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Economic indicators for the Northern Prawn Fishery

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Abstract

ABARES has undertaken economic surveys of key Commonwealth fisheries since the early 1990s. Financial profit and loss statements as well as detailed capital inventories have been collected in these surveys to provide a large database of primary information. The information contained in this database can be used to construct a range of economic indicators to assist Commonwealth fishery managers meet their economic objective of maximising economic returns to the Australian community from the harvest of Commonwealth fishery resources. ABARES survey data analysis has enabled financial performance (the financial position of the average boat operating in the fishery), and economic performance (net economic returns achieved in the fishery as a whole) for the Commonwealth's key fisheries to be reported in its annual Australian fisheries surveys report. More recently productivity and profitability indexes, entitlement values and cost of management have been added to this tool kit. This paper shows how fishery surveys data have been used by ABARES to construct a range of indicators, that when taken together help managers to assess their performance against their economic objective. Results from analysis of the Commonwealth Northern Prawn Fishery are used in this paper to illustrate the use of these indicators.

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1 Introduction

The Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES) has undertaken regular surveys of key Commonwealth fisheries since the early 1990s. During these surveys, financial profit and loss statements as well as detailed capital inventories are collected to form a primary data source on Commonwealth fisheries. The resulting data are used to assess the financial performance of operators in the fishery and the economic performance of the fishery as a whole. Both performance measures act as important indicators for fishery managers and are reported annually in the Australian fisheries surveys report series (see Box 1).

A distinction is made in the ABARES reports between the two key indicators, financial performance and economic performance. Financial performance estimates are calculated for the average boat in a fishery and include all cash receipts and cash costs that have been earned and incurred within the survey period. These estimates reflect the average boat's profit and loss statement for all business activities, including in cases where they have operated in a number of fisheries. Economic performance, on the other hand, reports the net economic return (NER) for the fishery level as a whole. The NER estimates differ from financial performance estimates because they relate only to the surveyed fishery — that is results exclude revenues and costs attributable to operating in other fisheries — and include other economic costs such as depreciation, the opportunity cost of capital and the opportunity cost of labour.

Economic performance is relevant mainly to fishery managers and policymakers. This is because NER relates only to the specific fishery being managed. Moreover, by taking into account all cash receipts, cash costs and economic costs, NER indicates the economic return to society associated with harvesting the fishery resource. For this reason, NER is the key economic performance indicator referred to in the *Fisheries Management Act 1991.* According to the Act, the Australian Fisheries Management Authority (AFMA) is required to maximise NER to the Australian community through managing Commonwealth fisheries. Although estimates of NER do not reveal how a fishery has performed relative to maximum potential NER (maximum economic yield) in a given period, interpretation of NER trends and drivers, together with other economic indicators, can assist in assessing AFMA's performance against this objective.

In 2013, ABARES expanded the reporting under the Australian Fisheries Surveys report series to include a range of other economic indicators that draw on data collected from the surveys to provide a more comprehensive assessment of fishery level performance. These indicators include productivity and profitability indexes as well as entitlement values and management costs (see Box 1). These indicators can provide further validation and insight to the trends in financial and economic performance. For instance, the productivity analysis can shed light on movements in productivity as a result of changes in inputs and outputs, and whether changes in the NER being earned in the fishery are driven by productivity changes or changes in the fishery's terms of trade; for example, changes in the input and output prices faced by the average fisher. To illustrate the use of these indicators in practice, this paper presents an economic indicator analysis of the Commonwealth Northern Prawn Fishery.

Box 1 Economic indicators in fisheries management

In September 2007, the Australian Government released the Commonwealth Fisheries Harvest Strategy Policy to provide guidelines for sustainable and profitable management of Australia's Commonwealth fisheries. The objective of the Policy is to maintain key commercial stocks at ecologically sustainable levels and to maximise the economic returns to the Australian community by targeting maximum economic yield (MEY) (DAFF 2007). In order to assess the performance of Commonwealth fisheries against its MEY target, fishery managers frequently rely on economic indicators which provide them with information about economic activities in the fishery. There are a range of economic indicators used in fishery management and they generally serve two main purposes:

Informing management decisions against the economic objective

This type of economic indicator is forward-looking and can advise fishery managers on policy settings necessary to achieve MEY. Bioeconomic models provide indicators that serve this purpose and there are models developed for the NPF (Kompas & Che 2004) and the SESSF (Kompas & Che 2008). Management strategy evaluation based approaches that include an economic component can also serve this purpose and are a potential future research area for fishery management.

Monitoring management performance against the economic objective

This type of economic indicator is backward-looking and assesses the impact of previous management decisions on economic performance. Most of the indicators examined in this report fall under this category. This includes the survey-based estimation of NER, productivity indexes, entitlement values, management costs and profitability indexes.

Total factor productivity analysis is an economic tool used to assess how well fishers use inputs to produce outputs and how their ability to convert inputs to outputs over time has changed with changes in the fishery's operating environment. Productivity indexes inform fishery managers about the effect of management arrangements on average productivity levels in the fishery.

Similarly, the index profit decomposition analysis looks at the key drivers of average profitability in a fishery, such as productivity, fish stock, output price and prices of inputs. The correlation between the profitability index and indexes of the key drivers can provide an indication to fishery managers of the effect different factors have on profitability. The trends in indexes can also reveal information about the impact changes in management have on key drivers and, in turn, profitability.

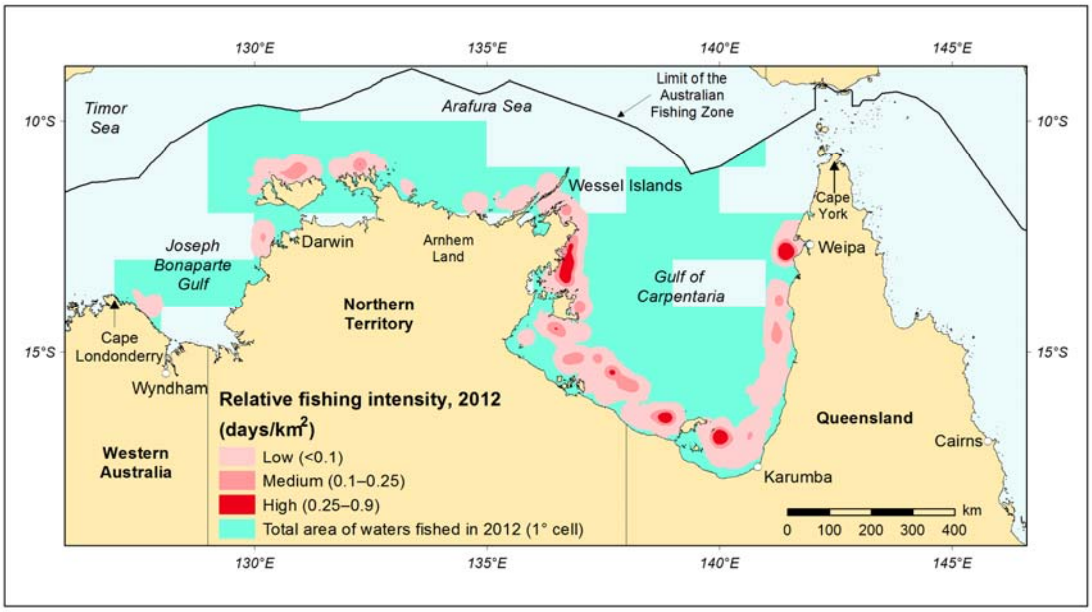
Entitlement values, on the other hand, signals the current value of resources in the fishery. When compared over time, entitlement values can serve as a general indicator for how well the resources in a fishery have been sustained or managed. If entitlement values are increasing over time, it suggests that resources are being managed effectively because operating in the fishery is deemed to have become more profitable. Measures of management cost, as a proportion of gross value of fishery production (GVP) and per active boat, also provide some general information about the cost effectiveness of fishery management — another key objective referred to in the *Fisheries Management Act 1991.*

2 Background

Description of the fishery

The Northern Prawn Fishery (NPF) is located off the Northern coast of Australia extending from Cape Londonderry in Western Australia to the Cape York Peninsula in Queensland, with most fishing activity occurring in the Gulf of Carpentaria (Map 1). The fishery uses otter trawl gear to target white banana prawn and two species of tiger prawn (brown and grooved), which collectively accounted for over 90 per cent of landed catch in both value and volume terms in 2011–12.

Map 1 Relative fishing intensity in the Northern Prawn Fishery, 2012



The fishery has two seasons: a short banana prawn fishery of 6–12 weeks starting around April and ending in June, and a longer tiger prawn season generally running from August to November. There are two distinct components of the NPF harvest strategy to manage the two components of the fishery (banana prawns and tiger prawns).

The key ports of landing for the NPF are Cairns, Darwin and Karumba with most of the catch offloaded onto mother-ships at sea (Woodhams et al. 2013). There are no formal recordings of where prawns caught in the NPF are unloaded. However, anecdotal information from industry suggests that majority of tiger, king and endeavour prawns are unloaded through Port of Cairns while banana prawns are normally unloaded in Port of Darwin when they are caught west of Wessel Islands and the other two ports when they are caught east of the islands.

Gross value of production and landed catch trends

In 2011–12 the NPF was the second most valuable Commonwealth fishery in terms of gross value of production (GVP), with a value of catch totalling $65 million. In the same year, white-legged banana prawns accounted for the largest share of GVP (61 per cent; $39 million), followed by brown tiger prawns (26 per cent; $17 million). Endeavour prawns are effectively a by-product caught when fishing for tiger prawns, and account for around 7 per cent ($4 million) of the fishery's total GVP.

Over the last ten years, real GVP in the NPF has declined considerably, falling from $182 million in 2001–02 to $62 million in 2011–12 (Figure 1). Most of the decline occurred in the first half of the decade, when landed catches of the two target species groups, banana and tiger prawns, followed declining trends (Figure 2). Since 2006–07, the volume of banana prawns caught in the fishery increased substantially as a likely result of favourable environmental conditions (Woodhams et al. 2013). However, despite increased banana prawn catch, real GVP in the fishery remained low. This was primarily driven by declining real unit prices received in the fishery over this period, which is likely to be negatively affected by strong appreciations in the Australian dollar, dampening the competitiveness of Australian prawn exports on international markets.

Figure 1 Real gross value of production in the Northern Prawn Fishery

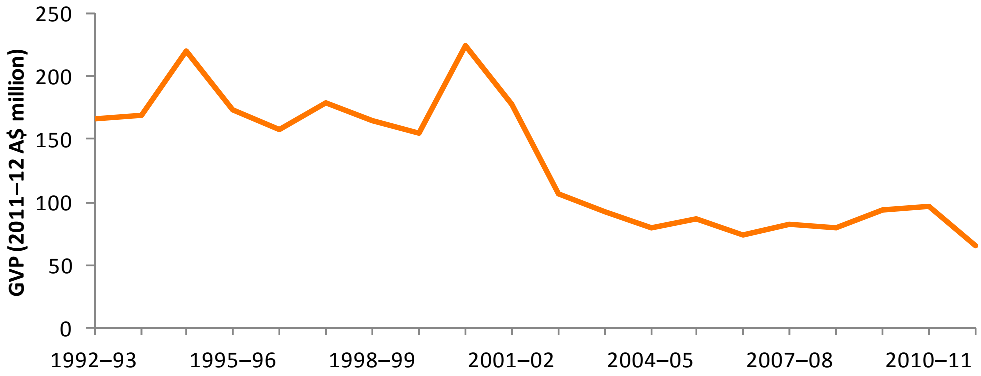
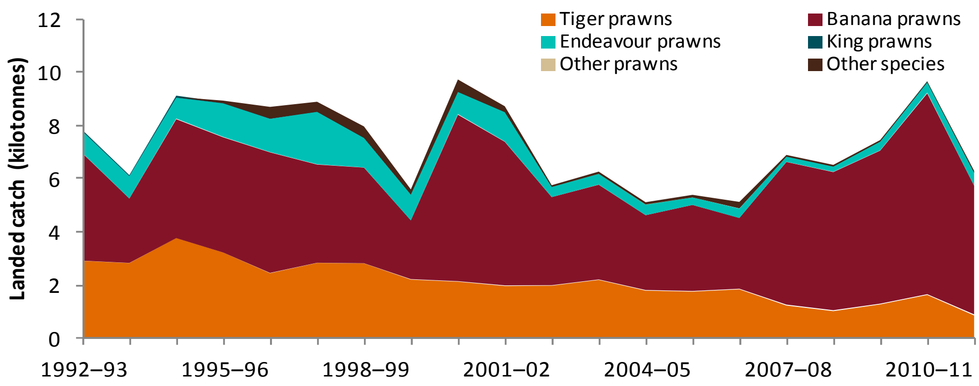


Figure 2 Landed catch of key species in the Northern Prawn Fishery



Current management arrangements

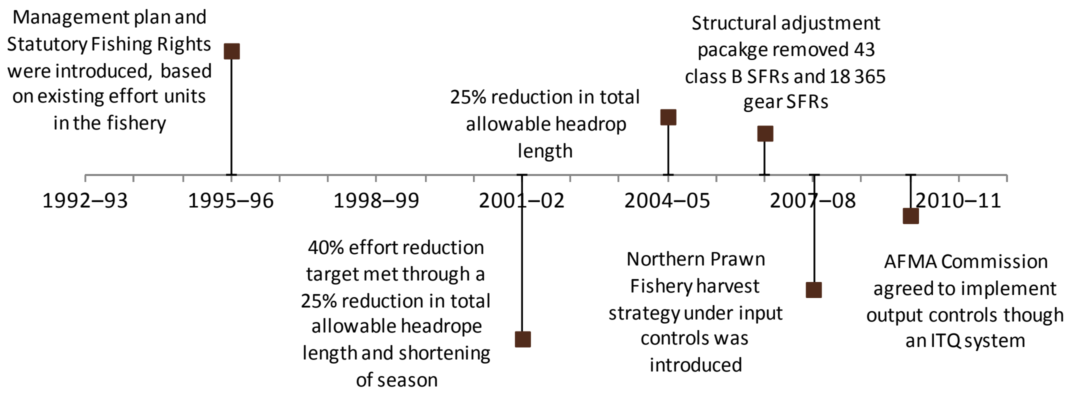
The NPF is currently managed using input controls. The main control is individual tradeable gear units, which limit the length of head rope on trawl nets. Controls on season length, spatial closures and other gear restrictions are also applied.

The NPF was the first fishery in Australia to adopt biomass at maximum economic yield (MEY) as its management target, in 2004. For tiger prawns, this is implemented by setting management limits according to the outputs of a bioeconomic model in line with the fishery's harvest strategy.

For banana prawns, limits will now be set based on a catch trigger and efficiency changes (AFMA 2013a, AFMA 2013b). This follows from the recent decision by the AFMA Commission in November 2013, which modified the previous input control system to include a MEY catch rate trigger for banana prawns and mechanisms to adjust total annual effort levels (AFMA 2013b). The AFMA Commission arrived at this decision after a series of discussions and research into the costs, benefits and risks associated with managing the fishery under alternative management options, including an individual transferable quota (ITQ) system (AFMA 2013a, AMFA 2013b).

The NPF was also involved in the Securing our Fishing Future (SoFF) structural adjustment package which took place in 2006–07 with the aim of removing excess capacity and improving profitability in the fishery (Figure 3). The structural adjustment package cost around $68 million and removed 43 class B Statutory Fishing Rights (SFRs) and 18 365 gear SFRs from the fishery (AFMA 2013b).

Figure 3 Active management interventions in the Northern Prawn Fishery



3 Economic indicators

Given the complexity of assessing performance against AFMA's economic objective of maximising net returns to the Australian community, a number of economic indicators can be considered when evaluating AFMA's performance against this objective. These include financial performance of the average vessel in a fishery, economic performance of the fishery as a whole, productivity changes in the fishery over time, profitability indexes that highlight the key drivers of profitability, changes in fisher entitlement values and changes in the cost of managing the fishery.

Financial Performance

The financial performance of the average boat provides a snapshot of all cash receipts and cash costs that have been earned or incurred within the survey period. These estimates reflect the average boat's profit and loss relating to fishing business activities across all fisheries that they operated in during this time. Boat level financial performance information provides some context for the surveyed fishery; for example, it may reveal how operators continue to generate profits in a fishery that has experienced negative economic returns. These estimates are relevant to all industry operators, who can compare their individual performance with that of the average boat.

Many of the operators who have participated in ABARES fishery surveys have indicated that they also operate in other fisheries during the survey periods. The incomes and expenses from these fisheries are included in the financial performance results. Financial performance results resemble profit and loss statements for the average boat, weighted based on landed catch of key species. Key categories used in this analysis include:

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

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.

Total cash costs include payments made for both permanent and casual hired labour 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.

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

On many boats, the costs of labour are reflected in the wages paid by boat owners and/or in the share of the catch they earn. However, in some cases, 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 labour provided. To allow for this possible underestimation, all owner/partner and family labour costs are based on estimates collected at the interview of what 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 ABARES 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 owning business of the surveyed boat. It includes the value of the boat, hull, engine and other onboard equipment (including gear). Estimates are also reported for 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 the 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 the proprietors owned all fishing assets. This enables financial performance of sample boats to be compared regardless of proprietors' equity in the business. Rate of return to boat capital is calculated by expressing profit at full equity as a percentage of total capital (excluding quota and licence value).

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Economic Performance

Economic performance, measured through the NER indicator shows the return to the Australian community from harvesting the fishery resource. According to the *Fisheries Management Act 1991,* the Australian Fisheries Management Authority (AFMA) is required to maximise NER to the Australian community through managing Commonwealth fisheries. Although estimates of NER do not reveal how a fishery has performed relative to the maximum potential in a given period, interpretation of NER trends and drivers, together with other economic indicators, can assist in assessing AFMA's performance against this objective.

The NER estimates differ from financial performance estimates because they are the long-run profits relating only to the surveyed fishery and include all economic costs. These costs include fuel, crew costs, repairs, the opportunity cost of family and owner labour, fishery management costs, depreciation and the opportunity cost of capital.

More specifically, a fishery's net economic return for a given time period can be defined as:

$$NR = \underbrace{R}_{\text{fish sale receipts}} - \underbrace{CC - OWNFL + ILR}_{\text{operating costs}} - \underbrace{OppK - DEP}_{\text{capital cost}} + \underbrace{recMC - totM}_{\text{management costs}}$$

Where:

NR	=	net returns
R	=	total cash receipts attributable to the fishery, excluding leasing income
CC	=	total cash costs attributable to the fishery
OWNFL	=	imputed cost of owner and family labour
ILR	=	interest and quota/permit leasing costs
OppK	=	opportunity cost of capital
DEP	=	depreciation
recMC	=	recovered management costs
totMC	=	total management costs.

Note that recovered management costs are those management costs paid by industry through management fees and are included in total cash costs (CC). These costs are removed (as indicated by '+ recMC') to prevent double counting given that these costs are a component of total management costs. Similarly, interest and quota/permit leasing costs are removed (indicated by '+ ILR') as these costs at the fishery level represent revenues that have been redistributed to external investors in the fishery.

Fish sale receipts are usually taken from fishers' financial accounts. Where a fisher operates in more than one fishery, they are asked to indicate what proportion of total fish sales is attributable to the fishery being surveyed. Any freight or marketing costs must also be deducted. This provides an estimate of net fishing receipts that incorporates only the 'beach price' that has been received for the catch; that is, the price received for fish at its first landing point.

Incomes received from leasing out quota and licences are not included as income in calculating net economic returns. This item represents a redistribution of profits among investors in the fishery. Also, the amount a fisher earns from leasing out quota and licences relates to the amount of profits the fishery is generating. Including leasing revenue would therefore result in double counting.

Operating costs include day-to-day operational expenses incurred to harvest fish in the fishery. Cash costs (CC) are a component of operating costs that includes those cost items that are easily identified in fishers' accounts, such as fuel, repairs and gear replacement.

Labour costs are often specified in fishers' accounts as wages. However, in calculating net returns, an estimate of the opportunity cost of labour is needed. The opportunity cost of labour is the wage that could have been earned performing a similar role elsewhere. Where a market wage is paid, it is assumed to represent the opportunity cost of labour and is included in the cash costs component of operating costs. The opportunity cost of owner and family labour is not easily identifiable in fishers' accounts. Often owners and their families are involved in operating a boat, either as skippers and crew or onshore as accountants and shore managers. While some will be paid market value for their labour, some will not be paid at all and others paid very high amounts, often as 'director fees' or 'manager fees'. In these cases, ABARES survey officers ask survey respondents to estimate the market value of owner and family labour—that is, the amount that would need to be paid to employ a non-family member to fulfil the same position. This amount is entered as a component of operating costs (OWNFL).

Quota and licence leasing costs and interest expenses are included in cash costs. However, these costs must be removed from calculation of net returns for the same reason they are excluded from income (see 'Fish sale receipts' above).

Capital costs calculation requires an estimate of the value of capital. ABARES survey officers ask fishers to provide information for all capital items associated with the fishing business (including hull, engine, onboard equipment, vehicles and sheds). Information collected for each item includes the year the capital item was manufactured and an estimate of what it would cost to replace that item with a new equivalent item. By accounting for previous depreciation and inflation, these data are used to estimate the total value of capital invested in the fishery for the survey year.

As mentioned, capital costs include the opportunity cost of capital (OppK) and depreciation (DEP). The opportunity cost of capital is the return that could have been earned if capital was invested elsewhere, rather than in the fishery. This cost is not identifiable in fishers' accounts. A real interest rate that represents the long-term average rate of return that could be earned on an investment elsewhere is applied to the value of capital in the fishery. For fisheries surveys, ABARES uses a rate of 7 per cent per year.

Depreciation expense is the cost of capital becoming less valuable over time as a result of wear and tear and obsolescence. Depreciation expense is not consistently identifiable in fishers' accounts, so ABARES calculates the annual depreciation of boats based on the capital inventory list collected during the surveys (described above) and predetermined depreciation rates for each capital item type.

Management costs are incurred to ensure the fishery continues operating and are therefore costs associated with harvesting fish in the fishery. Management costs are made up of two components: recovered management costs and non-recovered management costs. Recovered management costs (recMC) are those costs recovered from fishers and appear in the accounts of fishers as payments of management fees or levies. Non-recovered management costs are those management costs not charged to fishers, but instead are covered by the managing body or government. Calculation of net economic returns requires deduction of total management costs, which is the sum of these two components.

Total cash costs (CC) includes an estimate of recovered management costs based on management levy expenses contained in fishers' accounts. As this estimate of recovered management costs is based only on a sample of the fishery, it may not be consistent with the actual value of management costs recovered from the entire fishery. AFMA is able to provide an estimate of total management costs for each fishery—that is, the sum of both recovered and non-recovered management costs. For these reasons, recovered management costs from fishers' accounts are ignored (as indicated by +recMC in the net returns equation). Then, total management costs (totM) as supplied by AFMA are used to estimate net economic returns.

Productivity Analysis

Using boat level data collected in the surveys, total factor productivity (TFP) analysis looks at the ability of fishers in a fishery in converting inputs into outputs over time. Results from this analysis can assist in the evaluation of a fishery's economic performance and provide understanding to the factors driving changes in productivity. Changes in productivity generally reflect changes in a fishery's operating environment, such as management settings that regulate technology choice of fishers, or changing market conditions. Therefore, fishery managers can gain some understanding on the factors driving productivity change and effectiveness of various management decisions.

Market conditions range from variations in input costs, import competition, changes in Australia's terms of trade (appreciation or depreciation of the Australian dollar). Both changes in a fishery's operating environment and market conditions can provide fishers with incentives to pursue vessel level productivity improvements. This may be required in order to keep the business financially viable, for example, to offset any negative effects on profitability from adverse market conditions such as increasing input costs or competition. Adverse market conditions can also help drive autonomous structural adjustment within the industry. In fisheries, this is often characterised by fishing rights moving to the most profitable fishers and the least efficient or least profitable vessels exiting the industry, resulting in a more productive residual fleet.

There are various methods developed to quantitatively assess TFP trends for industries, and individual enterprises within industries (see Coelli et al. 2005 for discussion). In this paper the use of the Fisher quantity index to construct productivity indices for the NPF is illustrated (see Box 2). The Fisher quantity index is well suited to handling the range of inputs and outputs recorded in ABARES fisheries economic survey data. As with other index number approaches that measure productivity, the Fisher quantity index enables measurement of productivity trends with multiple inputs and outputs. The prices paid for inputs and received for outputs are used as weights to derive aggregations of outputs and inputs, which are expressed in index form. Output and input indexes are estimated using both a Laspeyres and a Paasche index approach. A geometric mean of these indexes is derived to determine the Fisher output and input indexes. Total factor productivity is measured as the ratio of the Fisher output and Fisher input indexes.

Total inputs consist of 13 items that can be split into 4 major groups:

Capital – capital costs account for all capital items associated with the fishing business. These include the boat, hull, engine, onboard equipment, vehicles and sheds. The estimate of capital is based on the depreciated replacement value. The quantity variable used for all capital is the average value of capital stock deflated by the respective prices paid indexes for each.

Fuel – Fuel costs include the costs of all fuel, oil and grease. The quantity variable used for all fuel is the average of fuel use deflated by the fuel price paid.

Labour – Labour includes the number of crew employed in boat-related aspects of the fishing business, such as crew or onshore administration costs, but do not cover the cost of onshore labour involved in processing fisheries products. It covers owner/partner, family and unpaid labour.

Repairs – Repairs costs include boat and motor vehicle repairs, gear costs and other repairs expenditure. The quantity variable is the value of all repairs deflated by the price of repairs.

Outputs, on the other hand, are the species caught by vessels in each fishery. For the NPF, this is mainly tiger and banana prawns. The price variable is the price received for the species caught. The quantity variable is the kilograms of each species caught by individual vessels.

Box 2 Fisher index

Using price and quantity data for a set of outputs (inputs), the Laspeyres quantity index Q_{0t}^{L} can be defined as:

$$Q_{0t}^{L} = \frac{\sum_{i=1}^{N} p_{i0} q_{it}}{\sum_{i=1}^{N} p_{i0} q_{i0}} = \sum_{i=1}^{N} W_{i0} \frac{q_{it}}{q_{i0}}$$

where

$$W_{i0} = \frac{p_{i0} q_{i0}}{\sum_{i=1}^{N} p_{i0} q_{i0}}$$

is the share of ith item in the total value of outputs (inputs) in the base period (denoted by 0) . The Laspeyres index compares a total quantity in time period (t) to a base period.

The Paasche index (Q_{0t}^{P}) is defined as:

$$Q_{0t}^{P} = \frac{\sum_{i=1}^{N} p_{it} q_{it}}{\sum_{i=1}^{N} p_{it} q_{i0}} = \left\{\sum_{i=1}^{N} W_{it} \left(\frac{q_{i0}}{q_{it}}\right)\right\}^{-1}$$

where

$$W_{it} = \frac{p_{it} q_{it}}{\sum_{i=1}^{N} p_{it} q_{it}}$$

is the share of ith item in the total value of outputs or inputs in the current period (denoted by t). Like the Laspeyres index, the Paasche index compares a total quantity in time (t) to a base period (0).

The Fisher index (Q_{0t}^{F}) is the geometric mean of Laspeyres and Paasche indexes, defined as:

$$Q_{0t}^{F} = \sqrt{Q_{0t}^{L} Q_{0t}^{P}}$$

The TFP index can be calculated as the ratio of the Fisher output (Q_{0t}^{FO})and input(Q_{0t}^{FI}) indexes:

$$TFP_{0t} = \frac{Q_{0t}^{FO}}{Q_{0t}^{FI}}$$

Profitability indexes

Another useful economic analysis that relies on the data collected from fishery surveys is the index profit decomposition. It is an approach that isolates relative contributions of different factors to changes in vessel-level profit over time and can help evaluate whether changes in fishery management have improved profitability in the fishery by looking at how the factors driving fishery profitability have responded following policy changes. These factors can be within the influence of management (such as productivity and stock biomass) while others lie outside management control (such as catch prices and input costs).

The method uses index numbers to decompose and quantify the relative contribution of drivers to a firm's profitability. It does so by examining the variable's share of profit for one firm and compares it with the share of profit of the same variable for a reference or benchmark firm. In the case of a fishery, a firm is represented by a vessel and the key variables that contribute to a vessel's profit include output price, prices of inputs (labour and fuel prices), productivity and fixed capital. For simplicity, output and inputs are together defined as 'netputs', where inputs are netputs with negative values and outputs are those with positive values. A vessel's variable profit is then defined as the sum of netput prices multiplied by netput quantities.

The reference vessel is normally selected based on the vessel that is the most profitable over the period of the analysis (Fox et al. 2006). However, in this report the reference vessel is defined as the average vessel in the most profitable year. This approach is considered more robust in multi-species fisheries where the catch composition of the most profitable vessel can be significantly different from other vessels in the fishery (Kompas et al. 2009). Once the reference vessel (vessel a) has been selected, the profit index ($\theta^{a,b}$) for each vessel can be expressed as a ratio of its variable profit (π^b) relative to the variable profit of the reference vessel (π^a):

$$\theta^{a,b} \equiv \pi^b / \pi^a$$

The profit index can also be rewritten using an aggregated Törnqvist price index ($P^{a,b}$) and an implicit quantity index ($Q^{a,b}$). Defining the profit index in this manner allows the contribution to profit from prices of all netputs between vessels a and b to be compared. With the Törnqvist price index, $P^{a,b}$, defined directly as the product of netput prices after adjusting for contributions to profit, the aggregate quantity index ($Q^{a,b}$) can be derived implicitly as (Skirtun and Vieira 2012):

$$\theta^{a,b} \equiv P^{a,b} \cdot Q^{a,b}$$

$$Q^{a,b} \equiv \theta^{a,b} / P^{a,b}$$

Here, productivity focuses on vessel utilisation of a fixed capital input, vessel length (K); this differs from measures of total factor productivity which focuses on utilisation of all inputs. More specifically, the productivity index ($R^{a,b}$) between vessels a and b is defined using the implicit quantity index in equation 3 as:

$$R^{a,b} \equiv Q^{a,b} / K^{a,b}$$

$$\equiv \theta^{a,b} / (P^{a,b} \cdot K^{a,b})$$

where $K^{a,b} = k^b / k^a$ and k is vessel length measured in metres. Therefore, the overall profit decomposition can be expressed as:

$$\theta^{a,b} = P^{a,b} \cdot R^{a,b} \cdot K^{a,b}$$

The multiplicative nature of the Törnqvist index allows the aggregate price index between vessels a and b to be further decomposed into a product of individual price differences such that the relative contribution to profit from the price index of each netput can be calculated:

$$\theta^{a,b} = P_O^{a,b} \cdot P_F^{a,b} \cdot P_L^{a,b} \cdot R^{a,b} \cdot K^{a,b}$$

where $P_O^{a,b}$, $P_F^{a,b}$ and $P_L^{a,b}$ represent the relative price indexes of output, fuel and labour.

Where stock information is available, profit and productivity indexes should be adjusted for the contribution of fish stocks (see Box 3). This provides a more accurate assessment of the two indexes. For example, in years of high stocks the unadjusted productivity index ($R^{a,b}$) will increase as vessels can increase their catch without using more capital. Similarly, the relative profit ($\theta^{a,b}$) index will also be inflated in years of high stocks, because income increases with higher catches while input costs remain stable. For consistent comparison of vessel profit and productivity over time, stock-adjusted indexes are preferred.

Box 3 Adjusting for stock biomass

To obtain the stock-adjusted profit index ($\theta_s^{a,b}$), only the productivity index ($R^{a,b}$) is stock adjusted. The stock-adjusted productivity index between vessels a and b ($R_s^{a,b}$) can be calculated by dividing the productivity index by the ratio of stocks observed for vessels a and b:

$$R_s^{a,b} = R^{a,b} / S^{a,b}$$

$$\theta_s^{a,b} = P_O^{a,b} \cdot P_F^{a,b} \cdot P_L^{a,b} \cdot R_s^{a,b} \cdot K^{a,b}$$

where $S^{a,b} = (s_b / s_a)$ and s_a and s_b are the fish stocks available to each vessel in their respective year. Stock effects to profit can be isolated by taking the difference of the profit index ($\theta^{a,b}$) and the stock-adjusted profit index ($\theta_s^{a,b}$).

For multi-species fisheries, calculation of stock (s) requires aggregating the biomass abundances of individual species into one measure of stock abundance. Given that the key drivers of a species' contribution to vessel profit are likely to be its catch and price, an aggregated measure of stock biomass can be computed by weighting each species' contribution to the aggregated abundance by the average price and quantity of catch for that species. As shown by Kompas et al. (2009), aggregated stock biomass for a particular year (s_t) can be defined as:

$$s_t \equiv \sum_{i=1}^{F} s_t^i \frac{p_t^i q_t^i}{\sum_{i=1}^{F} p_t^i q_t^i}$$

where s_t^i is the stock biomass for species i in time period t, p_t^i is its relevant price and q_t^i is the amount of that species caught in that time period.

Weighting stock contribution by price and quantity of catch for each key species offers a monetary valuation of biomass for those species, which allows a more direct link between biomass changes and profit to be made. While having an aggregated stock index specific to each vessel would be ideal, such an approach is problematic as catch differences do not necessarily reflect variations in biomass abundance across locations where individual vessels fish (Fox et al. 2006).

Entitlement values

Entitlement values reflect underlying beliefs about the health of the fishery's prawn stock and expected prices for that stock. In general, entitlement values reflect expected vessel profitability in the fishery. Over time, changes in entitlement values can provide an indication of economic performance in the fishery. However, it is important to note that for entitlement values to accurately reflect beliefs placed the value of the fishery resource, an efficient market system must exist for entitlement trade. That is, a quota market with many buyers and sellers, and low transaction cost.

Management cost

For Commonwealth fisheries, management cost typically covers biological monitoring and reporting; policy, regulation and legislation development; compliance and enforcement services; licensing services; research and performance assessment. Management cost is the total cost incurred to manage the fishery, which can exceed the recovered cost or levies collected.

Cost minimisation is a secondary economic objective of fishery management. Therefore, management cost can be an indicator of cost efficiency. Management cost per active boat reflects the burden on individual vessels operating in the fishery and give an idea to some of the barriers to entry (for example, fixed costs of operating). In contrast, management cost as a percentage of gross value of production (GVP) indicates cost efficiency of management. For example, lower management costs in fisheries with higher GVP can be considered more cost efficient than low GVP fisheries with higher management cost.

4 Results

Financial performance

Over the period from 2006–07 to 2009–10, total revenue increased considerably more than total cost in percentage terms (68 per cent compared to 55 per cent). This resulted in substantially higher boat cash income of $292,203 in 2009–10 compared to $113,415 in 2006–07. Both trends are consistent with the large increase in the volume of banana prawns caught in the fishery, from 2674 tonnes in 2006–07 to 5771 tonnes in 2009–10. This is likely to be influenced by favourable environmental conditions as the banana prawns are believed to be resilient to fishing pressure, and recruitment appears to be more closely associated with seasonal rainfall than fishing mortality (Woodhams et al. 2013). Given the aggregating nature of banana prawns, higher stock levels lead to both greater volume of landed catch and reduced unit cost of fishing.

Table 1 Financial performance of boats operating in the Northern Prawn Fishery, average per boat

		2006-07		2007-08		2008-09		2009-10	
Revenue									
Seafood receipts	$	841,469	(8)	1,399,537	(4)	1,451,485	(6)	1,491,121	(5)
Non-fishing receipts	$	75,054	(29)	53,767	(14)	75,068	(31)	48,251	(21)
Total cash receipts	$	916,523	(7)	1,453,304	(3)	1,526,553	(4)	1,539,371	(4)
Costs									
Administration	$	22,991	(16)	25,712	(15)	13,105	(10)	15,154	(10)
Labour	$	213,126	(9)	346,779	(3)	386,704	(5)	397,005	(3)
Freight and marketing	$	23,100	(11)	51,003	(8)	57,098	(10)	64,492	(8)
Fuel	$	288,471	(6)	405,429	(2)	406,137	(3)	319,204	(3)
Insurance	$	23,430	(12)	33,332	(6)	36,016	(5)	39,013	(4)
Interest paid	$	6,766	(33)	4,338	(66)	12,653	(27)	8,334	(19)
Licence fees and levies	$	20,264	(9)	25,821	(7)	32,373	(2)	39,176	(4)
Packaging	$	22,529	(11)	47,351	(5)	50,203	(4)	47,864	(4)
Repairs and maintenance	$	118,328	(9)	162,301	(4)	215,522	(5)	214,984	(6)
Other	$	64,104	(10)	77,101	(7)	85,985	(4)	83,600	(6)
Total cash costs	$	803,109	(7)	1,179,167	(2)	1,320,144	(2)	1,247,168	(3)
Boat cash income	$	113,415	(28)	274,138	(14)	206,410	(22)	292,203	(13)
less Depreciation [(a)]	$	48,964	(10)	46,991	(8)	36,334	(9)	35,026	(8)
Boat business profit	$	64,451	(51)	227,147	(16)	170,075	(27)	257,178	(14)
plus Interest, leasing and rent	$	18,159	(23)	13,149	(28)	40,121	(23)	29,232	(18)
Profit at full equity	$	82,611	(37)	240,296	(15)	210,196	(20)	286,410	(12)
Capital (excl. quota and license)	$	879,857	(8)	1,095,111	(5)	909,984	(5)	896,091	(5)
Capital (incl. quota and license)	$	3,097,084	(7)	3,824,277	(3)	3,648,877	(4)	3,652,054	(3)
Rate of return to boat capital [(b)]	%	9.4	(37)	21.9	(13)	23	(22)	32	(16)
Rate of return to full equity [(c)]	%	2.7	(37)	6.3	(13)	6	(22)	8	(13)
Population	no.	78		54		55		55	
Sample	no.	34		30		31		34	

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. Figures in parentheses are relative standard errors (RSEs). For any given standard error, an RSE will be higher for estimates closer to zero. A guide to interpreting RSEs is included in Appendix A.

Higher boat cash income along with lower depreciation and higher interest, leasing and rent meant profit at full equity increased over the same period. Profit at full equity for the average NPF boat was estimated at $286,410 in 2009–10, which represents an increase of 247 per cent compared to 2006–07. This drove the rate of return to boat capital and the rate of return to full equity up by similar rates. Overall, this suggests that the financial performance of the average boat in the fishery improved during the period from 2006–07 to 2009–10. For financial perfomance results for the 2010–11 and 2011–12 financial years, please see Skirtun et al. (2014 *forthcoming*).

Economic performance

Similarly, the economic performance of the fishery as a whole appeared to have improved over the period from 2006–07 to 2009–10. NER increased from -$2.9 million in 2006–07 to $7.8 million in 2007–08 and stayed positive up until 2009–10. For NER results for the 2010–11 and 2011–12 financial years, please see Skirtun et al. (2014 *forthcoming*). The increase in NER in 2007–08 was primarily driven by higher fishery cash profit owing to considerable increase in fishing income. Operating costs also increased, but to a lesser extent.

Table 2 Fishery cash profit and net economic returns for the Northern Prawn Fishery, total fishery A$ million

	2006-07		2007-08		2008-09		2009-10	
Fishing income	63.7	(9)	76.0	(3)	78.9	(5)	81.4	(5)
Operating costs	59.9	(7)	63.2	(2)	70.7	(2)	66.7	(4)
Fishery cash profit	3.9	(58)	12.8	(16)	8.2	(39)	14.7	(13)
less								
- owner and family labour	0.8	(23)	0.6	(18)	1.3	(32)	1.2	(24)
- opportunity cost of capital	2.4	(11)	1.6	(8)	1.4	(9)	1.2	(8)
- depreciation	3.7	(11)	2.6	(8)	2.0	(9)	1.9	(8)
plus interest, leasing and management fees	2.9	(10)	2.1	(11)	3.8	(13)	3.6	(7)
Net return (excluding management costs)	-0.1	(1732)	10.1	(18)	7.3	(40)	13.9	(14)
Management costs	2.7	na	2.3	na	2.5	na	2.2	na
Net return (including management costs)	-2.9	na	7.8	na	4.8	na	11.7	na

Notes: Longer time series are available on the ABARES website. Figures in parentheses are relative standard errors.

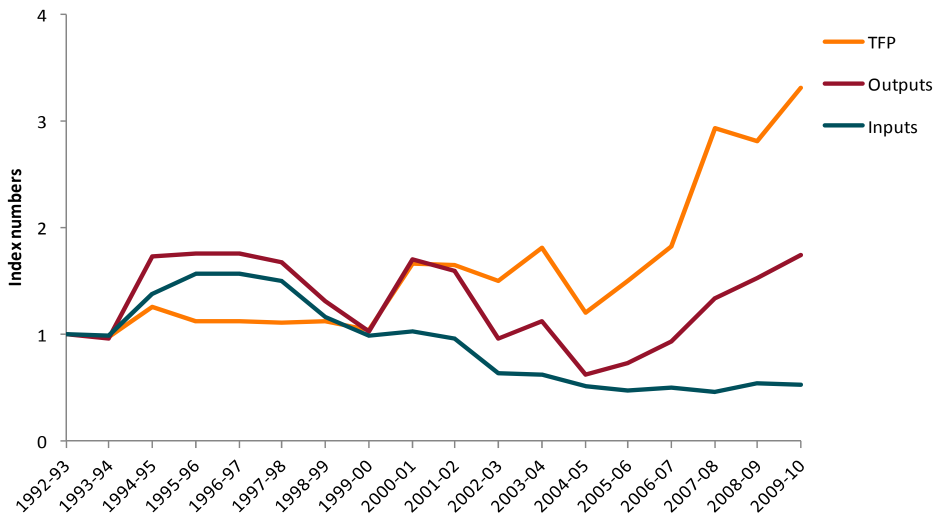
Real NERs in the NPF were largely positive in the 1990s due to a combination of high catch and real unit price (Figure 1d). With the exception of 2012–13, real average unit price in the NPF has followed a declining trend since 1999–00 (Figure 2). This was mainly driven by appreciations in the Australian dollar against the US dollar over this period. As a result of falling unit prices and declines in catch from 2000–01 to 2006–07, real NER in the fishery fell sharply in the first half of last decade, to –$16 million in 2004–05. Real NER then increased from 2007–08 to 2009–10 following the SoFF structural adjustment that aimed to remove excess capital in the fishery.

Productivity analysis

The productivity analysis for the NPF extends from 1992–93 to 2009–10. Between 1992–93 and 1999–00, the TFP index remained relatively close to one as the input and output indexes moved at similar rates (Figure 4). From 1999–00 to 2004–05, the input index declined at a faster rate than the output index and productivity increased as a result. This was likely influenced by the decline in vessel numbers which fell by 52 per cent during this period in response to declines in profitability. As such, it is expected that the least efficient vessels exited the fishery.

A number of significant management changes also occurred over this period. In 2000, the fishery moved from management based on vessel and engine size restrictions to gear based management, tradeable entitlements for headrope length. This move was aimed at providing the fleet with greater flexibility to match capacity to determined sustainable catches (Cartwright 2005). This greater flexibility meant that industry was better able to improve productivity to maintain profitability in the face of more restrictive management settings.

Figure 4 Productivity indexes for the Northern Prawn Fishery, 1992–93 to 2009–10



Between 2004–05 and 2009–10, productivity increased rapidly as input use decreased and output increased. The number of operating vessels declined as a result of the SoFF buyback and this was a major driver of the reduction in inputs (capital, labour, fuel and repairs). The increase in productivity reflects both a reduction in fleet size and the likely exit of the less efficient vessels. With fewer, more productive vessels competing for the same stock, the fishery was able to improve its ability converting inputs into outputs. This is consistent with results of Pascoe et al. (2012) who showed that the least efficient vessels exited the fishery through the buyback, and that the average efficiency of remaining vessels increased due to reduced crowding and higher catch rates.

Given the reduced number of vessels in the fishery and revised bioeconomic model outputs, AFMA made an allowance for a 33 per cent increase in headrope length in 2008. This combined with the allowance of quad-gear in 2006 is likely to have also contributed to the observed growth in productivity between 2004–05 and 2009–10.

Profitability indexes

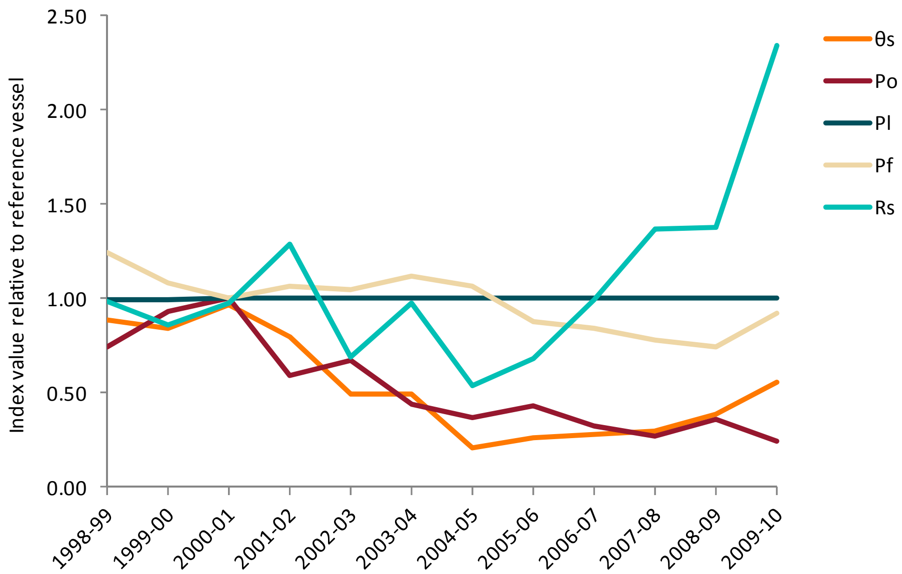
Under the profit decomposition analysis, a fishery's economic performance is estimated by geometric averages of individual sample vessel index results in each year. A profit index ($\theta^{a,b}$) less than one indicates a profit that is lower than that of the reference vessel. When comparing index values for output price ($P_O^{a,b}$), fuel price ($P_F^{a,b}$), labour price ($P_L^{a,b}$) and productivity ($R^{a,b}$), the following interpretation should be used:

- where an index has a value less than one, the positive contribution of that index to profit is less than that of the reference vessel
- where an index has a value greater than one, the positive contribution of that index to profit is greater than that of the reference vessel.

For example, if an input index, such as the fuel price index, has a value greater than one, it means that a vessel's profit is receiving a greater positive contribution from fuel prices relative to the reference vessel. This would reflect either, or both, a lower price paid for fuel by that vessel or fuel accounting for a lower share of its total costs. On the other hand, if an output price index has a value greater than one, it suggests that the price received for output is higher—that is, more favourable—than the price received by the reference vessel.

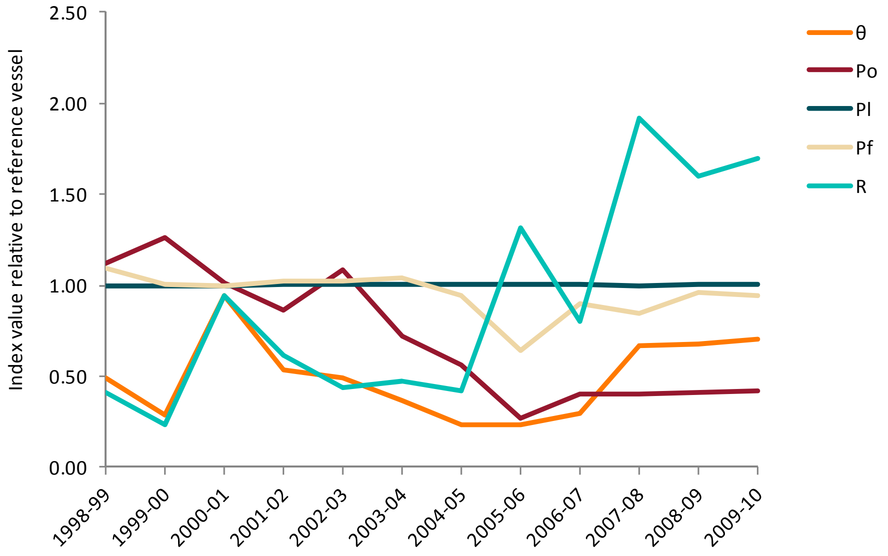
The results for the NPF analysis are split by the two fishing seasons, the banana prawn season and the tiger prawn season. The reference vessel selected is the average vessel in the most profitable year, which was 2000–01 in both seasons. For tiger prawn season, stock-adjusted profit for the average vessel followed a decreasing trend from 2000–01 to 2004–05 (Figure 5). It then gradually recovered but remained well below levels in 2000–01. The main driver behind the decline in stock-adjusted profit was output prices; falling prices had a strong negative influence on profit since 2000–01. However, substantial improvements in stock-adjusted productivity since 2005–06 have increased stock-adjusted profit. While fuel prices have had a negative influence on stock-adjusted profit since 2004–05, this influence is minor relative to the influence of output prices and productivity.

Figure 5 Key indexes for vessels in the tiger prawn season, average by financial year



For banana prawn season, profitability for the average vessel fell between 2000–01 and 2004–05 (Figure 6). Like the tiger prawn season, this decline in profitability was primarily driven by output prices. Since 2006–07, profitability in the banana prawn season has improved, with productivity being the key driver and the contribution to profit from output prices remaining low. As observed in the tiger prawn sector, fuel prices had a negative influence on profit but were of less importance relative to output prices and productivity

Figure 6 Key indexes for vessels in the banana prawn season, average by financial year



The contribution of productivity to profitability has been important for the NPF, given falling output prices. A contributing factor was the Securing our Fishing Future structural adjustment package implemented in 2006 which is likely to have removed the less productive vessels from the fishery (Skirtun & Vieira 2012). For the tiger prawn component of the fishery, management of stocks against a MEY target is also likely to have contributed to productivity improvements. As no stock information were available for the banana prawns, productivity growth in this component of the fishery also reflect large increases in banana prawn landings up to 2010–11; during which banana prawn catch peaked to 143 tonnes per vessel.

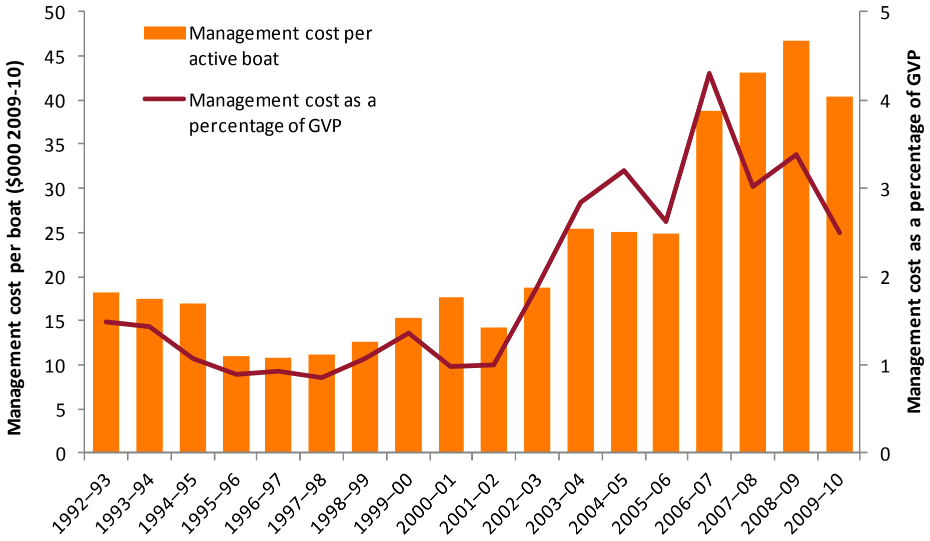
Entitlement values

Operating in the NPF requires two types of statutory fishing rights (SFRs): class B SFR, or more commonly referred to as boat SFR, and gear SFR. Class B SFR is required for the commercial use of a trawl boat in the fishery while gear SFR controls the lengths of the operational headrope and footrope the prawn trawl net is attached to (ComLaw 2012). Entitlement values are estimated values placed on the two types of SFR by fishers operating in the NPF. ABARES started to collect entitlement values in the 2011–12 NPF survey. For entitlement value estimates for 2011–12, please see Skirtun et al. (2014 *forthcoming*).

Management cost

Real management cost per active boat and management cost as a percentage of GVP are displayed in Figure 7. Management cost per active boat has followed an increasing trend from 2001–02 to 2008–09. This corresponds to a reduction in the number of active boats from 118 in 2001–02 to 55 in 2008–09. A fall in the number of active boats means that total management cost must be shared among a smaller number of operators in the fishery. The jump in average management cost post 2005–06 reflects the 36 per cent reduction in boat numbers between 2005–06 and 2007–08, resulting from the SoFF structural adjustment package.

Figure 7 Real management cost per active boat and as a share of GVP, 1992–93 to 2009–10



Similarly, management cost as a percentage of GVP has also fluctuated over the last decade, from 1 per cent in 2001–02 to 4 per cent in 2006–07 before dropping back down to around 2.5 per cent in 2009–10. This was the result of both increasing management cost and decreasing fishery GVP (with less boats operating) over the same period. In addition, the restructuring that took place in 2006 is likely to have contributed to the increase in management cost. It is difficult to conclude that management has become less cost efficient given that the increase in management cost as a percentage of GVP reflects a higher degree of research and environmental monitoring over the last decade, which is necessary to ensure the sustainability of the stock for future years to come.

5 Conclusion

The targeting of MEY across the key species caught in the fishery is consistent with the economic objective of the Harvest Strategy Policy for Commonwealth fisheries. However, the cost of constructing models that can estimate MEY is often prohibitive. A range of indicators has been constructed and used by ABARES to monitor the economic performance of Commonwealth fisheries. When taken together these indicators are able to provide an indication of the economic performance of a fishery and whether the economic objective of the Commonwealth Harvest Strategy Policy is being met.

This paper has illustrated a range of indicators as applied to the Commonwealth Northern Prawn Fishery. For the fishery overall, real NER in the NPF have been positive since 2006–07, growing to $13.9 million in 2009–10. The financial performance of the average vessel reveals a positive trend in total cash receipts over the period from 2006–07 to 2009–10. Profit at full equity improved significantly in the three years following 2006–07. Over the same period, both the productivity analysis and the profit decomposition showed that there have been significant improvements in productivity across the fishery. This is likely to be the result of the SoFF structural adjustment, which aimed to remove excess capital in the fishery and promote autonomous adjustment. When taken together, these indicators show a steady improvement in the economic performance of the fishery.

To better assist fishery managers meet their objective, ABARES is currently developing other indicators, including a time series of entitlement values as well as price forecasts of tiger and banana prawns. These will help provide some indication of the changes in the value of fishery resources over time and feed into economic and statistical models that aim to assess management performance.

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