Economic Performance Indicators for Fisheries

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Abstract. Fisheries management involves a degree of separation between ownership of the fish and associated natural resources, ownership and operation of fishing enterprises and management of the fishery as a whole. The arms length nature of some of the resulting relationships means that public reporting of a range of economic and biological performance measures is necessary. The purpose in this paper is twofold. First, a context and rationale is provided for the use of performance indicators in public sector resource management, specifically for fisheries. Second, an approach is developed for the use of indicators of performance against the economic efficiency objective of Australian Commonwealth fisheries management. Use of the framework is illustrated using survey data available for a number of Australian Commonwealth fisheries.

Keywords: Economic efficiency; performance indicators.

1. INTRODUCTION

As in any case where management and ownership of resources are separated, there is a role for regular reporting of performance of fisheries. Assessing the performance of public institutions involves measurement issues similar to, but somewhat more complex than, those experienced in the private sector. For government managed fisheries there are likely to be more facets to fisheries performance that are of interest than there are to the performance of a public company.

Whereas a public company can be characterised as having a single objective — maximising the company's net worth to shareholders — a fishery may yield returns in different ways to different people. In addition to straightforward commercial uses, there is likely to be a range of use and non use values — such as conservation values — that may be important to different people. While the ultimate aim is to maximise the net value of the resource to the community, there may not be a common currency across all individuals and values. Performance measurement may therefore require a package of performance measures relevant to a variety of values.

Roles of performance indicators for the public sector are discussed by Mayston (1985), Smith (1995) and Xavier (1991), among others. A good deal of the discussion is on measuring quality in areas such as health and education and on standard financial indicators for public sector enterprises — issues of limited relevance for fisheries management. However, three of Mayston's suggested roles which do seem relevant to fisheries management can be stated simply as: providing a basis for evaluation of outcomes; providing management incentives; and setting a trigger for further investigation.

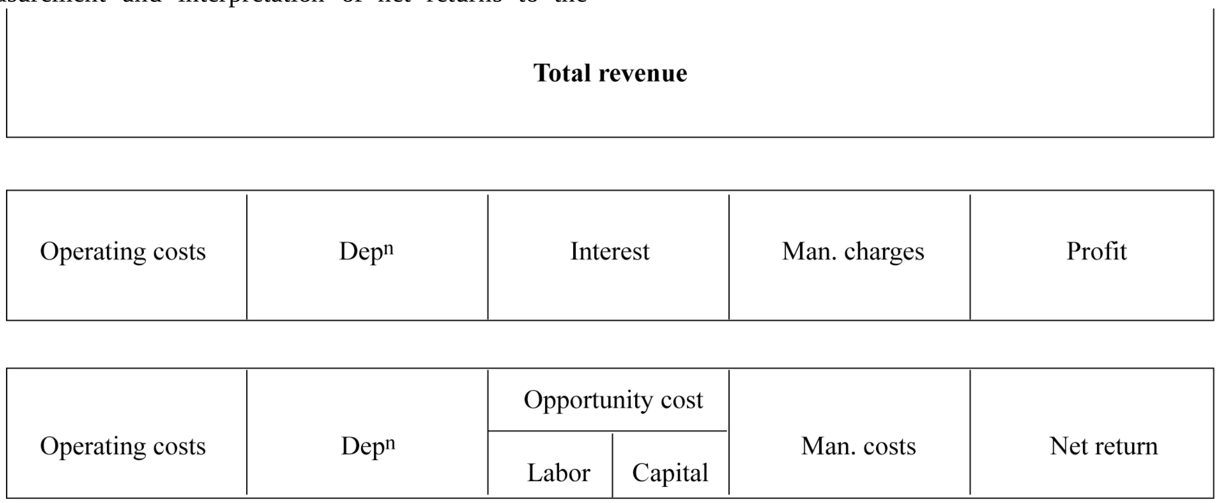
The purpose in this paper is to present an analysis of the economic performance of three Australian Commonwealth fisheries: the northern prawn fishery; the offshore trawl sector of the south east fishery; and the east coast tuna and billfish fishery.[1] In the next section, interpretation of the key indicator of economic performance of commercial fisheries — net returns to the fishery — is briefly reviewed. The case studies of the fisheries are then presented drawing upon ABARE survey data of costs and revenue in the fisheries.

2. INDICATORS OF ECONOMIC PERFORMANCE OF FISHERIES

The key economic question about the management of any fishery is whether it results in the maximisation of resource rent. In the rare case where there is a full biological and economic understanding of a fishery, estimation of the level of resource rent may be determined through a modeling process. More usually much more limited indicators of both potential and actual rent are available. Indicators of economic performance of fisheries can be viewed in two broad sets. First are indicators of commercial sector performance, based primarily on estimates of the net returns to the sector. Second are indicators of values of recreational fishing and other largely nonmarket values that are dependent on use of fisheries resources. Recreational and conservation values

[1] In Australia, each state or territory manages fisheries resources from the low water mark to 3 nautical miles offshore, and the Commonwealth government manages fisheries from 3 nautical miles offshore to the 200 mile limit of the EEZ.

are not discussed in this paper and the emphasis is on the measurement and interpretation of net returns to the commercial sector.



(Adapted from Whitmarsh, James, Pickering and Neiland 2000)

Figure 1: Net returns from commercial fishing

2.1 Net Returns from Commercial Fishing

A starting point for measuring economic rent is an estimate of the apparent net return to the fisheries resource — revenue from fishing less the social opportunity cost of capital and other inputs used in fishing (including management inputs). To produce reasonably accurate estimates of net return to the fishery, and value of fishing capital, requires quite detailed financial, input and output information for the fishery. Generally the most cost effective way of gathering such information is through a survey of a representative sample of operators in the fishery. Examples of surveys for other fisheries and some discussion of survey methods are contained in Brown (1997), ABARE (1996) and Holland, Gooday, Shafron, Ha and Lim-Applegate (2000).

The accounts of businesses involved in the fishery are primary sources in deriving a measure of the apparent net return to a fishery resource. However, there are potentially important ways in which measures of aggregate net return to the businesses involved in the fishery may differ from the net return to the fishery resource (Rose and Stubbs 1999). First, fishers often operate in more than one fishery and their accounts reflect those activities. Second, costs reported in the financial accounts of business may vary from social opportunity costs, particularly for capital, management costs and owners' or family labor. Finally, in some fisheries the full costs of management may not be charged to operators. The relationship between total revenue, financial accounts of fishers' costs and the social costs of fishing are illustrated in figure 1.

Any measure of the net return to the fishery needs to be considered in the context of market conditions and the condition of the fishery. In the absence of a full bioeconomic model of the fishery, quantitative or qualitative information on a number of aspects of the fishery may shed light on its relative efficiency. Of particular importance are; the condition of the fish stock, capital capacity, prices of the fishery's products and inputs and the management structure of the fishery.

- *Fish stocks*

If there is a systematic change over time in the fish stock and future stock levels depend on the survival of current stock, a measure of the net return for a single year may not be a sufficient indicator of long term rent. For example, if the fish stock is being fished down, the current net return includes revenue from selling off part of the fish stock that will not be available over the long term. Abundance and accessibility to fishers are highly variable over time for many fish species. A number of factors may influence the state of fish stocks and variables commonly used to indicate stock status. Changes in water temperatures, currents and other environmental factors may play an important part in determining the state of the fish stock, complicating any attempt to interpret catch, stock and economic data.

- *Capital structure*

Capital and other aspects of fishery structure may be important in interpreting estimates of net return to the fishery resource. For example, consider a fishery that has many more boats and much more associated capital than is necessary to land the current catch. What current costs to ascribe to capital in the fishery and what the links are between measures of current net returns and future rent may depend on the regulatory structure of the fishery and on factors outside the fishery. If there is little potential use for the boats outside the fishery, costing them at depreciated replacement cost will overestimate fishery costs and underestimate net returns. The interpretation is quite different if the boats have value outside the fishery and are leaving. In that case, costing current capital at full depreciated replacement cost will give a realistic estimate of current net returns to the fishery resource, but will underestimate the long term sustainable returns.

- *Market conditions*

Year to year fluctuations in fish prices may also drive large changes in net returns. Reliable measures of product prices are often likely to be essential to understanding the meaning of primary performance indicators. It is important to distinguish between price changes imposed by market fluctuations and price those that result from changes in fishing, handling or marketing methods. Innovation or adaptation in a fishery may often be reflected in a change in product prices. For example, the move to live capture of southern bluefin tuna for cage farming and the earlier reorientation of much of the Australian lobster industry to live exports have substantially raised product prices.

3. ESTIMATES OF NET RETURNS FOR SELECTED FISHERIES

Estimates of net return to the fishery resource are presented below for the northern prawn fishery, the offshore trawl component of the south east fishery and the east coast tuna and billfish fishery. The estimates are based on ABARE survey data. The current fisheries surveys program involves surveying each Commonwealth fishery every few years, or more frequently where the fishery is undergoing major changes and monitoring is particularly important.

Based on logbook and boat registry information collected from all licensed fishing operations in Commonwealth fisheries, and supplied by the Australian Fisheries Management Authority (AFMA), a representative sample of boats is selected in each fishery and stratified by type of operation, boat size and catch. The information collected is summarised in ABARE's annual *Australian Fisheries Surveys Report.*

The measure of net returns to the fishery is defined as:

$$\mathrm{NR} = \sum_{i=1}^{n} Ri - \sum_{i=1}^{n} pi(OCi - (di + r)Ki) - M$$

where

- NR — net returns;
- R_i — total cash receipts attributable to the fishery, excluding any receipts from leasing or sales of licenses 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 licenses or quota *less* licence fees and levies 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 paper);
- M — costs of managing the fishery; and
- n — number of boats operating in the fishery.

A couple of points are worth noting. First, the annualised cost of the full depreciated replacement value of capital is used in the estimates reported in this paper. As is discussed further in the sections on the south east fishery eastern tuna and billfish fisheries, this is not the appropriate value in all cases.

Second, many boats operate in more than one fishery during the course of a year. To provide reliable estimates of the economic returns from an individual fishery, it may be 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. In producing the estimates presented here for the northern prawn fishery for each boat, costs and capital were apportioned to the fishery in proportion to the percentage of that boat's total revenue from fishing earned in that fishery. For the offshore trawl sector of the south east fishery and the east coast tuna and billfish fishery, the total revenue, costs and capital for each boat were included in the calculations for the sector.

3.1 Northern Prawn Fishery

The northern prawn fishery accounted for about 27 per cent of the total value of production from Commonwealth fisheries in 1998-99, a year in which catch was relatively small at 7984 tonnes (ABARE 2000). The fishery targets three commercial groups of prawns with banana and tiger prawns accounting for about 80 per cent of the value of landed catch. Seasonal environmental factors, particularly rainfall, can lead to large variations in banana prawn resources, and consequently catches, in any given year.

The Commonwealth government accepted managerial responsibility for the northern prawn fishery in 1988 under the terms of the Offshore Constitutional Settlement. The northern prawn fishery is managed by a set of input controls. The key features are: limited entry; a system boat units based on boat size and engine capacity, permanent and seasonal closures, gear limitations and a controlled season start.

In the 1992-93 season, a voluntary buyback scheme was introduced as a means of reducing capacity in the fleet. Reductions in capacity were sought to improve the economic viability of the fleet and assist in conserving prawn stocks. The strategy involved a compulsory reduction in boat unit numbers on 1 April 1994 if the buyback had not withdrawn sufficient effort. The buyback scheme led to a compulsory 30.76 per cent reduction in the number of units held against each trawler in 1994 and resulted in a smaller fleet of 129 active vessels fishing, down from 160 in 1991-92 (Brown 1997).

Despite the initial success of the buyback scheme in controlling effort, effort creep has remained a problem in the fishery. Increases in effective effort have been achieved in the fishery through the adoption in new technologies, changes in vessel configuration, and cumulative gains in fishing skills. The Northern Prawn Fishery Assessment Group (NPFAG) has reported that that there was evidence that tiger prawns were biologically overfished at the end of the 1996 (Northern Prawn Fishery Assessment Group 1997) and 1997 seasons (Die and Wang 1998), and that the increases in effort have resulted in tiger prawn stocks staying below the level that would achieve maximum sustainable yield. Sustainable long term average annual catches for both banana and tiger prawns have been estimated to be around 4000 tonnes (Bureau of Resource Sciences 1998).

To achieve maximum sustainable yield the NPFAG advised in 1997 that fishing effort directed at tiger prawns should be reduced by 25 per cent by 1999. In response the Northern Prawn Management Advisory Committee (NORMAC) agreed in 1997 on a package of effort reduction measures, including further fishing closures, a switch to gear units and a reduction in total gear units with the aim of reducing effective effort in the range 20–25 per cent (AFMA 1997). Gear units will be based on headrope length, affecting the area of sea floor which can be swept by trawlers. The proposed effort reduction package for the northern prawn fishery is yet to be implemented and is currently under review.

Estimates of the net return to the northern prawn fishery are shown in table 1. Fluctuations in the price received and catch of the two main species have been a significant determinant of the changes in the net return to the fishery over the period 1990-91 to 1997-98. For example, high unit prices and relatively high catches of both species in 1994-95 resulted in a high net return for the fishery in that year. Conversely, 1991-92, was a year where low prices were received, in real terms, for both tiger and banana prawns (table 2), with a correspondingly low net return. Operating costs for the period in real terms have remained relatively constant while labor costs have fluctuated to a greater extent.

Table 1: Net returns to the northern prawn fishery (real 1999-00 dollars)

	Revenue a $m	**Cash costsa,b** $m	**Capitala,c** $m	**Net returnsd** $m	**Management costs e** $m	**Vessel numbers**
1990-91	132.5	98.3	87.5	18.0	na	169
1991-92	103.0	84.0	71.0	7.8	na	160
1992-93	114.4	88.1	60.9	18.3	na	129
1993-94	125.2	96.0	53.1	19.4	na	132
1994-95	154.4	103.6	69.1	39.1	1.23	133
1995-96	131.3	98.8	82.1	18.8	1.10	134
1996-97	123.7	90.1	71.7	21.4	1.00	128
1997-98	148.8	97.3	68.6	39.0	1.20	130

Notes: **a** Revenue is fishing receipts from the northern prawn fishery. All costs and capital have been multiplied by (northern prawn fishery fishing receipts/total fishing receipts); **b** Cash costs include imputed operator and family labor costs but exclude licence and levy payments and interest payments; **c** Replacement capital (depreciated capital) for 1990-91 and 1991-92 is calculated by applying the replacement capital value for boat in three size groups in 1992-93 to population for 1990-91 and 1991-92 and then adding depreciation estimates; **d** Net return measure does not include any management costs **e** Costs to AFMA of managing the fishery (Source: Andrew Kettle, AFMA, personal communication, December 1999)

Table 2: Catch and unit price received for banana and tiger prawns in the northern prawn fishery (real 1999-00 dollars)

	Tiger catch tonnes	**Gross value** $'000	**Unit price** $/kg	**Banana catch** tonnes	**Gross value** $'000	**Unit price** $/kg
1990-91	3364	69 584	20.68	6987	58 818	8.42
1991-92	4142	69 698	16.83	2508	26 156	10.43
1992-93	2891	58 767	20.33	4058	48 296	11.90
1993-94	2806	77 214	27.52	2433	30 355	12.48
1994-95	3744	91 917	24.55	4490	50 896	11.34
1995-96	3202	60 293	18.83	4347	45 711	10.52
1996-97	2431	46 823	19.26	4546	46 797	10.29
1997-98	2811	61 790	21.98	3711	36 835	9.93
1998-99	2795	53 820	19.26	3608	43 589	12.08

Source: ABARE (2000).

While care should be taken in interpreting the results for the reasons mentioned above, the fishery has earned significant net returns over the survey period. To judge whether or not the 1993-94 restructure resulted in increased net returns and, if so, whether the increase was sufficient to compensate for the costs of the package, is not possible from the existing data set. Nevertheless, the suggestion that the restructure had a beneficial effect is not inconsistent with the series of positive net returns from 1993-94.

The northern prawn fishery clearly does make a substantial net contribution to the Australian economy, but it is not clear how much of the industry's potential is realised. Any assessment of the potential net returns that could be earned by the fishery needs to be made in light of the economic, biological and institutional knowledge of the fishery. From a biological perspective, an implication of the analysis by Die and Wang (1998) is that the industry has the potential to reach and sustain a higher tiger prawn harvest than that achieved in recent years, probably with lower effort. Raising catch and lowering total effort would increase net returns.

Considering the institutional structure of northern prawn management, it is not surprising that there appears to be potential to increase the net return from the fishery. Use of input constraints to limit catch may induce inefficiencies in a number of ways. Input constraints have their output limiting effect primarily by making it increasingly difficult, and therefore more costly, to catch target species. Constraining the use of some inputs, but not others, means that the fishers' choice of input combinations is distorted away from the least cost combination.

Selective input constraints provide an incentive for fishers to find new ways of increasing effective effort by concentrating on advances in technology and management of uncontrolled inputs. Inevitably, effective effort will increase as fishers find their way around selective input controls. So new controls will eventually be necessary to limit catch. Such a sequence of management changes is evident in the northern prawn fishery. There are two cost consequences of periodic management changes in input controlled fisheries that are additional to the general cost increasing effects described above. First, the process of researching, negotiating and designing a new management policy increases management costs and has other direct costs to those operators in the fishery involved in the process. Second, each change in management renders some equipment redundant, at least in the fishery in which the management change occurs. Over time, such redundancy will tend to increase capital costs.

The reported capital figures (table 1) may also provide insight into important trends in the fishery. The increase in the value of replacement capital in the fishery over the last three years surveyed is likely to be a reflection of the measures taken by operators to increase the capabilities of their vessels subject to prevailing input restrictions.

The inefficiencies that result from using input controls in managing the fishery, combined with the large size of the fishery, suggest that there may be significant returns from research aimed at improving the way the fishery is managed. For instance, research into the information and technologies required to change the management system from one based on input controls to one based on output controls, could have the potential to result in a substantial increase net returns.

3.2 Offshore Trawl Sector of the South East Fishery

The offshore trawl sector of the south east fishery is that part of the larger south east fishery targeting primarily orange roughy, and to a lesser extent blue grenadier, with mid to deep water trawls. The offshore fleet consists mainly of the larger boats and operates predominantly out of Tasmanian and Victorian ports. The gross value of production from onshore and offshore trawl sectors in 1998-99 was an estimated $59.2 million from a total catch of 27 750 tonnes (ABARE 1998). Of that, 4728 tonnes of orange roughy was landed, worth $15.2 million.

Stock depletion and declines in the total allowable catch have resulted in total catch of orange roughy catch falling from 44 000 tonnes in 1990, or 74 per cent of the total catch weight for the trawl sector to 4700 tonnes (17 per cent) in 1998-99. Despite the big decline in catches, orange roughy remains the highest earning species in the fishery, accounting for 26 per cent of the total value of production for the fishery in 1998-99 (ABARE 2000).

The system used to manage the south east fishery moved from one based initially on input controls to one based on output controls in the late 1980s. Individual transferable quotas (ITQs) were introduced into the trawl component of the south east fishery in 1989. Initially, only one species, eastern gemfish, was managed this way. At the beginning of 1992, ITQs were introduced for a further fifteen species, including orange roughy. From January 1994, full and permanent transferability of quota has been permitted. Prior to this, operators were only allowed to lease quota on a seasonal basis to other operators within the fishery; the sale of quota was prohibited. Under this system each of these species is subject to a total allowable catch apportioned between the operators who are entitled to fish. The total allowable catches can be adjusted each year by the fishery's managers in response to environmental fluctuations or to satisfy management objectives.

Table 3: Net returns to the offshore sector of the south east fishery (real 1999-00 dollars)

	Revenuea	**Cash costsa,b**	**Capitala,c**	**Net returnsd**	**Vessel numbers**
	$m	$m	$m	$m	
1990-91	59.7	44.0	21.8	10.0	39
1991-92	52.5	31.3	17.6	18.4	33
1992-93	42.2	27.0	18.1	12.2	31
1993-94	50.9	29.2	14.6	19.0	29
1994-95	31.7	20.8	22.0	7.2	27
1995-96	27.2	22.3	15.9	2.1	23
1996-97	27.2	18.1	6.8	8.0	19
1997-98	na	na	na	na	20

a Revenue, costs and capital estimates are totals for boats included in sample (there is no attempt apportioning 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) for 1990-91 and 1991-92 is calculated by applying the replacement capital value for boat in three size groups in 1992-93 to population for 1990-91 and 1991-92 and then adding depreciation estimates; **d** Net return measure does not include any management costs

The need to provide information into the total allowable catch (TAC) setting process led to the establishment, in 1993, of the South East Fishery Assessment Group (SEFAG) to provide stock assessments for each of the quota species. For orange roughy a TAC is allocated for a number of separate management zones — eastern, southern, western and remote zone. AFMA's management target is to maintain the spawning biomass of each orange roughy stock above 30 per cent of the spawning biomass that existed at the onset of significant commercial fishing in 1988. When there is a greater than 50 per cent probability that a stock is below the target, AFMA's strategy is to set TACs so that the biomass rebuilds to the target level within five to ten years (Bureau of Resource Sciences 1998). Since the introduction of the assessment process there have been substantial reductions in the TAC for orange roughy (table 4). The depleted nature of the resource has meant that quota has not been met in recent years in the western and southern management zones.

Estimates of net returns to the fishery resource for the offshore component of south east fishery are provided in table 3. For survey purposes, catch composition determines whether a vessel is classified as having operated in the offshore fishery. If a vessel landed more than 10 000 kilograms of orange roughy in a year it is classified as having operated in the offshore fishery.

Some caution has to be exercised when interpreting the results of the grouping of boats as offshore trawl. The concentration of the sector on fishing for orange roughy makes it worthwhile to examine the performance of the sector separately, given that the orange roughy stock is not targeted in other fisheries. However, operations in the fishery overlap with other activities in the south east and nearby fisheries. Changes in boat numbers operating in the fishery may indicate changes in catch composition rather than operators making a decision about exiting or entering the fishery.

The results shown in table 3 indicate the importance of examining economic and biological indicators over an extended time. The net income measures for most of the period reported in table 3 are unlikely to reflect the level of resource rent attainable over the long term. The period for which the measures are reported is one of fishing down of orange roughy stocks. The level of net return sustainable over the longer term is likely to be closer to the levels for the final two years than those for earlier years.

The heavy catch rates may have influenced the price received for the species. The unit price received for catch in the offshore sector rose rapidly, from $1.48 a kilogram in 1990-91 to almost $3.80 in 1995-96 (table 4). Over the same period total catch declined from 33 111 tonnes to 4515 tonnes. It is possible that declining supplies provide a partial explanation of the rising prices. If the quantity supplied by the sector did influence the price received, the rapid drawdown of the orange roughy stock may have been to the disadvantage of the industry.

Despite effectively selling off a portion of the fish stock, net returns to the fishery have tended not to have been large over the survey period. The generally declining net returns since 1991-92 have been accompanied by falls in the number of vessels operating in the fishery and consequently declining operating costs and wage measures. High prices for most trawl sector species resulted in the high net return to the fishery in 1993-94 (ABARE 1996).

Table 4: Orange roughy caught in the south east fishery (real 1999-00 dollars)

	TAC **a** tonnes	Total catch tonnes	Unit price $/kg	Gross value $'000
1990-91	23 450	33 111	1.48	48 990
1991-92	18 254	18 160	2.52	45 828
1992-93	14 298	12 023	3.60	43 268
1993-94	11 527	9965	3.57	35 559
1994-95	9256	6528	3.61	23 566
1995-96	7952	4515	3.78	17 062
1996-97	6502	3129	3.71	1 1607
1997-98	6442	7443	3.79	28 238
1998-99	44 57 **b**	4728	3.29	15 573

a TACs for calendar years (1990-91 = 1991 etc). **b** excludes Cascade Plateau.
Source: ABARE (2000).

The impact the decline in the orange roughy resource had on the fishery is also reflected in the estimated capital series. Estimates of the market value of vessels bought and fitted for a high volume orange roughy fishery have declined as the main species, and hence the prospects for the sector of the fishery have diminished. The measures of capital cost used in estimating net returns in table 3 are based on the total value of capital for all boats involved in the fishery for each year. When a boat drops out of the offshore fishery its total capital value drops out of the base for calculating annual capital cost. It may be that a number of boats that were commissioned specifically for the offshore trawl had only limited use in that sector before losing substantial value in being relegated to other fisheries. In principle, any such capital losses should be subtracted from the net returns reported here.

From an institutional viewpoint, fisheries managed through output controls can suffer from incentives for high grading as operators attempt to fill their quota with high value catch. In multispecies fisheries, discarding those species for which quotas are already filled can be a problem. Because of this, indicators of the prevalence this behaviour can be an important qualifier to the economic information reported on the fishery.

In this sector of the south east fishery, binding quotas are unlikely to create an economic problem. Fishers' are able to target quota species effectively. Operators in the sector are not at risk of running out of quota for one or more species in a mixed catch. There is little potential gain from attempts to highgrade orange roughy.

Two other aspects of the ITQ system may detract from its efficiency. First, there is no formal market or central reporting of market information. It may be that different market participants have significantly different quota market information sets. Such information differentials can limit the efficiency of a market in quota. Second, the rapid draw down in total quota an uncertainty about the condition of the stock has meant that the future value of a share of quota held now is likely to be uncertain but expected to diminish. The uncertainty about future value may also limit the efficiency of the quota market.

3.3 Eastern Tuna and Billfish Longline Fishery

The eastern tuna and billfish fishery, while managed as a single fishery, is a complex fishery system involving multiple species and multiple fishing methods. The fishery is divided into zones partitioned along inshore/offshore boundaries and northern/southern boundaries (Campbell and Miller 1998). There is also a significant recreational fishing sector targeting the same stocks. This sector is managed by the state government.

Australian longliners have traditionally targeted yellowfin, with targeting of big eye and swordfish increasing in the mid 1990s, catches of those species are now comparable with yellowfin. Other commercial species caught by domestic longliners include albacore, striped marlin and southern bluefin tuna — although southern bluefin tuna resources are managed by the southern bluefin tuna Commonwealth fishery. Black marlin and blue marlin are also occasionally caught. However, domestic longliners developed a voluntary code of practice to discourage the taking of black and blue marlin in recognition that these species are the key target species of the gamefishing sector. There is also a purse seine and pole sector that targets mainly skipjack tuna for the domestic canning industry. A number of Japanese boats were permitted to operate in the fishery under bilateral agreements or as part of joint venture activities up to 1996-97.

Currently around 230 longline operators are authorised to fish in the eastern tuna and billfish fishery, although only around sixty of these do so on a full time basis. A large body of latent effort exists in the fishery as some operators do not use their pelagic longline entitlements. The vessels used by the longline fleet have traditionally been smaller boats, generally converted tuna pole vessels or trawlers. Some operators have recently invested in larger boats (Campbell and Miller 1998) providing the ability to extend the range of their operations and move further offshore (Ward, Hampton, Caton and Gunn 1997).

Currently, the commercial fishery is managed by input controls, with the emphasis on reducing effort. These controls include limited entry, zoning, boat restrictions, bycatch provisions and gear restrictions. Longline endorsements relate to specific areas of access with a total of seven categories of endorsements issued. Coinciding with this, vessels fishing within 50 nautical miles of the coast were subject to a maximum size of 32.67 metres. Purse seine operators have also been subject to limited access arrangements through area specific endorsements relating to four zones.

However, new management arrangements are soon to be introduced to the fishery. It is proposed that the existing management system will be replaced by a new system based on gear units and boat based Statutory Fishing Rights. The allocation of these rights will be linked to historical involvement in the fishery and economic factors.

It would be difficult to derive a reliable estimate of net returns to the fishery from the available data set. A large proportion of boats in the fishery also operate in one or more other fisheries. In the ABARE survey collections to 1996-97, no information was collected on the costs incurred in each fishery. Table 5 contains estimates of performance for boats that earned more than 65 per cent of their revenue from this fishery. The estimates are of total revenue and costs, with no attempt to apportion costs between the different fisheries in which those boats operate. Revenue earned from the fishery by the selected subset of boats accounts for a substantial proportion of total revenue from the fishery. Nevertheless, the estimates in table 5 exclude revenue and costs for the large number of boats outside the subsample. It also includes costs incurred and revenue earned by the subsample boats in other fisheries.

Table 5: Net returns to the east coast tuna and billfish fishery (real 1999-00 dollars)

	Revenue **a**	Operating costs **a,b**	Capital **a,c**	Net returns **d**	Management costs **e**	Vessel numbers
	$m	$m	$m	$m	$m	
1990-91	14.4	14.1	14.7	-2.2	na	57
1991-92	9.2	9.8	13.5	-2.3	na	52
1992-93	10.1	9.4	11.2	-0.6	na	44
1993-94	9.5	9.3	9.5	-1.4	na	35
1994-95	13.8	13.3	13.6	-2.0	0.9	49
1995-96	19.0	18.2	19.2	-2.8	0.8	69
1996-97	35.7	32.0	24.2	-0.8	0.7	99

a Revenue, costs and capital estimates are totals for boats included in sample (there is no attempt apportioning to fishery); **b** Cash costs include imputed operator and family labor costs but exclude licence and levy payments, interest payments; **c** Replacement capital (depreciated capital) for 1990-91 and 1991-92 is calculated by applying the replacement capital value for boat in three size groups in 1992-93 to population for 1990-91 and 1991-92 and then adding depreciation estimates; **d** Net return measure does not include any management costs; **e** Costs to AFMA of managing the fishery (Source: Andrew Kettle, AFMA, personal communication, December 1999)

Net returns from the activities of the selected subsample of boats most dependent on the east coast tuna and billfish fishery were negative for all years of the survey period (table 5). The results presented do not account for management costs. For the fishery as a whole, real management costs averaged $0.77 million per year for the final four survey years. If the estimates in table 5 reflect the true state of the fishery, the fishery operated at a net cost to the Australian economy over the survey period.

An examination of the performance individual boats showed considerable year to year variation in revenue and net income for many boats. Unpredictable variations in catch and revenue may explain why some operators make losses in some years but continue fishing. Still, the long term survival of businesses depends on their achievement of positive returns on average. The most obvious potential explanations for persistent negative return measures are under reporting of revenue by operators, or overestimation of the true costs of capital or unpaid labor.

It seems unlikely that misreporting of revenue is the primary cause of the low calculated net returns. The process of logbook recording and monitoring is essentially the same across all Commonwealth fisheries. As is evident from the northern prawn and south east fishery results, operators do record results that reveal persistent positive net returns in some fisheries. There is nothing to suggest that the reporting incentives faced by boat owners and operators would differ between fisheries.

A more likely explanation of persistently negative measures of net returns concerns the estimation of opportunity costs of labor and capital. If a substantial part of the fleet had little economic use outside the fishery, valuing capital at depreciated replacement cost would overestimate its true economic cost. Similarly, if some or all of the operators could not realistically find paid employment at the assumed market rates, operator and family labor would be over valued in the calculations underlying the table 5 results.

In order to cast some light on the question of labor and capital values, a measure of boat cash income is presented in figure 2. The imputed operator and family labor costs are excluded from the measure of net economic returns defined above. Depreciation and the full opportunity cost of capital are excluded from costs, but actual interest payments and licence and levy payments are added. Boat cash income provides a measure of the availability of cash income for operators and others providing unpaid labor and to provide a return to capital. At the extreme, when it could be assumed that boat capital had no other use, the full amount of boat cash income would be available for unpaid labor. Such an extreme would make sense only if net returns in all other fisheries in which the boats also operate had similarly negative returns. Boat cash income for the period would not be enough to cover management costs and minimal returns to unpaid labor, even in the unlikely case that the bulk of boat capital could be regarded as having no opportunity cost.

The evidence in table 5 and figure 2 seems sufficient to conclude that there are almost certainly negative returns to the fishery for the period 1990-91 to 1996-97. The difference between revenue and cash operating costs for the subset of boats earning more than 65 per cent of

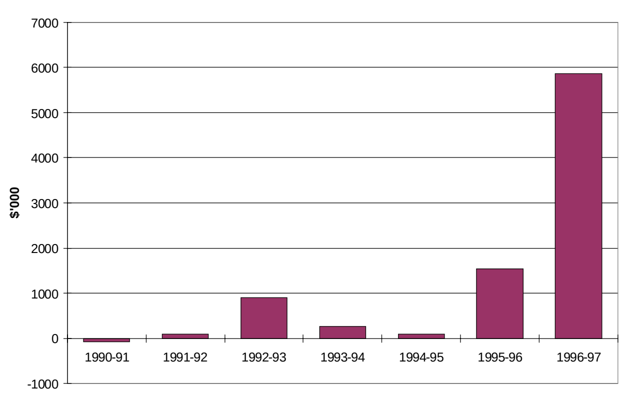


Figure 2: Boat cash income

their revenue from the fishery is minimal. Even if the capital and unpaid labor resources employed on those boats had very low opportunity costs, the net return after accounting for management costs is likely to be negative. The selected subset of boats does not provide comprehensive coverage of activities in the fishery. It is likely, nevertheless, to provide a reasonable measure of the aggregate performance in the fishery. Inspection of the distributions of net return and boat cash income for the full ABARE sample and the subsample, showed few notable differences. Further, although a large number of boats in the fishery were excluded from the sample population, it was on the basis of their having landed less than 10 tonnes of tuna, and thus being likely to have little impact on or dependence on the fishery.

Since 1996-97 total catch by the Australian fleet has expanded. Catches of broadbill and bigeye roughly doubled between 1996-97 and 1998-99 (ABARE 2000). Also since 1996-97, there has been no bilateral agreement allowing Japanese boats to operate in the fishery. It seems unlikely that removal of fishing pressure by the Japanese fleet is responsible for the change in Australian catch. Throughout the period in which Japanese boats operated in the fishery there were no constraints on licenced Australian operators undertaking fishing in the same areas. Only potential gear conflicts and any direct competition for stocks would have constrained the Australian fleet. While data on abundance and fishing pressure on the main species in the fishery are scarce, a sudden increase in availability of fish to the Australian fleet hardly seems consistent with the assessment provided by Campbell (1999). As well, while the Japanese fleet targeted bigeye, they did not target broadbill.

The degree of competition between commercial and recreational fishing activities in the fishery is unclear. As is noted above, marlin catch by the commercial fleet is constrained by a voluntary code of practice. Both the commercial and recreational sector also target several tuna species. The evidence on stock abundance and exploitation rates is somewhat scanty for most of those species (Campbell 1999). What evidence there is does not suggest that there is strong pressure on stocks. Nevertheless, it is the impact of a variation in catch in one sector on catch conditions in the other sector that is important. Even with a fairly low overall pressure on stocks competition between the two sectors could be significant.

4. CONCLUDING COMMENTS

In this paper, the economic performance of three Commonwealth fisheries has been analysed using a framework based on a measure of the net returns to the fisheries. The results of the analysis highlight the importance of integrating economic and biological indicators in assessing the performance of fisheries management. Consideration of the net returns to commercial fisheries cannot be undertaken without a thorough understanding of the ecological, market and institutional factors which impinge on the economic functioning of the fisheries. By examining the full range of indicators and their interactions, it is possible to both assess the past performance of management and to identify future management directions that will improve the management of fisheries.

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