, where a specialist boat derives at least 80 per cent of its gross fishing receipts from the Torres Strait prawn fishery.

Financial performance of boats

The principal measures of financial performance for Australian endorsed boats operating in the Torres Strait prawn fishery and specialist Torres Strait prawn boats are shown in table 1. The estimates shown in the table include income obtained and cost incurred by boats that operate in other fisheries, such as the northern prawn fishery, or state fisheries, such as the Queensland east coast trawl fisheries.

Receipts

While the prawn harvest remained relatively constant between 2000-01 and 2001-02, the estimated average per boat prawn receipts for all boats in the fishery fell from around $789 000 in 2000-01 to $671 000 in 2001-02. Average per boat prawn receipts for specialists fell by less, from $577 000 in 2000-01 to $557 000 in 2001-02. The lower prawn receipts were the result largely of the fall in per unit prawn prices over the survey period (figure D).

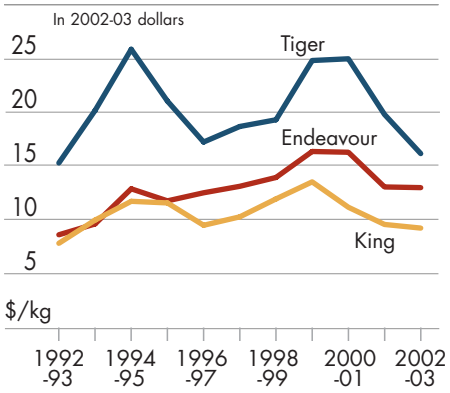
1 Estimated financial performance of boats operating in the Torres Strait prawn fishery

		Specialists				All boats			
		2000-01		2001-02		2000-01		2001-02	
Prawn receipts	$	576 599	(4)	556 662	(3)	788 649	(14)	671 429	(9)
Other fishing receipts	$	54 634	(37)	61 339	(18)	134 419	(27)	68 343	(22)
Nonfishing receipts	$	4 946	(70)	3 000	(63)	28 225	(34)	20 276	(35)
Total cash receipts	$	636 179	(6)	621 001	(3)	951 293	(9)	760 048	(7)
Administration	$	12 035	(24)	10 873	(16)	13 005	(13)	11 148	(12)
Crew costs	$	221 353	(4)	202 404	(4)	285 095	(8)	225 279	(7)
Freight and marketing expenses	$	15 871	(8)	11 376	(19)	21 490	(11)	14 717	(15)
Fuel	$	132 525	(4)	123 106	(4)	158 212	(4)	140 891	(6)
Insurance	$	14 064	(18)	14 757	(10)	15 492	(8)	18 877	(8)
Interest paid	$	16 441	(64)	17 642	(40)	9 919	(38)	16 782	(24)
Licence fees and levies	$	9 715	(6)	8 863	(4)	13 578	(12)	15 911	(25)
Packaging	$	10 639	(10)	11 151	(6)	10 644	(14)	11 456	(15)
Repairs and maintenance	$	94 216	(9)	117 631	(6)	102 615	(9)	111 948	(8)
Other costs	$	23 902	(13)	32 183	(19)	21 407	(8)	28 556	(14)
Total cash costs	$	550 763	(4)	549 986	(4)	651 458	(6)	595 564	(5)
Boat cash income	$	85 416	(54)	71 015	(22)	299 835	(21)	164 484	(17)
less depreciation **a**	$	17 899	(19)	20 630	(9)	29 549	(19)	27 830	(12)
Boat business profit	$	67 517	(63)	50 385	(29)	270 286	(23)	136 655	(22)
plus interest leasing and rent	$	16 584	(63)	21 536	(35)	10 703	(37)	23 465	(20)
Profit at full equity	$	84 102	(40)	71 921	(14)	280 989	(22)	160 120	(17)
Capital									
– excluding quota and licences	$	487 421	(10)	539 958	(5)	530 026	(7)	584 584	(5)
– including quota and licences	$	na		1 529 376	(3)	na		2 242 396	(12)
Rate of return to boat capital **b**	%	17.3	(47)	13.3	(15)	53.0	(20)	27.4	(14)
Rate of return to full equity **c**	%	na		4.7	(14)	na		7.1	(9)

a Depreciation adjusted for profit or loss on capital items sold. **b** Excluding value of quota and licences. **c** Including value of quota and licences. **na** Not applicable.
Note: Figures in parentheses are relative standard errors. A guide to interpreting these is included in appendix A.

For the fleet as a whole, other fishing receipts were estimated to have fallen by 50 per cent from around $134 000 in 2000-01 to $68 000 in 2001-02.

D Torres Strait prawn fishery: real unit values



Costs

For the fleet as a whole, average per boat total cash costs are estimated to have decreased by around 9 per cent to $596 000 in 2001-02 (table 1). This decrease was driven largely by decreasing crew and fuel costs. Crew costs fell by 21 per cent to $225 000 in 2001-02 and fuel costs fell by 11 per cent to around $141 000. In part the decrease in fuel costs is a reflection of the increasing trend to purchase fuel net of the diesel fuel rebate. The average per boat cost for repairs and maintenance increased by 9 per cent in 2001-02 to around $112 000.

For specialist boats, average per boat total cash costs are estimated to have remained stable at around $550 000 in 2001-02. Crew costs fell by 9 per cent between 2000-01 and 2001-02 to $202 000. Average per boat fuel costs fell by 7 per cent to around $123 000. Partially offsetting these decreasing costs, average per boat repairs and maintenance costs for the specialist boats increased by 25 per cent to around $118 000 in 2001-02.

It is important to note that crew costs include the estimated cost of replacing owner operator and family labor. On many boats where owner skippers are involved or family labor is involved, the labor payments can be low or even nil. To reflect the true market value of the labor, operators are asked to estimate what it would cost to replace owner operator and family labor with paid crew and staff. This is likely to more accurately reflect the true market value of the labor used in the fishing operation.

Boat cash income and profit

Average per boat cash income for the fleet as a whole fell by 45 per cent from $300 000 in 2000-01 to $164 000 in 2001-02. Boat cash income for specialists fell by 17 per cent to around $71 000 in 2001-02.

Boat business profit is defined as boat cash income less depreciation (adjusted for profit and loss on capital items sold). Across the fleet, boat business profit is estimated to have fallen by 50 per cent from $270 000 in 2000-01 to $137 000 in 2001-02. Average boat business profit for specialist vessels is estimated to have fallen by 25 per cent to around $50 000 in 2001-02.

Profit at full equity is calculated by adding leasing costs, interest payments and rent payments to boat business profit. While these costs affect the financial position of the individual operator, they represent some profits that have been redistributed to other investors in the fishery. For the entire fleet, profit at full equity is estimated at around $160 000 per boat in

2001-02, a 43 per cent fall from 2000-01. For Torres Strait prawn specialists, profit at full equity was estimated at around $72 000 per boat, a 15 per cent fall from the previous year. These figures represent the estimated average return that would have been earned by the business unit, had the boat and capital (including quota and licences) been fully owned by the operator.

Rates of return

The rate of return to boat capital is calculated on total capital (excluding the value of quota and licences) as if the proprietors wholly owned all assets. This is done so that the financial performance of all boats can be compared regardless of proprietors' equity in the business.

The estimated average rate of return to boat capital (excluding the value of quota and licences) for the entire Torres Strait prawn fleet fell to 27 per cent in 2001-02 from 53 per cent in 2000-01. Driving this decrease was the increase in the average value of boat capital and lower profit at full equity. For specialists, the rate of return to boat capital was estimated to have fallen from 17 per cent in 2000-01 to 13 per cent in 2001-02. Similar to the entire fleet, this was a result of increasing boat capital and lower profit at full equity over the survey period.

The rate of return to full equity (including quota and licences) provides an indication of the return to total capital invested in the business unit. This measure includes changes in the value of quota and licences, boat capital as well as changes in the profitability of the fishing operation. It is the profit from fishing that accrues to the owners of the capital.

The estimated value of quota and licences per boat operating in the Torres Strait prawn fishery was around $1.7 million in 2001-02 and the rate of return to full equity for the fishery was estimated at 7.1 per cent for 2001-02. For Torres Strait prawn specialists, the estimated value of quota and licences per boat was around $1 million in 2001-02 leading to a rate of return to full equity of 4.7 per cent.

Economic performance of the fishery

While the measures of financial performance in table 1 provide an indication of the financial health of fishing operators in the Torres Strait prawn fishery, they do not provide an indication of AFMA's performance against their objective of maximising economic efficiency. This is because the figures in table 1 include costs, receipts and capital from fisheries other than the Torres Strait prawn fishery.

Maximising economic efficiency in a fishery involves maximising economic rent. The term 'economic rent' is used to describe the part of the return from the use of a natural resource that stems from the scarcity of that resource. The concept of economic rent arose in the early nineteenth century from the realisation that rent for land was not set by the owners of the land but rather by the potential profitability that users could reap from using the land (Barlowe 1958). In a fishery, economic rent is the long run surplus income after all other costs have been met, such as fuel, bait, labor, repairs and the necessary return on capital to justify any investment. Any resource rent in fisheries is commonly accrued by fishing operators.

As an indicator of economic rent, ABARE has calculated net returns to the Torres Strait prawn fishery using survey data. However, net returns in a given year may differ from the long run economic rent for a number of reasons. Of particular importance are the condition of the fish stock, capital structure and market conditions. For example, if the fish stock is being fished down then net returns in that year will include revenue from selling off part of the fish stock that will not be available over the long term. Consequently the calculated net returns will overestimate the long term economic rent available from the fishery. More detail can be found in Rose et al. (2000).

Net returns in the Torres Strait prawn fishery and assessment of fishery management

The measure of net return to the fishery includes only those receipts and costs that are attributable to the Torres Strait prawn fishery. As a result, the estimated receipts and costs in table 2 will differ from those in table 1 which include all receipts and costs of boats operating in the fishery, including those incurred while fishing in other fisheries such as the northern prawn and Queensland east coast trawl fisheries.

Despite a fall in the costs of the fishery, real net returns (including management costs) for the Torres Strait prawn fishery are estimated to have fallen from $4.8 million in 2000-01 to around $2.8 million in 2001-02. These net returns are much lower than the estimated average net returns for the northern prawn fishery ($38.3 million), yet higher than the average for the south east trawl fishery ($2 million).

There are two main steps involved in assessing the economic efficiency of fishery management arrangements. First, it needs to be determined what type of management regime is

2 Net returns to the Torres Strait prawn fishery
In 2002-03 dollars

	Revenue a	Cash costs a,b	Capital a,c	Net returns (excl. management costs) d	Management costs e	Net returns (incl. management costs)	Number of vessels
	$m	$m	$m	$m	$m	$m	no.
1992-93	17.6 (10)	14.9 (10)	11.4 (13)	1.4 (33)	na	na	61
1993-94	17.6 (15)	14.8 (15)	10.1 (14)	0.8 (81)	na	na	64
1994-95	19.1 (14)	16.0 (13)	11.2 (14)	1.1 (61)	na	na	60
1995-96	18.2 (8)	15.9 (8)	9.5 (10)	0.6 (54)	na	na	60
1996-97	19.9 (12)	16.9 (12)	8.6 (10)	1.5 (49)	na	na	80
1997-98	22.3 (8)	17.6 (8)	7.0 (8)	3.3 (20)	0.2	3.1	83
1998-99	26.9 (15)	21.5 (15)	12.0 (22)	3.3 (41)	0.2	3.1	82
1999-2000	26.8 (13)	20.8 (12)	10.6 (17)	4.0 (28)	0.2	3.8	79
2000-01	28.6 (13)	21.4 (14)	11.9 (26)	5.1 (22)	0.3	4.8	78
2001-02	24.7 (10)	19.7 (11)	10.0 (17)	3.1 (15)	0.3	2.8	75

a Amount attributable to fishery. **b** Cash costs include imputed operator and family labor costs but exclude licence and levy payments and interest payments. **c** Replacement capital (depreciated capital). **d** excludes management costs. Calculated as per the definition in this report. **e** AFMA management costs (A. Kettle, AFMA, personal communication, 4 September 2002).
Note: Figures in parentheses are relative standard errors. A guide to interpreting these is included in appendix A.

likely to allow for economic returns to be maximised (including the cost of management). Once this is established, the level of catch/effort required to achieve maximum returns needs to be determined. Setting catch/effort too high will result in the dissipation of economic returns, while setting it too low will result in missed profitable opportunities.

The Torres Strait prawn fishery is managed under the *Torres Strait Fisheries Act 1984*, rather than the *Fisheries Management Act 1991*. The objective of the Torres Strait Protected Zone Joint Authority (PZJA) is the optimal use of the fishing resource (Kung, Turnbull and Murphy 2003). The *Torres Strait Fisheries Act* allows management of the whole Torres Strait protected zone, across both the Australian and PNG jurisdictions. Reflecting the assumed cross-jurisdictional distribution of the prawn stock in the Torres Strait prawn fishery, it is necessary to take a whole zone approach to management of the fishery. This includes scientific assessments across jurisdictions, accounting for all users and setting optimal fishing effort that applies to commercial and indigenous users from both countries.

To date the stock assessments carried out in the Torres Strait prawn fishery have been in Australian jurisdictional waters only. The allocation of fishing days in the Australian waters between the Australian commercial, Torres Strait Islander and PNG commercial users are apportioned from a total effort allocation based on this assessment. A new stock assessment including the prawn stock in PNG waters is to be undertaken in the near future (Ryan Murphy, AFMA, personal communication, November 2003). Assessment of the whole fishery stock could then be used to determine the total optimal effort across both countries for allocation between all users.

As described above, effort controls have been the primary management tools used in the Torres Strait prawn fishery. An attempt has been made to control effort by restricting the number of boats, the number of fishing days, the type of gear used and the areas to be fished.

One of the main problems with effort or input controls is that ownership of fish is by capture. Therefore individuals have a strong incentive to compete to maximise their catch — race to fish — which results in overcapacity and reduction in overall net returns. A second, although related problem is effort creep. This is where fishers substitute unrestricted inputs for restricted inputs in an attempt to increase their relative fishing power. The effect is that individual fishers end up using a combination of inputs that do not minimise costs for the level of catch and consequently net returns to the entire fishery are not maximised. Research by the Queensland Department of Primary Industries (Turnbull 2003) has shown that effort creep has taken place in the Torres Strait prawn fishery over the past ten years. Fishing power has increased on average by 1.9 per cent a year for tiger prawn catches in the fishery. The effort creep has come mainly in the form of increased engine horsepower and increased use of technology such as GPS (satellite positioning) and computer mapping software.

Where effort creep occurs, it is likely that input controls will need to be tightened frequently to ensure that fishing mortality is in line with management targets. As Rose (2002) explains, each set of rule changes can be expensive as they generally make some boats and gear redundant. For the Torres Strait prawn fishery, the effort creep contributed to the 10 per cent reduction in net size in 2003. As well, the process of researching, designing and negotiating changes in management regimes can be costly for both fishers and managers. In estimating

the long run net returns to the fishery, both sets of periodic costs — those of research and negotiation and those of reinvestment — should be set against any apparent net returns in the years between changes in management regime.

The recent scientific assessment estimated that the effort required to achieve the biologically sustainable harvest of tiger, endeavour and king prawns is 10 300 days (Caton 2003). According to logbook data, in the 2002 fishing season around 10 300 days were used. However, the harvest that results in maximum economic returns over the long term is below the maximum biological yield (see Gooday and Galeano 2003 for a more detailed synopsis).

In addition there appears to be significant latent effort present in the fishery, with 24 per cent of the 13 532 allocated fishing days in 2002 not used. With significant latent effort present in the fishery any above average profits can be competed away relatively quickly with the activation of that effort. Until the management arrangements lead to a scenario where latent effort is removed, it is unlikely that net returns can be maximised.

Detailed analysis of the relative costs and benefits of alternative management arrangements in the Torres Strait prawn fishery has not been undertaken. However, the obvious alternative to effort controls would be a system of individual transferable quotas (ITQs) and a total allowable catch. This form of management would avoid the problems associated with effort creep. However, ITQs have other potential problems. The potential for ITQs to encourage discarding and difficulties in setting an optimal total allowable catch in fisheries with unpredictable abundance (such as short lived prawn species) have been recognised (Rose 2002).

Given the problems associated with implementing ITQs in the Torres Strait prawn fishery, it is not clear whether the net benefits of ITQ management would outweigh the net benefits of the current arrangements. In comparing the net benefits of effort controls and ITQs it is important that the full costs associated with each regime are accounted for. For example, the periodic costs involved in the development of new sets of rules under an input controlled fishery to correct for effort creep must be taken into account. Similarly, the potential loss of profitable opportunities under an ITQ regime in years of high abundance needs to be considered.

south east trawl fishery

- Average per boat fishing receipts for offshore boats, inshore boats and Danish seiners all rose in 2001-02
- However, costs rose by more than receipts for the offshore boats and inshore boats. Consequently, average per boat cash income for offshore boats fell by 24 per cent in 2001-02, to $260 000, and for inshore boats also by 24 per cent to $24 100. Average per boat cash income for Danish seiners rose by 16 per cent to over $79 000 in 2001-02.
- In the two years covered by the most recent survey, estimated real net returns (including management costs and assuming constant stocks) to the fishery resource were an estimated $2.5 million in 2000-01 and $0.5 million in 2001-02.

The fishery

The south east trawl fishery is one of Australia's oldest commercial fisheries. Although some processing facilities and export markets have been developed, the fishery continues to supply the bulk of market requirements for fresh fish in New South Wales, Victoria, Tasmania and South Australia.

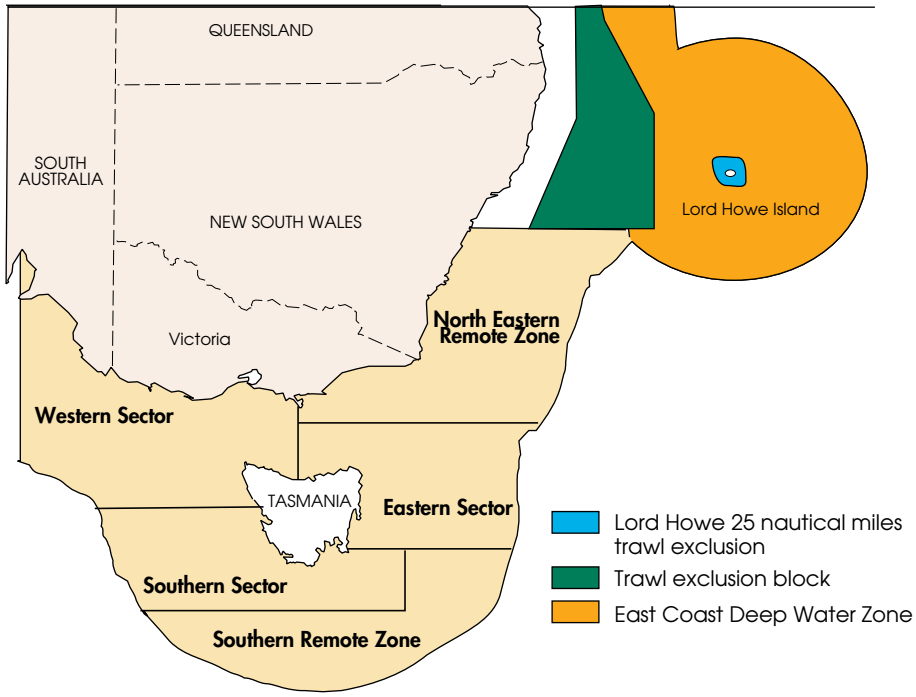
The bulk of the catch consists of twenty species or species groups managed by quota. However, around a hundred species of finfish and deepwater crustaceans are commercially caught. The major species landed (by gross value) are orange roughy, blue grenadier, ling, tiger flathead and silver warehou. Many of the fish species caught in the south east trawl fishery are also caught in other Commonwealth and state fisheries and by recreational fishers. Two types of trawl method are used: otter board (demersal and midwater) and Danish seine.

The south east trawl fishery covers an area of the Australian Fishing Zone extending southward from Sandy Cape in southern Queensland, around the New South Wales, Victorian and Tasmanian coastlines to Cape Jervis in South Australia and includes the east coast deepwater zone (figure A).

The volume of catches in the south east trawl fishery have fluctuated in recent years, primarily reflecting fluctuating orange roughy catches (figure B). The catch of blue grenadier has increased substantially since the mid-1990s.

In the past decade the real gross value of production from the south east trawl fishery has ranged from a high of $87 million (in 2002-03 dollars) in 1992-93 to a low of around

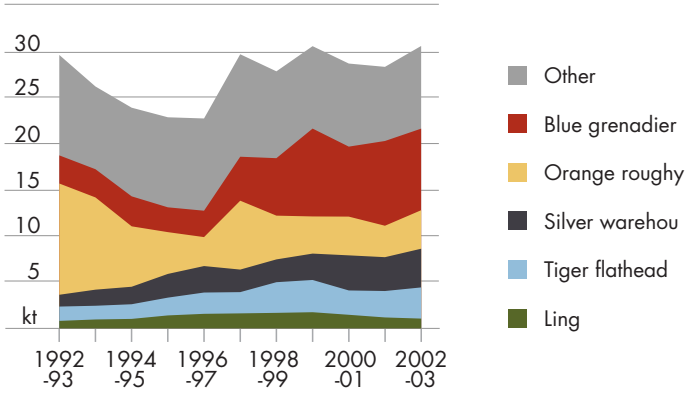
A **Map of the south east trawl fishery**



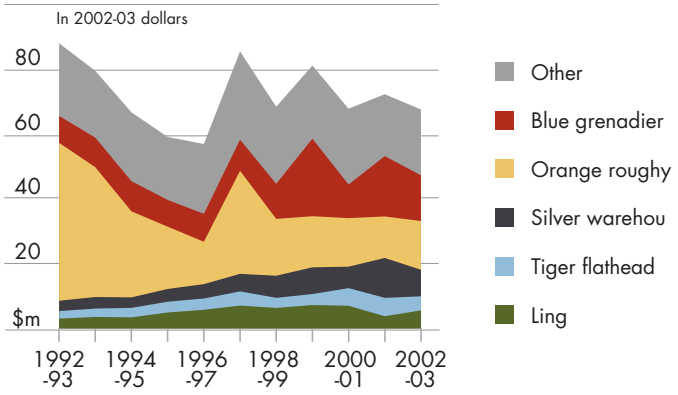
$57 million in 1996-97 (figure C). In 2002-03 the real gross value of production was $68 million.

Until the mid-1980s total south east fishery landings were dominated by catches taken off New South Wales and eastern Bass Strait. However, during the late 1980s and early 1990s, increased targeting of orange roughy and blue grenadier in waters around Tasmania brought

B **South east trawl fishery: catch**



C South east trawl fishery: real gross value of production



about a marked increase in Tasmanian and Victorian landings. More recently, the downturn in orange roughy catches has resulted in increased effort in the shallower waters of the south east trawl fishery. Major ports for landing quota species are Port Melbourne, Ulladulla, Devonport, Eden, Lakes Entrance, Portland and Hobart (Smith and Wayte 2001).

Biological status of the fishery

The South East Fishery Assessment Group (SEFAG) is responsible for synthesising biological and ecosystem information on the south east trawl fishery to provide advice to AFMA. In addition this group coordinates, evaluates and regularly undertakes stock assessments in the fishery.

The biological status of stocks in the south east trawl fishery is published on an annual basis by the Bureau of Rural Sciences. A summary of the biological status of the major species caught in the south east trawl fishery is presented in table 1. For more details of the most recent published assessments for the fishery, see Caton (2003).

1 Status of species caught in the south east trawl fishery

Status	Species
Uncertain	Blue-eye trevalla, eastern school whiting, western gemfish, jackass morwong, john dory, pink ling, mirror dory, ocean perch, royal red prawn and spotted warehou
Fully fished	Blue grenadier and flathead
Overfished	Blue warehou, eastern gemfish, orange roughy, redfish and silver trevally

Source: Caton (2003).

Management of the fishery

The south east trawl fishery is currently managed using a combination of individual transferable quotas (ITQs) and input controls (limited entry, mesh size and area restrictions). Before ITQ management, the trawl fishery was divided into three sectors (eastern A, eastern B and south west), with different input control requirements.

ITQs were initially introduced to manage the trawl capture of eastern gemfish in 1989. In 1992, the use of ITQs was extended to cover a further fifteen species. At this time, operators were only allowed to lease quota on a seasonal basis to other operators within the fishery, and the sale of quota was prohibited. Full and permanent transferability of quota has been permitted since January 1994.

Under the ITQ system, each quota species is subject to a total allowable catch (TAC) apportioned between the operators who are entitled to fish. The TAC is set each year by AFMA, in consultation with relevant stakeholders.

The quota management system in the south east trawl fishery is administered using an 'undercatch'/'overcatch' approach. Under this approach, up to 20 per cent (depending on the species) of the total individual quota entitlement underused or overused in one year may be carried over to the next. Therefore, the TAC set in one year may differ from the actual TAC, once undercatch and overcatch have been included. Since the introduction of ITQs, the only total allowable catch regularly exceeded (although still within the actual TAC, which includes agreed undercatch limits) is that for orange roughy in the eastern sector. Even when catches recorded in state waters are added, catches for the remaining species have tended to be below their total allowable catches (Caton 2003).

A number of changes to the management of the south east trawl fishery have occurred in recent years. Restrictions on the length of vessels were lifted in 1997. On 1 January 1998, a global TAC for three of the quota species, pink ling, blue warehou and blue-eye trevalla, was determined to cover the whole of the south east fishery, including the nontrawl component. This has been gradually extended to cover more species and, in 2003, there were twenty species/species groups/species management sectors for which a global TAC was determined and apportioned to operators in the south east trawl fishery and gillnet hook and trap fishery (formerly southern shark and south east nontrawl fisheries). Global TACs also apply to the four shark species in the Great Australian Bight trawl fishery.

Quotas for pink ling and blue warehou can now be seasonally leased across the different trawl and nontrawl sectors, although the permanent transfer of quota between the different sectors is not possible. However, it is possible for an operator in one sector to hold quota in another under a separate fishing permit. Up until the end of 2001, quota for blue-eye trevalla could not be seasonally leased between the trawl and nontrawl sectors. However, from 1 January 2002, 10 per cent (58 094 kilograms in 2002) of the TAC of blue-eye trevalla may be leased from the nontrawl sector to the trawl sector.

In 1999, the east coast deep water zone fishery was incorporated into the management of the fishery and, in 2000, access to the area was permitted to anyone holding a class A permit who applied to fish in the zone. For the 2003 fishing season, trawl trigger limits apply for some species such as orange roughy.

In October 1999 the AFMA board agreed to the concept of incorporating the Commonwealth Victorian inshore trawl fishery into the south east trawl fishery. From 2003, the fishery has been managed under an ITQ system, where quotas for several species such as flathead and blue warehou have been allocated to operators in addition to the global TACs. However,

from 2004, the Victorian inshore trawl quota will be included in the global TAC set for the south east fishery.

Also in 1999, a marine protected area in the Southern Tasmanian Seamounts was declared and is now closed to trawl and demersal nontrawl fishing.

In late 2002 AFMA introduced trip limits for the endeavour dogfishes (*Centrophorus* spp.) to discourage targeted fishing, while providing adequate flexibility to allow operators to land incidental catches. This group comprises Harrisons dogfish (*C. Harrissoni*), endeavour dogfish (*C. moluccensis*) and southern dogfish (*C. uyato*).

From January 2003, an area surrounding St Helens Hill off eastern Tasmania has been closed to trawl fishing. The objective of this strategy, which was developed in close consultation with industry, is to protect part of the eastern zone orange roughy stock, and combined with an annual TAC, to rebuild the eastern zone orange roughy stock. Also in May 2002 it was agreed that the southern remote zone of the fishery and the South Tasman Rise fishery be managed together under a competitive TAC. Under the system a TAC of 800 tonnes was set, with Australia's share 600 tonnes and New Zealand's share 200 tonnes. This TAC applied in 2003, and under an agreement with the New Zealand government the annual TAC will be reduced automatically over a number of years if the fishery fails to meet catch performance criteria.

As part of the process of implementing the Southern and Eastern Scalefish and Shark Management Plan (the SESS plan) (which encompasses the Great Australian Bight trawl fishery, south east trawl fishery, and gillnet hook and trap fishery), AFMA revoked the South East Trawl Plan on 31 December 2002. SFR options (which arose as a result of the revocation of the SETF plan) were issued to those persons who held SFRs under the SETF plan in 2002. Fishing permits and quota will continue to be used until the SESS plan commences full operation and SFRs are granted to eligible persons. It is anticipated that under the plan, separate levies, budgets and management advisory committees will be maintained.

Boats surveyed

For the purpose of the survey, the population was defined as boats endorsed for the south east trawl fishery that caught fish in the survey years. Based on the type of fishing operation, boats in the fishery can be divided into four subgroups: inshore trawl boats, offshore boats, Danish seiners and factory trawlers.

Inshore trawl boats generally operate on the continental shelf and upper shelf to around 500 metres. They target a range of species, most destined for the domestic market.

The offshore fleet consists mainly of larger boats that operate primarily out of Tasmanian and Victorian ports. The main target species are orange roughy and spotted warehou, although with the decline in the total allowable catches of orange roughy, some boats are moving toward catching fish for the domestic market.

The Danish seine fleet comprises generally smaller, low powered vessels that operate in shallower waters targeting predominantly whiting and flathead.

The fourth group, factory trawlers, a relatively new group, targets blue grenadier and silver warehou off the west coast of Tasmania. These boats catch large quantities of fish and have onboard processing facilities.

Based on logbook data, there were 67 inshore boats in 2000-01 and 57 in 2001-02. Of these, 26 and 28 were sampled respectively. For the offshore sector, there were 18 boats in the population in both 2000-01 and 2001-02 of which six and five were sampled. There were 21 boats in the Danish seine fleet in 2000-01 and 22 in 2001-02, and in both years, six were sampled.

There are only a small number of factory trawlers operating in the south east trawl fishery. The fishing operations of these boats are significantly different from any other fishing operations in the fishery. Ideally, information for these factory trawlers should be included in the total. However, as ABARE was unable to sample any of the factory trawlers, the results presented here exclude factory trawlers.

Financial performance of boats

Table 2 provides the major measures of financial performance for boats (excluding factory trawlers) that operated in the south east trawl fishery in 1998-99 and 2001-02. Table 3 contains information on the performance of boats in the fishery by triptile. To calculate triptiles, the population was ranked according to fish sales, with the third of the population with the lowest fish sales comprising the lower or bottom triptile, and so on. The weighted average cost and earnings for operators within each group was then calculated.

The estimates in tables 2 and 3 include receipts and costs from other fisheries in which the boats operate.

Receipts

Average per boat fishing receipts for the fleet as a whole in 2001-02 were estimated to be $714 000, up 9 per cent from the previous year (table 2).

On average, fishing receipts rose by 10 per cent for both the inshore and Danish seine fleets to around $574 000 and $333 000 respectively in 2001-02. Fishing receipts for offshore boats rose by 4 per cent to around $1.63 million in 2001-02.

For the fleet as a whole, average per boat nonfishing receipts are estimated to have risen by 19 per cent over the survey period to $73 200 per boat.

Overall, average per boat total cash receipts for the fleet are estimated to have been $787 000 in 2001-02, up 10 per cent from the previous year.

Costs

Average per boat total cash costs for the fleet as a whole rose by an estimated 13 per cent to $707 000. This rise was consistent across the three groups.

For the fleet as a whole, average per boat crew costs represented around 33 per cent of total cash costs in 2001-02, and as crews are generally paid on sharefishing arrangements, rises in average per boat crew costs reflected increases in fishing receipts across the three groups. For the entire fleet, average per boat crew costs rose by 10 per cent in 2001-02 to $231 000. It is important to note that crew costs include the estimated cost of replacing owner operator and family labor with employees to do the same work. The reason for this is that on many boats where owner skippers are involved or family labor is involved, the labor payments could be low or even nil. To reflect the true market value of the labor, operators are asked to estimate what it would cost to replace owner operator and family labor with paid crew and staff. This is likely to more accurately reflect the true market value of the labor used in fishing operations.

2 Estimated financial performance of boats operating in the south east trawl fishery

		Inshore boats				Offshore boats			
		2000-01		2001-02		2000-01		2001-02	
Fishing receipts	$	519 150	(9)	573 651	(9)	1 562 924	(6)	1 625 010	(14)
Nonfishing receipts	$	54 200	(15)	61 375	(16)	151 133	(33)	178 820	(32)
Total cash receipts	$	573 350	(9)	635 026	(9)	1 714 057	(6)	1 803 830	(16)
Administration	$	15 060	(11)	12 350	(9)	19 702	(23)	23 329	(25)
Crew costs	$	167 710	(10)	193 765	(9)	480 714	(6)	481 543	(11)
Freight and marketing	$	78 740	(12)	82 054	(13)	103 233	(26)	186 710	(14)
Fuel	$	113 490	(9)	124 803	(11)	332 843	(16)	338 055	(22)
Insurance	$	18 190	(9)	21 490	(10)	42 063	(12)	58 039	(16)
Leasing	$	9 090	(21)	13 928	(20)	78 690	(32)	85 477	(19)
Licence fees and levies	$	15 730	(15)	20 688	(15)	41 065	(9)	61 940	(13)
Repairs and maintenance	$	81 960	(11)	103 233	(14)	239 133	(11)	252 995	(18)
Other costs	$	41 800	(10)	38 602	(8)	32 333	(18)	55 463	(6)
Total cash costs	$	541 770	(8)	610 913	(9)	1 369 776	(5)	1 543 551	(11)
Boat cash income	$	31 590	(41)	24 113	(99)	344 281	(24)	260 279	(56)
less depreciation **a**	$	19 170	(12)	21 839	(10)	34 866	(7)	31 731	(2)
Boat business profit	$	12 410	(100)	2 274	(1 061)	309 415	(27)	228 548	(64)
plus interest, leasing and rent	$	26 040	(16)	27 126	(12)	78 692	(32)	85 482	(19)
Profit at full equity	$	38 450	(37)	29 400	(79)	388 107	(22)	314 030	(48)
Capital									
– excluding quota and licences	$	372 760	(9)	453 788	(12)	1 209 936	(16)	1 183 314	(19)
– including quota and licences	$	na		1 150 864	(8)	na		3880 974	(12)
Rate of return to boat capital **b**	%	10.3	(36)	6.5	(85)	32.1	(32)	26.5	(29)
Rate of return to full equity **c**	%	na		2.6	(82)	na		8.1	(44)

Continued ➪

Average per boat fuel costs, which represented 20 per cent of the fleet's total cash costs in 2001-02, rose by 7 per cent to $142 000. The increase in fuel costs was relatively large for the Danish seine and inshore fleets. Fuel costs for offshore boats remained relatively constant.

Repairs and maintenance costs were the next largest cost component, averaging $113 000 across the fleet in 2001-02, an increase of 17 per cent from the previous year. Again, the relatively large increase in repairs and maintenance costs were experienced in the Danish seine and inshore fleets where average per boat repairs and maintenance costs rose by 20 per cent and 26 per cent respectively.

Boat cash income and profit

For the fleet as a whole, average cash income per boat fell by an estimated 13 per cent to $80 500 in 2001-02. The fall was only evident in the offshore and inshore boats sectors. Reflecting increased costs, average per boat cash income fell in both these sectors by 24 per cent to $260 000 and $24 100 respectively. In contrast, average per boat cash income for the Danish seine fleet rose by 16 per cent to $92 000.

2 Estimated financial performance of boats operating in the south east trawl fishery *continued*

		Danish seiners				All boats			
		2000-01		2001-02		2000-01		2001-02	
Fishing receipts	$	302 835	(13)	333 248	(10)	653 541	(5)	714 224	(7)
Nonfishing receipts	$	7 259	(32)	17 367	(25)	61 360	(16)	73 188	(17)
Total cash receipts	$	310 095	(13)	350 615	(9)	714 902	(6)	787 412	(8)
Administration	$	3 617	(19)	5 389	(17)	13 579	(10)	12 808	(10)
Crew costs	$	110 312	(15)	122 318	(15)	209 488	(6)	230 962	(6)
Freight and marketing	$	53 796	(16)	57 411	(11)	77 957	(10)	95 885	(8)
Fuel	$	22 813	(12)	27 308	(13)	132 776	(8)	142 263	(11)
Insurance	$	9 717	(11)	11 324	(13)	20 566	(7)	25 967	(8)
Leasing	$	586	(79)	523	(69)	19 225	(23)	24 164	(14)
Licence fees and levies	$	6 791	(14)	6 065	(16)	18 262	(9)	25 027	(9)
Repairs and maintenance	$	20 520	(17)	24 605	(12)	96 476	(8)	113 191	(11)
Other costs	$	13 229	(9)	16 192	(12)	34 531	(8)	36 648	(5)
Total cash costs	$	241 380	(11)	271 135	(10)	622 861	(5)	706 917	(7)
Boat cash income	$	68 715	(40)	79 480	(27)	92 041	(19)	80 495	(38)
less depreciation **a**	$	11 416	(26)	10 010	(30)	20 301	(8)	20 992	(7)
Boat business profit	$	57 298	(49)	69 469	(33)	71 740	(24)	59 503	(52)
plus interest, leasing and rent	$	3 170	(49)	4 709	(47)	30 450	(16)	32 871	(11)
Profit at full equity	$	60 468	(46)	74 179	(30)	102 190	(17)	92 374	(34)
Capital									
– excluding quota and licences	$	214 154	(12)	205 644	(12)	483 501	(8)	532 884	(10)
– including quota and licences	$	na		690 728	(11)	na		1 553 121	(6)
Rate of return to boat capital **b**	%	28.2	(39)	36.1	(27)	21.1	(21)	17.3	(29)
Rate of return to full equity **c**	%	na		10.7	(24)	na		5.9	(33)

a Depreciation adjusted for profit or loss on capital items sold. **b** Excluding value of quota and licences. **c** Including value of quota and licences. **na** Not applicable.
Note: figures in parentheses are relative standard errors. A guide to interpreting these is included in appendix A.

Examining triptiles, based on the value of fish sold, boat cash income rose for small and midrange operators but fell for the larger operators (table 3). For small operators, the estimated rise in average per boat receipts (27 per cent) well exceeded the estimated rise in average per boat total cash costs (17 per cent). Average per boat cash income for this group rose markedly from an estimated loss of $1700 in 2000-01 to a surplus of $20 900 in 2001-02.

In contrast, the midrange operators experienced a more modest rise in average per boat receipts (12 per cent), which was almost offset by a similar rise in cash costs, resulting in average per boat cash income rising only slightly to $51 200 in 2001-02.

Average per boat receipts for the larger group of operators rose by 12 per cent, much less than the 18 per cent rise in average per boat costs, resulting in average per boat cash income for this group falling from around $217 000 in 2000-01 to $169 000 in 2001-02.

Boat business profit is defined as boat cash income less depreciation (adjusted for profit and loss on capital items sold). Depreciation remained relatively stable across all three categories, so changes in boat business profit closely reflected the changes to boat cash income already discussed in detail above. For the fleet as a whole, average per boat business profit fell by an estimated 17 per cent to $59 500 in 2001-02.

3 Estimated financial performance of boats operating in the south east trawl fishery, by triptile

		Lower triptile				Middle triptile			
		2000-01		2001-02		2000-01		2001-02	
Fishing receipts	$	217 590	(10)	283 050	(6)	437 120	(3)	486 190	(3)
Nonfishing receipts	$	24 890	(22)	24 230	(17)	26 580	(28)	32 350	(18)
Total cash receipts	$	242 490	(10)	307 280	(5)	463 700	(4)	518 540	(3)
Administration	$	6 990	(14)	7 350	(10)	10 360	(17)	9 750	(16)
Crew costs	$	91 990	(8)	110 430	(8)	135 690	(9)	154 350	(7)
Freight and marketing	$	31 830	(15)	42 590	(10)	62 100	(9)	67 860	(12)
Fuel	$	45 050	(16)	50 790	(17)	79 080	(14)	80 630	(12)
Insurance	$	9 880	(15)	9 640	(11)	20 670	(11)	23 060	(11)
Leasing	$	2 130	(40)	2 990	(32)	4 310	(37)	6 960	(27)
Licence fees and levies	$	8 470	(11)	8 480	(14)	11 810	(17)	14 080	(14)
Repairs and maintenance	$	30 720	(15)	33 720	(16)	55 920	(13)	73 980	(26)
Other costs	$	14 670	(15)	14 550	(13)	21 250	(14)	23 420	(9)
Total cash costs	$	244 170	(7)	286 420	(6)	416 870	(6)	467 300	(7)
Boat cash income	$	–1 680	(809)	20 860	(57)	46 830	(37)	51 240	(48)
less depreciation **a**	$	10 280	(13)	10 990	(16)	15 350	(12)1	6 560	(12)
Boat business profit	$	–11 970	(115)	9 870	(129)	31 480	(59)	34 680	(74)
plus interest, leasing and rent	$	4 600	(23)	9 200	(24)	20 940	(23)	20 740	(20)
Profit at full equity	$	–7 370	(184)	19 070	(67)	52 420	(32)	55 420	(42)
Capital									
– excluding quota and licences	$	192 170	(12)	189 030	(10)	318 070	(12)	374 980	(10)
– including quota and licences	$			591 700	(8)			152 920	(8)
Rate of return to boat capital **b**	%	–3.8	(181)	10.1	(73)	16.5	(37)	14.8	(45)
Rate of return to full equity **c**	%			3.2	(69)			4.8	(44)

Continued ➪

Profit at full equity is estimated by adding leasing costs, interest charges and rent payments to boat business profit. While these costs affect the financial position of the individual operator in the fishery, from a broader perspective they represent profits that are redistributed to other investors in the fishery. Profit at full equity provides a measure of the return that would have been earned by the business unit had the boat and capital (including entitlements) been fully owned by the operator.

Average per boat profit at full equity for the fleet is estimated to have been $92 400 in 2001-02, down 10 per cent on 2000-01 (table 1). Average per boat profit at full equity fell markedly in both the offshore and inshore sectors (by 19 per cent and 24 per cent respectively) but increased by around 23 per cent to $74 200 in the Danish seine fleet.

Rates of return

The rate of return to boat capital is calculated on total capital (excluding the value of quota and licences) as if the proprietors wholly owned all assets so that the financial performance of all boats can be compared regardless of the proprietors' equity in the business.

3 Estimated financial performance of boats operating in the south east trawl fishery, by triptile *continued*

		Upper triptile			
		2000-01		2001-02	
Fishing receipts	$	1 242 890	(9)	1 368 450	(11)
Nonfishing receipts	$	127 810	(19)	162 300	(20)
Total cash receipts	$	1 370 700	(9)	1 530 750	(12)
Administration	$	22 440	(13)	21 260	(16)
Crew costs	$	384 240	(9)	426 610	(9)
Freight and marketing	$	133 070	(11)	176 590	(10)
Fuel	$	261 810	(11)	294 210	(16)
Insurance	$	29 460	(15)	45 050	(15)
Leasing	$	48 950	(26)	62 260	(22)
Licence fees and levies	$	33 140	(14)	52 310	(16)
Repairs and maintenance	$	193 510	(10)	230 970	(11)
Other costs	$	35 900	(10)	46 940	(11)
Total cash costs	$	1 153 310	(6)	1 362 030	(9)
Boat cash income	$	217 390	(27)	168 720	(52)
less depreciation **a**	$	33 820	(9)	35 320	(8)
Boat business profit	$	183 570	(31)	133 400	(67)
plus interest, leasing and rent	$	61 980	(20)	68 400	(17)
Profit at full equity	$	245 550	(25)	201 800	(46)
Capital					
– excluding quota and licences	$	898 750	(13)	1 030 860	(15)
– including quota and licences	$			2 904 460	(17)
Rate of return to boat capital **b**	%	27.3	(24)	19.6	(42)
Rate of return to full equity **c**	%			6.9	(42)

a Depreciation adjusted for profit or loss on capital items sold. **b** Excluding value of quota and licences. **c** Including value of quota and licences. **na** Not applicable.
Note: Figures in parentheses are relative standard errors. A guide to interpreting these is included in appendix A.

For the fleet as a whole, the estimated average per boat rate of return to boat capital fell from 21 per cent in 2000-01 to 17 per cent in 2001-02 (table 1). The large falls in average per boat rates of return to boat capital in the offshore and inshore fleets were partly offset by an increase in the Danish seine sector.

The estimated rate of return at full equity includes the value of the quota and licences. For the fleet as a whole, the average per boat rate of return at full equity was estimated at 5.9 per cent in 2001-02 (table 1).

Economic performance of the fishery

While the measures of financial performance in tables 2 and 3 provide an indication of the financial health of fishing operators in the south east trawl fishery, they do not provide an indication of AFMA's performance against their legislated objectives of maximising economic efficiency and providing efficient and cost effective management. This is because the figures in tables 2 and 3 include costs, receipts and capital from fisheries other than the south east trawl fishery.

Maximising economic efficiency in a fishery involves maximising of economic rent. The term 'economic rent' is used to describe the part of the return from the use of a natural resource that stems from the scarcity of that resource. The concept of economic rent arose in the early nineteenth century from the realisation that rent for land was not set by the owners of the land but rather by the potential profitability that users could reap from using the land (Barlowe 1958). In a fishery, economic rent is the long run surplus income after all other costs had been met, such as fuel, bait, labor, repairs and the necessary return on capital to justify any investment. Any resource rent in fisheries is commonly accrued by fishing operators.

As an indicator of economic rent, ABARE has calculated net returns to the south east trawl fishery using survey data. However, net returns in a given year may differ from the long run economic rent for a number of reasons. Of particular importance are the condition of the fish stock, capital structure and market conditions. For example, if the fish stock is being fished down then net returns in that year will include revenue from selling off part of the fish stock that will not be available over the long term. Consequently, the calculated net returns will overestimate the long term economic rent available from the fishery. More detail can be found in (Rose et al. 2000).

Net returns in the south east trawl fishery and assessment of fishery management

The measure of net return to the fishery includes only those receipts and costs that are attributable to the south east trawl fishery. As a result, the estimated receipts and costs in table 4 will differ from those in tables 2 and 3 which include all receipts and costs of boats operating in the fishery, including those incurred while fishing in other fisheries such as state managed trawl fisheries.

The real net returns to the south east trawl fishery (in 2002-03 dollars) for the period 1996-97 to 2001-02 are presented in table 4. Net returns to the fishery (including management costs) have averaged around $2.0 million a year. In 2000-01 and 2001-02 real net returns were estimated at $2.5 million and $0.5 million respectively.

These net returns are low relative to some other ABARE surveyed fisheries. There are two possible reasons for these low returns. It may be that the fishery is being managed optimally and this is the highest level of net returns achievable. In this case effort should be concentrated on minimising the cost of management for the level of returns. Alternatively, it may be that the fishery is being managed suboptimally and changes to either the type of management tools or level of catch/effort could lead to higher returns.

There are two main steps involved in assessing the economic efficiency of fishery management arrangements. First, it needs to be determined what type of management regime is likely to allow for economic returns to be maximised (including the cost of management). Once this is established, the level of catch/effort required to achieve maximum returns needs to be determined. Setting catch/effort too high will result in the dissipation of economic returns, while setting it too low will result in missed profitable opportunities.

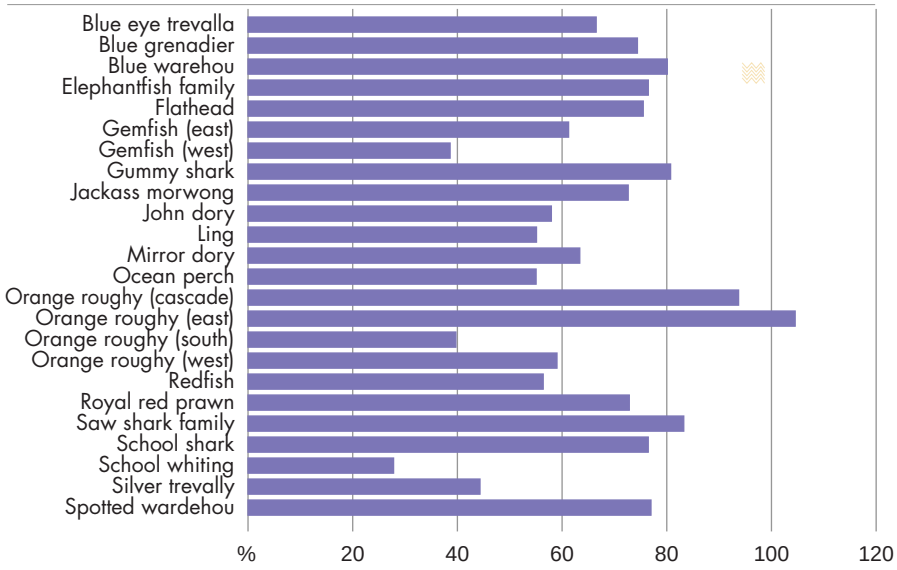
The main management tool in the south east trawl fishery is a system of individual transferable quotas (ITQs) and a total allowable catch (TAC). ITQs have been widely advocated as the best management tool to maximise economic efficiency (Rose 2002). Che and Kompas (2002) have demonstrated that cost savings are achieved when quota is traded as quota flows to the more efficient fishers. They demonstrated that in the south east trawl fishery, cost savings of 1.8–2.1 cents per kilogram for every 1 per cent increase in the volume of quota traded have been achieved.

4 Net returns to the south east trawl fishery
In 2002-03 dollars

	Revenue **a**	Cash costs **a,b**	Capital **a,c**	Net returns (excl. management costs) **d**	Management costs **e**	Net returns (incl. management costs)	Number of vessels
	$m	$m	$m	$m	$m	$m	no.
1996-97	68.0 (17)	56.6 (11)	37.9 (11)	5.0(108)	2.0	3.0	109
1997-98	74.2 (16)	60.0 (11)	32.4 (12)	8.3 (63)	2.8	5.5	109
1998-99	60.5 (14)	53.2 (13)	24.5 (13)	3.1 (90)	2.5	0.6	103
1999-00	66.5 (15)	59.5 (14)	23.0 (15)	2.9(142)	2.8	0.1	101
2000-01	72.1 (12)	63.0 (11)	23.4 (11)	5.2 (56)	2.7	2.5	106
2001-02	70.1 (14)	63.8 (13)	19.8 (11)	2.9 (95)	2.4	0.5	97

a Amount attributable to fishery. **b** Cash costs include imputed operator and family labor costs but exclude licence and levy payments and interest payments. **c** Replacement capital (depreciated capital). **d** Excludes management costs. Calculated as per the definition in this report. **e** AFMA management costs (A. Kettle, AFMA, personal communication, 4 September 2002).
Note: Figures in parentheses are relative standard errors. A guide to interpreting these is included in appendix A.

D Percentage of actual TAC caught in the south east trawl fishery in 2002



While it appears that ITQs are the management tool most likely to maximise economic returns in the fishery, it is important that the TAC is set at a level that allows for economic returns to be maximised. This is the second step in the process of assessing the economic efficiency of management arrangements.

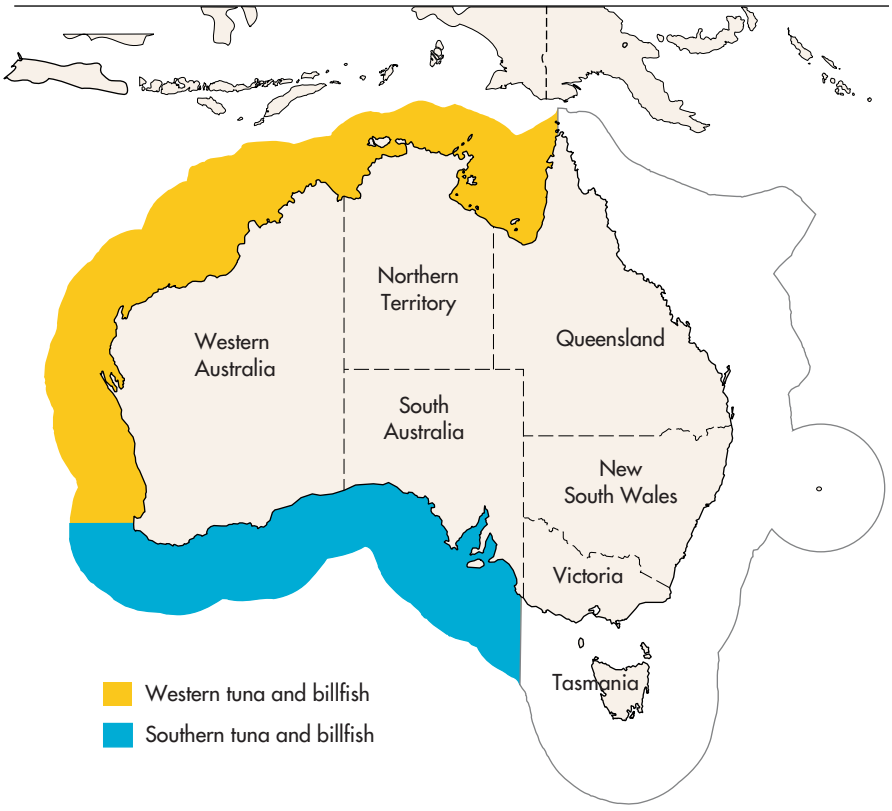
Whether the current TACs set in the south east trawl fishery have been set at the optimal level is not clear. In the 2002 fishing season, only around 71 per cent of the 'actual TAC' for the fishery was landed, with only one species (eastern zone orange roughy) reaching its TAC (figure D). TACs that maximise economic efficiency in a multispecies fishery such as the south east trawl fishery would probably result in not all TACs being caught each year. However, with quotas only binding for one species in 2002 and catches of most species being well below their TACs, it is likely that economic returns will at least partially be dissipated, as the TACs appear to have limited impact on restraining the level of effort in the fishery. If quotas have limited impact on restraining the level of effort, there is an incentive for fishers to race to fish to maximise their share of the catch — which results in overcapacity and reduction in overall net returns.

Detailed analysis of the optimal TACs in the south east trawl fishery has not been undertaken. Current research for the south east trawl fishery at ABARE is directed at identifying methods to improve the economic performance of this fishery.

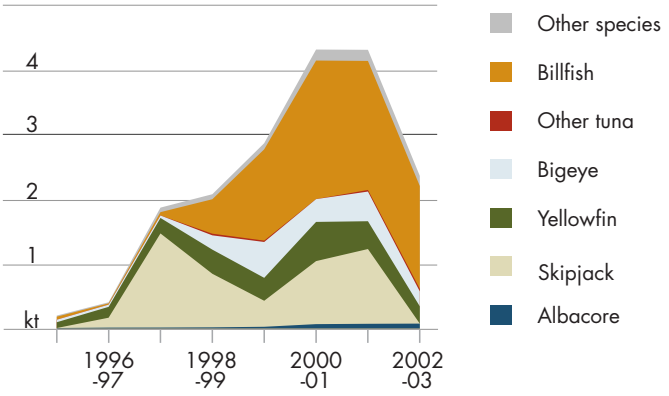
southern and western tuna and billfish fishery

- Average per boat fishing receipts are estimated to have been around $902 000 in 2001-02.
- Boat cash income is estimated to have averaged just under $134 000 per boat in 2001-02.
- Estimated real net returns (including management costs and assuming constant stocks) to the fishery resource were low — an estimated $0.6 million in 2001-02.

A Management areas of the southern and western tuna and billfish fisheries



B Southern and western tuna and billfish fishery: longline production

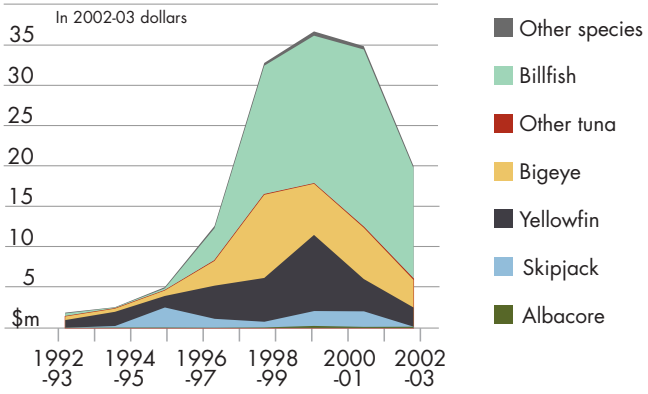


The fishery

The southern and western tuna and billfish fisheries encompass the area of the Australian Fishing Zone (AFZ) that is not covered by the eastern tuna and billfish fishery (figure A). In addition, the fishery includes the high seas area of the Indian Ocean Tuna Commission (IOTC) area of competence. Within the AFZ, the western tuna and billfish fishery extends westward from Cape York Peninsula to Cape Leeuwin in the south west of Western Australia. The southern tuna and billfish fishery extends from Cape Leeuwin in the south west of Western Australia, along the Great Australian Bight to the South Australian/Victorian border (figure A).

Historically, the main southern and western tuna and billfish fishery catch was taken by Japanese longliners under bilateral agreements. The longliners, which targeted high valued bigeye in the south west and yellowfin and striped marlin in the north west, but these longliners have been excluded from the fishery since November 1997. A domestic pelagic long-

C Southern and western tuna and billfish fisheries real gross value of production



line fishery has subsequently developed targeting broadbill swordfish in addition to bigeye and yellowfin. Incidental catches of albacore tuna, skipjack tuna, long tailed tuna and southern bluefin tuna are also taken. The purse seine and pole sectors have historically targeted low value skipjack tuna.

1 Effort in the domestic longline southern and western tuna and billfish fishery

	Active longliners a	Effort (millions hooks)		
		Southern	Western	Total
1994	16	0.28	0.11	0.39
1995	15	**b**	0.51	na
1996	11	**b**	0.26	na
1997	9	**b**	0.5	na
1998	20	0.08	0.97	1.0
1999	37	0.01	2.9	2.9
2000	51	1.7	3.9	5.6
2001	42	1.7	4.5	6.2
2002	na	1.4	4.5	5.9

a Reported more than 1 day at sea in a given year.
b Confidential. **na** Not available.
Source: Caton (2001) and AFMA (2003b).

Catch in the southern and western tuna and billfish fishery by domestic vessels increased significantly between 1995-96 and 2001-02, to a maximum of 4300 tonnes in 2000-01 and 2001-02 but has since fallen to be around 2350 tonnes in 2002-03 (figure B). The increased catch in the late 1990s followed the exclusion of Japanese longline vessels in 1997, with the number of active domestic longliners increasing from nine to 51 between 1997 and 2000 (Caton 2003). Fishing effort across the southern and western fishery by the domestic fleet increased significantly over the same period reaching 6.2 million hooks set in 2001, six times the number set in 1998 (table 1). Catch by the Japanese fleet between the late 1980s and 1997 reached a maximum of around 1800 tonnes in 1987, but averaged around 650 tonnes a year (Caton 2003).

Over the period 1998-99 to 2002-03 around 82 per cent of catch in the fishery was taken by longline and minorline methods, with the remainder taken by the purse seine and pole sectors.

The real gross value of the catch from the fishery also increased substantially after the mid-1990s (figure C), from under $2 million (in 2002-03 dollars) in 1995-96 to around $36.6 million in 2000-01. However, the value subsequently fell dramatically to around $20 million in 2002-03, mainly owing to the big fall in catch in that year. Changes in the exchange rate have also had an impact on the GVP of the fishery as the majority of the catch is exported to markets in Japan and the United States.

Over the period 1998-99 to 2002-03 around 97 per cent of the GVP was taken by longline and minorline methods, with the remainder by the purse seine and pole sectors.

Biological status of the fishery

Yellowfin tuna

Yellowfin tuna are thought to be possibly fully fished in the western Indian Ocean but probably only moderately fished adjacent to the southern and western tuna and billfish fisheries (Caton 2003).

Yellowfin tuna are fast growing, maturing at about two years of age and inhabit tropical and subtropical waters. They can grow to over 100 kilograms and reach 180 centimetres in length

when they are six years old although the average dressed weight of those caught by longliners off Western Australia is less than 40 kilograms.

It is uncertain whether or not the catch rates in the southern and western tuna and billfish fishery are affected by the broader Indian Ocean catch by longliners and purse seiners. The level of mixing between yellowfin stocks caught in the southern and western tuna and billfish fisheries and the broader region is unknown.

Bigeye tuna

Bigeye tuna are slower growing than yellowfin tuna but reach 200 centimetres in length and over 180 kilograms when around eight years old. In the Pacific Ocean, bigeye tuna are capable of long range movements but do display some localised long term residence (Caton 2003). There is no corresponding information for Indian Ocean fish and there is no specific bigeye tuna assessment for the southern and western tuna and billfish fishery, but it is thought to be unlikely that bigeye tuna caught in the fishery represent a separate stock. However, some level of isolation from the broader Indian Ocean could occur (Caton 2003).

The Indian Ocean Tuna Commission's (IOTC) Working Party on Tropical Tunas has determined that the status of bigeye tuna is overfished in the Indian Ocean. However, catches of bigeye tuna in the southern and western tuna and billfish fishery represent only 0.3 per cent of the Indian Ocean catch (S. Bolton, AFMA, personal communication, January 2004). In the western Indian Ocean, purse seiners catch large numbers of juvenile bigeye tuna along with adult skipjack tuna and yellowfin tuna. As bigeye tuna are slower growing and later to mature than these other tunas, Caton (2003) suggests that the catch of these juvenile bigeye tuna may be unstainable in the long term.

Broadbill swordfish

The status of broadbill swordfish has been assessed as fully fished (Caton 2003). Swordfish have been known to grow to over 550 kilograms, with females generally growing faster than males and reaching a larger size. Females and males reach sexual maturity at four years and two years respectively. Most swordfish taken in the southern and western tuna and billfish fisheries are usually in the range 20–100 kilograms, averaging 50 kilograms (Caton 2003).

Swordfish have a wide and complex distribution throughout the Indian Ocean. Recent genetic studies suggest that swordfish in the Indian Ocean comprise two or more stocks (Caton 2003). There is no qualitative assessment of the Indian Ocean stocks. However, after preliminary work on an Indian Ocean assessment the Working Party on Billfish of the IOTC concluded that the recent rapid increase in swordfish catches is unlikely to be sustainable in the long term.

Albacore tuna

Compared with yellowfin tuna, albacore tuna grow relatively slowly reaching maturity at about 85 centimetres in length and at around five or six years of age, reaching a maximum length of about 120 centimetres when more than ten years of age.

Albacore tuna are generally taken as bycatch while longliners target swordfish, bigeye tuna and yellowfin tuna and catch has been small (less than 100 tonnes a year) during the 1980s and 1990s by both Japanese and domestic longliners. Consequently, there is no formal assessment of albacore tuna in the southern and western tuna and billfish fishery (Caton 2003).

Management of the fishery

After the introduction of the *Fisheries Management Act 1991* the number of fishing concession holders for the southern and western tuna and billfish fisheries was 278. In 1994 the Australian Fisheries Management Authority (AFMA) board endorsed a recommendation to establish a Management Advisory Committee (Western Tuna MAC) for the western tuna and billfish fishery in order to establish a formal consultation process for development of management arrangements for the fishery.

In 1998, after receiving advice from Western Tuna MAC, the AFMA board removed vessel length restrictions. Prior to the change, vessels greater than 32.67 metres were restricted to offshore waters. Also in 1998, AFMA agreed to remove the internal boundaries in the southern and western tuna and billfish fisheries except for the line that separates the western and southern fisheries at 34ºS at Cape Leeuwin. Currently, the areas applying to fishing permits may be for: western tuna and billfish fishery only (north of 34ºS and west of Cape York Peninsula); southern tuna and billfish fishery only (south of 34ºS and eastward to 141ºE); or both areas. Prior to the removal of the internal boundaries in 1998, there were thirteen possible area descriptions for permits in the entire southern and western tuna and billfish fisheries. Table 2 shows that the majority of current permits give access to both the southern and western fisheries, with only a small number of permits giving access to only the western fishery. It is important to note that more than one fishing method is commonly held on a single permit.

Currently the southern and western tuna and billfish fishery is managed by input controls, based on limited entry. The management arrangements applying to the southern tuna and billfish fishery is identical to that of the western tuna and billfish fishery, with access to both fisheries through a standard fishing permit. These fishing permits are issued annually and specify the area of operation and the fishing method(s) that may be used. However, from July 2003, purse seine permits have been managed separately.

To reduce the interaction of pelagic longline fishing on seabirds, operators are required to use bird scaring 'tori' lines when line setting when south of 30ºS. In addition, new regulations require operators to set their gear at night when south of 30ºS and laws were introduced in 1998 prohibiting the take of blue and black marlin by commercial operators. In addition, agreement has been reached within Western Tuna MAC to the voluntary release of sailfish and spearfish whether dead or alive.

2 Permits in the southern and western tuna and billfish fishery – 2002

	Longline	Minor line	Pole and line	Purse seine	Total
WTBF	6	5	1	0	7
STBF	38	37	16	8	45
Both WTBF and STBF	46	63	20	5	72
Total	90	105	37	13	124

Source: AFMA (2003b).

AFMA is in the process of developing a management plan for the southern and western tuna and billfish fisheries that will consolidate the management of the southern and western sectors with the removal of the boundary at 34ºS. The draft plan proposes to introduce statutory fishing rights (SFRs) in the form of individual transferable quotas (ITQs) and total allowable catches (TACs) (AFMA 2003c). TACs will initially be set for bigeye tuna, broadbill swordfish, yellowfin tuna and striped marlin. Each year the TAC can be varied according to management requirements. Caton (2003) suggests that a management plan must also take into account the interaction with fisheries of the broader Indian Ocean.

Boats surveyed

For the purpose of the survey, the population was defined as longline boats endorsed for the southern and western tuna and billfish fishery that caught fish in the survey years. Boats that held an endorsement but did not catch tuna during the survey year were excluded from the survey population.

There were a total of 46 eligible longline vessels in 2000-01 and 44 eligible longline vessels in 2001-02. An insufficient sample size was achieved for 2000-01, so results could not be published for that year. For 2001-02, nonresponse among the operators of boats with relatively small tuna and billfish catch was high. The realised sample from this group of boats was too small to derive estimates. In order to address this, the population was narrowed to only include boats that caught greater than 26 tonnes of tuna and/or billfish. This narrowed the population down to 33 vessels while still representing 95 per cent of catch in the fishery in that year. Of these 33 boats, twelve were sampled. The results presented in the tables below are estimates for this narrowed population of longline boats in the southern and western tuna and billfish fishery.

Financial performance of boats

The selected measures of financial performance for longline boats that caught greater than 26 tonnes of tuna and billfish in the southern and western tuna and billfish fishery in 2001-02 are reported in table 3. It is important to note that the figures shown in table 3 include costs and earnings from other Commonwealth and/or state fisheries.

Receipts

Average total cash receipts for longline operators in the fishery were estimated at around $902 000 per boat in 2001-02. Tuna and billfish receipts were estimated to account for around 95 per cent of total cash receipts with other finfish, bycatch and nonfishing receipts such as the diesel fuel rebate and insurance claims accounting for the remainder.

Costs

Total cash costs for longline boats in the southern and western tuna and billfish fishery are estimated to have averaged $769 000 per boat in 2001-02, equivalent to around 85 per cent of total cash receipts (table 3).

Crew costs are estimated to have accounted for the largest proportion of total cash costs, at around 30 per cent or $230 000 per boat in 2001-02. It is important to note that crew costs include the estimated cost of replacing owner operator and family labor with employees to do the same work. The reason for this is that on many boats where owner skippers are involved or family labor is involved, the labor payments could be low or even nil. To reflect the true market value of the labor, operators are asked to estimate what it would cost to replace owner operator and family labor with paid crew and staff. This is likely to more accurately reflect the true market value of the labor used in fishing operations.

The next largest cash cost was fuel, estimated at an average of nearly $105 000 per boat in 2001-02 or 14 per cent of total cash costs.

Repairs and maintenance include repairs to the boat as well as gear replacement and repairs. Average repairs and maintenance costs in 2001-02 were estimated at over $104 000 per boat, again around 14 per cent of cash costs.

Boat cash income and profit

Boat cash income is simply total cash receipts less total cash costs. Boat cash income is estimated to have averaged almost $134 000 per boat in 2001-02.

Boat business profit, which is calculated by allowing for depreciation of capital, was estimated at around $50 000 per boat. This follows an estimated average depreciation per boat of $83 700.

Profit at full equity is calculated by adding leasing costs, interest payments and rent payments to boat business profit. While these costs affect the financial position of the individual operator, they represent some profits that have been redistributed to other investors in the fishery. Profit at full equity was estimated at around $112 000 per boat for boats operating in the longline sector of the fishery and this is the estimated average return that would have been earned by the business unit had the boat and capital (including licences) been fully owned by the operator.

3 Estimated financial performance of longline boats that caught greater than 26 tonnes of tuna and billfish in the southern and western tuna and billfish fishery in 2001-02 Average per boat

Tuna and billfish receipts	$	855 940	(13)
Other fishing receipts	$	24 810	(22)
Nonfishing receipts	$	21 740	(57)
Total cash receipts	$	902 490	(13)
Administration	$	19 320	(14)
Bait	$	74 410	(13)
Crew costs	$	229 880	(13)
Freight and marketing	$	42 490	(12)
Fuel	$	104 520	(14)
Insurance	$	17 200	(14)
Interest paid	$	44 780	(26)
Leasing	$	17 480	(38)
Licence fees and levies	$	16 760	(13)
Repairs and maintenance	$	104 460	(11)
Other costs	$	97 440	(11)
Total cash costs	$	768 740	(8)
Boat cash income	$	133 750	(50)
less depreciation **a**	$	83 690	(18)
Boat business profit	$	50 070	(148)
plus interest, leasing and rent	$	62 250	(26)
Profit at full equity	$	112 320	(57)
Capital			
– excluding licences	$	1 366 560	(13)
– including licences	$	2 104 340	(9)
Rate of return to boat capital **b**	%	8.2	(55)
Rate of return at full equity **c**	%	5.3	(55)

a Depreciation adjusted for profit or loss on capital items sold. **b** Excluding value of quota and licences. **c** Including value of quota and licences. **na** Not applicable.
Note: Figures in parentheses are relative standard errors. A guide to interpreting these is included in appendix A.

Rates of return

The rate of return to boat capital is calculated on total capital (excluding the value of licences) as if the proprietors wholly owned all assets so that the financial performance of all boats can be compared regardless of the proprietors' equity in the business. It is calculated by dividing profit at full equity by boat capital. In the longline sector of the southern and western tuna and billfish fishery the rate of return to boat capital was 8.2 per cent.

The estimated rate of return at full equity includes the value of the licences and is calculated by dividing profit at full equity by total capital (including licences). For the fleet as a whole, the average per boat rate of return at full equity was estimated at 5.3 per cent in 2001-02 (table 3).

Economic performance of the fishery

While the measures of financial performance in table 3 provide an indication of the financial health of fishing operators in the southern and western tuna and billfish fishery, they do not provide an indication of AFMA's performance against their legislated objectives of maximising economic efficiency and providing efficient and cost effective management. This is because the figures in table 3 include costs, receipts and capital from fisheries other than the southern and western tuna and billfish fishery.

Maximising economic efficiency in a fishery involves maximising economic rent. The term 'economic rent' is used to describe the part of the return from the use of a natural resource that stems from the scarcity of that resource. The concept of economic rent arose in the early nineteenth century from the realisation that rent for land was not set by the owners of the land but rather by the potential profitability that users could reap from using the land (Barlowe 1958). In a fishery, economic rent is the long run surplus income after all other costs had been met, such as fuel, bait, labor, repairs and the necessary return on capital to justify any investment. Any resource rent in fisheries is commonly accrued by fishing operators.

As an indicator of economic rent, ABARE has calculated net returns to the southern and western tuna and billfish fishery using survey data. However, net returns in a given year may differ from the long run economic rent for a number of reasons. Of particular importance are the condition of the fish stock, capital structure and market conditions. For example, if the fish stock is being fished down, then net returns in that year will include revenue from selling off part of the fish stock that will not be available over the long term. Consequently, the calculated net returns will overestimate the long term economic rent available from the fishery. More detail can be found in (Rose et al. 2000).

Net returns in the southern and western tuna and billfish fishery and assessment of fishery management

The measure of net return to the fishery includes only those receipts and costs that are attributable to the southern and western tuna and billfish fishery. As a result, the estimated receipts and costs in table 4 may differ from those in table 3, which includes all receipts and costs of boats operating in the fishery, including those incurred while fishing in other fisheries.

The real net returns (including management costs) to the narrowed population of the southern and western tuna and billfish fishery for 2001-02 are estimated to have been $0.6 million (table 4). It is important to note that the figures in table 4 exclude boats with a catch of less than 26 tonnes. In most fisheries, net returns of boats with relatively small catch are usually close to zero. If this is the case then the estimates presented in table 4 give a true indication of the total net return to the longline fishery.

This estimate of $0.6 million is low relative to some other ABARE surveyed fisheries. There are two possible reasons for this. First it, may be that the fishery is being managed optimally and this is the highest level of net returns achievable. In this case, effort should be concentrated on minimising the cost of management for the level of returns. Second, it may be that the fishery is being managed suboptimally and changes to either the type of management tools or level of catch/effort, could lead to higher returns.

There are two main steps involved in assessing the economic efficiency of fishery management arrangements. It needs to be determined first what type of management regime is likely to allow for economic returns to be maximised (including the cost of management). Once this is established, the level of catch/effort required to achieve maximum returns needs to be determined. Setting catch/effort too high may result in the dissipation of economic returns, while setting it too low may result in missed profitable opportunities.

Currently the southern and western tuna and billfish fishery is managed by limited entry. One of the main problems with input controls is that ownership of fish is by capture. Therefore, individuals have a strong incentive to compete to maximises their catch — race to fish — which results in overcapacity and reduction in overall net returns.

There is a significant amount of latent effort in the fishery. Table 1 shows that there were 90 permits in the fishery in 2002. According to logbook data only around half of these were active in that year. This means that any net returns achieved in the fishery will be quickly dissipated by the activation of the latent effort. Until a management regime is implemented in the fishery that removes latent effort, long run net returns are likely to be close to zero.

Proposed management arrangements for the southern and western tuna and billfish fishery include individual transferable quotas (ITQs) and a total allowable catch (TAC). ITQs have

4 Net returns to the longline southern and western tuna and billfish fishery
In 2002-03 dollars

	Revenue a	Operating costs a,b	Capital a,c	Net returns (excl. management costs) d	Management costs e	Net returns (incl. management costs)	Number of vessels
	$'000	$'000	$'000	$'000	$'000	$'000	no.
2001-02	29 963 (13)	23 464 (9)	28 774 (23)	1 638(142)	1 085	553(142)	33

a Amount attributable to fishery. **b** Cash costs include imputed operator and family labor costs but exclude licence and levy payments and interest payments. **c** Replacement capital (depreciated capital). **d** Excludes management costs. Calculated as per the definition in this report. **e** AFMA management costs (A. Kettle, AFMA, personal communication, 4 September 2002).
Note: Figures in parentheses are relative standard errors. A guide to interpreting these is included in appendix A.

been widely advocated as the best management tool to maximise economic efficiency (Rose 2002). Che and Kompas (2002) have demonstrated that in the south east trawl fishery, cost savings are achieved when quota is traded as quota flows to the more efficient fishers.

While it is likely that ITQs are the management tool most likely to maximise economic returns in the fishery, it is important that the TAC is set at a level that allows for economic returns to be maximised. Detailed analysis of the optimal TACs for this fishery has not been undertaken. It is well noted that unpredictable abundance of fish limits managers' ability to set an optimal TAC and this may detract from the efficiency of using ITQs. Setting a TAC based on average abundance will result in missed opportunities in years of high abundance. In years of low abundance, an average TAC may overestimate availability of catch. As Rose (2002) suggests, a conservative TAC may be necessary to provide fishers with assured catch and thus gain the incentive benefits of ITQs. Even given the loss of opportunity in high abundance years, the chances are relatively high that ITQs within a fairly arbitrary but conservative TAC will deliver some positive net return to owners of quota and to the economy as a whole. An equally arbitrary set of input controls is unlikely to assure a positive net return over time.

survey methods and definitions

Collecting survey data

ABARE surveys are designed and samples selected on the basis of information supplied by the Australian Fisheries Management Authority (AFMA). This information includes data on the size of the catch, fishing effort and boat characteristics.

Because it is not possible to survey all the boats in a fishery, a sample of boats is selected based on their 'representativeness'. Where possible, boats are classified into subgroups based either on the fishing method used (longline boats, purse seine boats, trawlers and so on) or on the size of operations (typically small, medium and large producers). A number of representative boats from each subgroup is then targeted for the survey.

The owners of the sample boats are contacted by ABARE and face to face interviews are conducted. Interviewers ask for information on the physical and financial details of the fishing business. In a number of instances, the skipper of the boat may also be interviewed. In general, information is collected for the preceding two financial years. Major Commonwealth fisheries are surveyed every two years.

Definitions of key variables

Cash receipts represent returns from the sale of fish, nonfishing activities including charter operations, and other sources (insurance claims and compensation, quota and or endorsements leased out, government assistance and any other revenue) in the financial year.

For the majority of operators, this information is readily available from their own records. However, different operators record their fishing income in different ways. In some cases, such as where fish are sold through a cooperative, some operators may only record the payments received from the cooperative. These payments may be net of commissions and freight as well as net of other purchases made through the cooperative.

In other cases, the crew is paid directly for the catch by the cooperative or agency and the owner's financial records might include only the amount of revenues they received after the crew's share had been deducted.

For these reasons, operators are asked to provide a breakdown of the total catch of their boat and an estimate of the total value of that catch. For consistency, marketing charges may need to be added back into fishing receipts for some boats to give a gross value. Where this is necessary these selling costs are also added into the cost estimates to offset the new revenue

figure. Receipts also include amounts received in the survey year for fish sold in previous years.

Cash costs include the payments made for both permanent and casual hired labor and payments for materials and services (including payments on capital items subject to leasing, rent, interest, licence fees and repairs and maintenance). Capital and household expenditures are excluded.

Labor costs are usually the highest cash cost in the fishing operation. Labor costs include wages, salaries and an estimated value for owner/partner, family and unpaid labor. Labor costs cover the cost of labor involved in boat related aspects of the fishing business, such as crew or onshore administration costs, but do not cover the cost of onshore labor involved in processing the fisheries products.

On many boats, the costs of labor are reflected in the wages paid by boat owners and/or in the share of the catch they earn. In some cases, however, such as where owner skippers are involved, or where family members work in the fishing operation, the payments made can be low or even nil, which will not always reflect the market value of the labor provided. To allow for this possible underestimation, all owner/partner and family labor was based on estimates collected at the interview of the amount it would cost to employ someone else to do the work.

Boat cash income is the difference between total cash receipts and total cash costs.

Depreciation costs have been estimated using the diminishing value method based on the current replacement cost and age of each item. The rates applied are the standard rates allowed by the Commissioner of Taxation. For items purchased or sold during the survey year, depreciation is assessed as if the transaction had taken place at the midpoint of the year. This method of calculating depreciation is also used in other ABARE industry surveys.

Boat business profit is boat cash income less depreciation.

Profit at full equity is boat profit, plus rent, interest and lease payments.

Capital is the value placed on the assets employed by the surveyed boat business. It includes the value of the boat, hull, engine and other onboard equipment (including gear). Estimates are also reported of the value of quotas and endorsements held by the surveyed boat. Estimates of the value of capital are based on the market value of capital and are usually obtained at interview but in some cases quota and endorsement values are obtained from industry sources.

Depreciated replacement value is the depreciated capital value based on the current age and replacement values of boat and gear. The value of quota and endorsements held is not included in the estimate.

Rate of return to boat capital is calculated as if all fishing assets were wholly owned by the proprietors. This enables the financial performance of sample boats to be compared regardless of the proprietor's equity in the business. Rate of return to boat capital is calcu-

lated by expressing profit at full equity as a percentage of total capital (excluding quota and licence value).

Rate of return to full equity is calculated by expressing profit at full equity as a percentage of total capital (including quota and licence value).

Debt information was collected at interview. Change in debt over the year is calculated as the difference between debt at 1 July and the following 30 June.

Boat business equity is derived by deducting the boat business debt from the value of capital employed in, and owned by, the fishing business.

The equity ratio is boat business equity expressed as a percentage of capital employed in the fishing business. The debt and equity figures shown are averages for those boats for which information on debt was available.

Net returns to the fishery are estimated as the gross revenue earned in a single fishery, less an estimate of the fishing costs incurred in that fishery including management costs, less the full annualised cost of capital.

Apportioning boat receipts and costs among fisheries

Many boats operate in more than one fishery. To provide estimates of the economic returns from an individual fishery, it is necessary to apportion boat receipts and costs among the fisheries.

Apportioning fishing receipts to particular fisheries is generally straightforward, as information on sales by major species can generally be used to calculate the receipts associated with a fishery. Calculating the costs of a fishing operation that are attributable to a fishery can be more difficult, however. In this report, costs have been apportioned to a fishery based on the proportion of total fishing revenue associated with that fishery.

The net return to the fishery is defined as:

$$\sum_{i=1}^{n} R_i - \sum_{i=1}^{n} p_i\left[OC_i + (d_i + r)K_i\right] - M$$

where

R_i = total cash receipts attributable to the fishery, excluding any receipts from leasing or sales of licences or quota for boat i;

p_i = proportion of total fishing receipts attributable to the fishery for boat i;

OC_i = total cash costs *less* interest paid on debt *less* expenditure on leasing or purchase of licences or quota for boat i;

K_i = value of capital associated with boat i (depreciated replacement value);

d_i = depreciation rate for boat i (depreciation *less* capital appreciation associated with boat i divided by K_i);

r = real interest rate (assumed at 7 per cent for calculations in this report);

M = costs of managing the fishery;

n = number of boats operating in the fishery.

Sample weighting

The estimates presented in this report are calculated by appropriately weighting the data collected from each sample boat and then using these weighted data to calculate estimates for the population. Sample weights are calculated such that the weights summed represent the target population, and the sum of the weighted catch of the sample equals the logbook totals supplied by AFMA. Technical details of the method of weighting used are given in Bardsley and Chambers (1984).

Reliability of estimates

A relatively small number of boats out of the total number of boats in a particular fishery are surveyed. Estimates derived from these boats are likely to be different from those that would have been obtained if information had been collected from a census of all boats. How closely the survey results represent the population is influenced by the number of boats in the sample, the variability of boats in the population and most importantly the design of the survey and the estimation procedures used.

To give a guide to the reliability of the survey estimates, measures of sampling variation have been calculated. These measures, expressed as percentages of the survey estimates and termed 'relative standard errors', are given next to each estimate in parentheses. In general, the smaller the relative standard error, the more reliable the estimate.

Use of relative standard errors

These relative standard errors can be used to calculate 'confidence intervals' for the survey estimate. First, calculate the standard error by multiplying the relative standard error by the survey estimate and dividing by 100. For example, if average total cash receipts are estimated to be $100 000 with a relative standard error of 6 per cent, the standard error for this estimate is $6000.

There is roughly a two in three chance that the 'census value' (the value that would have been obtained if all boats in the target population had been surveyed) is within one standard error of the survey estimate. There is roughly a nineteen in twenty chance that the census value is within two standard errors of the survey estimates. Thus, in this example, there is approximately a two in three chance that the census value is between $94 000 and $106 000, and approximately a nineteen in twenty chance that the census value is between $88 000 and $112 000.

Comparing estimates

When comparing estimates across groups or years it is important to recognise that the differences are also subject to sampling error. As a rule of thumb, a conservative estimate of the standard error of the difference can be constructed by adding the squares of the estimated standard errors of the component estimates and then taking the square root of the result.

For example, suppose the estimates of total cash receipts were $100 000 in one year and $125 000 in the previous year — a difference of $25 000 — and the relative standard error is given as 6 per cent for each estimate. The standard error of the difference can be estimated as:

$$\sqrt{[(0.06 \times \$100\,000)^2 + (0.06 \times \$125\,000)^2]} = \$9605$$

so the relative standard error of the difference is:

$$(\$9605/\$25\,000) \times 100 = 38\%.$$

It should be noted that there may be changes in the fishery populations from one year to the next. If these population changes are substantial, differences in estimates may be caused more by the changes in population than by changes in the variables themselves.

Nonsampling errors

The values obtained in a survey are affected by errors other than those related directly to the sampling procedure. For example, it may not be possible to obtain information from certain types of boats, respondents may provide inaccurate information or respondents may differ from nonrespondents in a variable being surveyed.

ABARE's experience in conducting surveys has resulted in procedures aimed at minimising nonsampling errors. However, when drawing inferences from estimates derived from sample surveys, users should bear in mind that both sampling and nonsampling errors occur.

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Department of Health and Ageing

Department of Industry, Tourism and Resources

Department of Natural Resources and Mines, Queensland

Department of Primary Industries, Queensland

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Fisheries Resources Research Fund

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Snowy Mountains Engineering Corporation

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