Australian Government
Department of Agriculture and Water Resources
ABARES

Australian fisheries economic indicators report 2015

Financial and economic performance of the Northern Prawn Fishery

Andrea Bath and Richard Green

Research by the Australian Bureau of Agricultural and Resource Economics and Sciences

December 2016

Cataloguing data

Bath, A & Green, R 2016, *Australian fisheries economic indicators report 2015: financial and economic performance of the Northern Prawn Fishery*, Australian Bureau of Agricultural and Research Economics and Sciences, Canberra, December. CC BY 3.0.

ISSN 2204-9444
ISBN 978-1-74323-322-1
ABARES project 43505

Internet

Australian fisheries economic indicators report 2015: financial and economic performance of the Northern Prawn Fishery is available at agriculture.gov.au/abares/publications.

Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES)

Postal address GPO Box 858 Canberra ACT 2601
Switchboard +61 2 6272 3933
Email info.abares@agriculture.gov.au
Web agriculture.gov.au/abares

Acknowledgements

The ABARES fisheries survey program involves the cooperative effort of industry, fisheries management, agencies and ABARES staff.

Industry—ABARES surveys are voluntary, so the cooperation of Northern Prawn Fishery fishing operators and their accountants in providing data is essential for the success of the fisheries surveys. Without this assistance the surveys would not be possible. Comments by the Northern Prawn Fishing Industry Pty Ltd are also gratefully acknowledged.

Management agencies—the Australian Fisheries Management Authority (AFMA) provided logbook and address data, fishery management costs and general information about the surveyed fisheries.

ABARES staff—Patricia Hobsbawn and Rupert Summerson helped by providing data and maps. Robert Curtotti and David Galeano provided comments.

The Department of Agriculture and Water Resources funded this report through the Fisheries Resources Research Fund and ABARES.

Photo credits

Mike Gerner

Contents

Tables

Figures

Maps

Boxes

Summary

This report provides financial and economic performance indicators for the Commonwealth Northern Prawn Fishery (NPF), one of the key Commonwealth fisheries that ABARES has surveyed for financial and economic performance since the early 1990s. Survey-based results are presented for the 2012–13 and 2013–14 financial years, and preliminary non-survey-based results are presented for the 2014–15 financial year. The indicators presented are financial performance estimates for the average boat operating in the fishery, the net economic returns (NER) and total factor productivity (TFP) of the fleet, the terms of trade and management costs faced by fishers operating in the NPF and trends in entitlement values (a key asset held by fishers in the NPF). Progress against maximum economic yield (MEY) targeting in the fishery to date is also included. Fishery managers can use these indicators to inform management decisions and monitor performance of the fishery.

Key findings

Financial performance

- Profit at full equity for the average NPF boat increased from 2004–05 to 2010–11. A sharp decline in the profit at full equity (71 per cent) occurred in 2011–12 due to reduced volumes of banana prawns landed. Higher catch and prices for banana prawns since 2011–12 saw profits increase from 2012–13 to 2013–14 (Table 1).
- Fuel and crew costs make up the largest proportions of cash costs in the fishery. For 2012–13 and 2013–14, fuel costs made up 40 per cent and 33 per cent of total cash costs, respectively, and crew costs 25 per cent and 29 per cent of total cash costs, respectively.

Table 1 Key financial performance results, boat-level average, 2012–13 and 2013–14

Category	Unit	2012–13	2013–14
Total cash receipts	$	1 521 421	2 000 522
Total cash costs	$	1 254 613	1 587 839
Boat cash income	$	266 808	412 683
– less depreciation	$	37 632	39 769
Boat business profit	$	229 175	372 913
– plus interest, leasing, rent	$	9 891	10 025
Profit full equity	$	239 066	382 939
Rate of return to full equity	%	6.2	10.0

Economic performance

- NER in the fishery was at its highest in 2000–01, at $86 million in 2014–15 dollar terms, but fell sharply in the following years to reach a low of –$17 million in 2004–05 as prices and catch declined. After 2004–05, NER generally improved—except for 2011–12, when both catch and prices fell again. This turned NER negative for the first time since 2007–08.
- In the two most recent years of the survey net economic return of the fishery is estimated to have increased from $5.2 million in 2012–13 to $12.3 million in 2013–14 (Table 2). The increase in NER from 2012–13 to 2013–14 was primarily driven by faster growth in fishing income than in fishing costs. The growth in fishing income was driven by increased landings of tiger prawns and banana prawns offsetting slightly lower beach prices for each.

- In 2014–15 fishing income is forecast to increase due to increased prices for banana and endeavour prawns, despite reduced levels of catch. Increased trawling hours in the fishery over 2014–15 contributed to increased operating costs. However, this was partially offset by lower fuel prices during 2014–15. Net return excluding management costs is estimated to rise in 2014–15, but higher management costs will fully offset this gain and result in stable net return inclusive of management costs.

Table 2 Key economic performance results, Northern Prawn Fishery, 2012–13 to 2014–15

Category	Unit	2012–13	2013–14	2014–15p
Fishing income	$m	81.2	97.8	100.9
Operating costs	$m	72.9	82.6	85.5
Fishery cash profit	$m	8.3	15.2	15.5
– less owner and family labour, opportunity cost of capital and depreciation				
– plus interest, leasing and management fees				
Net return (excluding management costs)	$m	7.6	14.3	14.7
Net return (including management costs)	$m	5.2	12.3	12.3

p Preliminary estimate.

Other indicators

- TFP in the NPF is strongly related to changes in landed catch. The TFP index fell significantly between 2010–11 and 2012–13, when banana prawn catch fell from 5 755 tonnes to 2 990 tonnes. Apart from this period, the index rose for most of the decade up to 2013–14. Most of this gain occurred in the period after the implementation of the structural adjustment package in 2006–07.
- Changes in the terms of trade in the NPF are driven mainly by fuel prices and the price of banana prawns, which are exposed to competition from imported prawns. For most of the 10-year period to 2013–14, the terms of trade index followed a declining trend. This decline is largely attributable to increased fuel prices (especially to 2009) and to a lesser extent low prices for banana prawns caused by a high Australian dollar. A recovery in the terms of trade in 2012–13 was caused largely by decreases in labour and repair costs and a recovery in banana prawn prices, which allowed NER to recover despite declines in productivity in that year.
- Management costs per active boat remained high between 2007–08 and 2014–15 relative to earlier years in the 2000s because total management cost levels did not decline along with the number of boats post the structural adjustment package in 2006–07.

Implications for management

- Several management arrangements implemented in the past are expected to have contributed to the improvements in productivity and NER over the period of declining terms of trade, from 2004–05 to 2010–11. Targeting of MEY in the tiger prawn component of the fishery began in 2004–05. In addition, the structural adjustment package (completed in 2006–07) removed excess capital by removing boat and gear statutory fishing rights (SFRs) from the industry. The introduction of the fishery harvest strategy in 2007–08 has also enabled clear management responses to changes affecting the fishery. The resilience of the fleet in the operating environment of rising inputs and steady output prices is due in large part to an increase in productivity resulting from these management changes. The management changes that have been made are expected to have brought the fishery closer towards meeting the management objective of maximising returns to the Australian community.

- Two primary species are caught in the NPF—tiger prawns and banana prawns. The tiger prawn component of the fishery has a biomass target explicitly related to MEY, however the banana prawn resource is environmentally driven, making it difficult to develop a stock–recruitment relationship. This means it is currently not possible to implement an explicit MEY biomass target for banana prawns. Instead a banana prawn catch-rate trigger is in place, which targets catch rates associated with profitable levels of fishing rather than stock levels. If in the future it is possible to reliably estimate a stock–recruitment relationship for banana prawns then management should consider a move to a more explicit MEY biomass target.
- The fishery is currently managed according to input (effort) controls. The merits of moving to output controls (in the form of individual transferable quota) in the fishery have been intensively evaluated for several years, however there are difficulties in setting catch quotas for the highly variable white banana prawn fishery. Output controls avoid the issues associated with effort creep, that is, the increased use over time of unregulated inputs by fishers. The result of effort creep is catch beyond the intended level and fishers using a suboptimal combination of inputs. Given the NPF is managed with input controls it is important that managers monitor fishing power over time as an indicator of whether or not effort creep is becoming a problem in the fishery, so that it may be addressed.

1 Introduction

ABARES has surveyed key Commonwealth fisheries regularly since the early 1990s. It uses the data 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 indicators for fishery managers (Box 1). In 2013, to provide a more comprehensive assessment of fishery level performance, ABARES expanded the former Australian fisheries surveys report series to include other economic indicators that draw on data collected from the surveys. These indicators include productivity and terms of trade indexes, entitlement values and management costs. In this report, survey-based results are presented for 2012–13 and 2013–14; preliminary non-survey-based results are presented for 2014–15.

The report distinguishes between the two primary 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 earned and incurred in the survey period. These estimates reflect the average boat's profit and loss statement for all business activities, including where boats have operated in several fisheries.

The key indicator of economic performance presented is net economic returns (NER), which is reported at the fishery level. NER estimates differ from financial performance estimates because they relate only to the surveyed fishery; results exclude revenues and costs attributable to operating in other fisheries and include other economic costs such as the opportunity cost of capital and labour. For definitions of these costs see Appendix A.

Other indicators also provide relevant information on performance. Boat-level financial performance information provides a context for determining trends in the surveyed fishery; for example, positive financial profits at the boat level may reveal how operators continue to operate in a fishery that has experienced negative economic returns. These estimates are relevant to all industry operators and enable them to compare their boat's performance with that of the average boat. Other indicators included are productivity indexes, terms of trade analysis, entitlement values, management costs and progress against maximum economic yield (MEY) targeting in the fishery.

The estimate of NER indicates the economic return to society associated with harvesting the fishery resource. Under the *Fisheries Management Act 1991*, the Australian Fisheries Management Authority (AFMA) is required to pursue the maximisation of NERs to the Australian community through managing Commonwealth fisheries (AFMA 2014). Estimates of NER do not reveal how a fishery has performed relative to maximum potential NER (maximum economic yield) in a given period, but interpreting NER trends together with other economic indicators can assist to assess AFMA's performance against this objective. For example, in general, a period of rising NER that is strongly linked to productivity growth, and not associated with a decline in stock levels, implies that MEY is being approached.

Box 1 Economic indicators in fisheries management

In September 2007 the Australian Government released the Commonwealth Fisheries Harvest Strategy Policy and Guidelines. It aims to maintain key commercial stocks at ecologically sustainable levels and maximise economic returns to the Australian community by targeting maximum economic yield (MEY) (DAFF 2007). To assess the performance of Commonwealth fisheries against their MEY targets, fishery policymakers frequently rely on economic indicators that provide them with information to inform management decisions and monitor performance.

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. Bio-economic models provide indicators that serve this purpose; models have been developed for the Northern Prawn Fishery (Kompas & Che 2004), the Great Australian Bight Trawl Fishery (Kompas et al. 2012) and the Southern and Eastern Scalefish and Shark Fishery (Kompas & Che 2008). Approaches based on management strategy evaluation that include an economic component can also serve this purpose.

Monitoring management performance against the economic objective

This type of economic indicator is retrospective and assesses previous economic performance. It can provide insight into the impact of previous management decisions on economic performance. Several indicators examined in this report fall under this category. This includes the survey-based estimation of NER, productivity indexes, entitlement values, management costs, latency and terms of trade analysis.

The Australian Fisheries Management Authority (AFMA) has the management objective of maximising net economic returns to the Australian community in its role of managing and monitoring commercial Commonwealth fishing. For commercial fishing, NER is intended to show the returns to the community—incorporating all costs of the fishery, including recovered and unrecovered management costs, the value of fuel rebates and the opportunity costs of labour and capital. Positive NER generated after accounting for these costs reflects the resource rent accruing to fishers from accessing the fishery (Wessel 1967, Gooday and Galeano 2003). A positive trend in NER is an indicator that the fishery is moving towards a position of MEY.

Many factors influence the level of NER in a fishery. Many of these are outside the control of fishery managers, for example fuel prices. However, fishery managers have some control over the stock level so an important indicator is whether or not managers have implemented MEY targets and whether stocks are at (or moving towards) that desired level.

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 into outputs over time has changed with changes in the fishery's operating environment. Productivity indexes can inform fishery managers about the effect of management arrangements on average productivity levels in the fishery. Results from both NER and total factor productivity analysis trends should be interpreted in light of information on stock status.

Analysis of fishers' terms of trade indicates what the drivers of changes in profitability or NER may be. It uses an index approach to examine changes in the price of inputs and outputs for a fishery over time and reveals information about the productivity improvements required to offset long-term declines in the terms of trade.

In contrast, entitlement values (or quota values) signal the expected value of future profits to be obtained from the fishery. When compared over time, entitlement values can serve as a general indicator of how well the resources in a fishery have been sustained or managed. If entitlement values are increasing over time, this suggests improvements are being made in the way resources are being managed because operating in the fishery is deemed to have become more profitable.

Measures of management costs, in absolute terms, as a proportion of gross value of fishery production (GVP) and per active boat, also provide information about the cost-effectiveness of fishery management. This is another key objective of the *Fisheries Management Act 1991*.

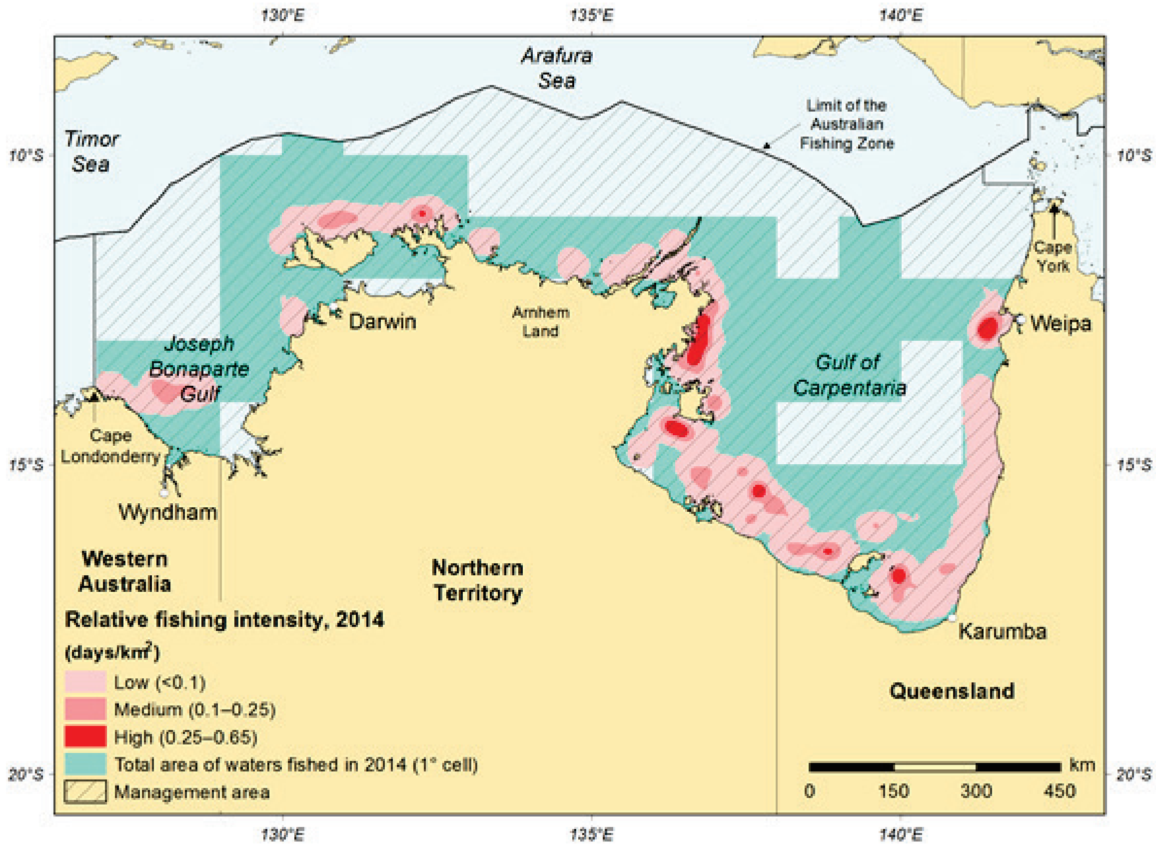
Latency, or the proportion of uncaught quota, can indicate the level of economic incentive for fishers to participate in the fishery. A fishery where operators are not using their right to fish is unlikely to be near its MEY target.

2 Background

Fishery description

The Northern Prawn Fishery is located off the northern coast of Australia, from Cape Londonderry in Western Australia to Cape York Peninsula in Queensland. Most catch is taken from the southern and western Gulf of Carpentaria and along the Arnhem Land coast (Map 1). The fishery uses otter trawl gear to target a range of tropical prawn species.

Map 1 Relative fishing intensity, Northern Prawn Fishery, 2014



Key economic trends

Banana prawns usually contribute most of the catch in the fishery (Figure 1) and, despite the unit value being lower than for tiger prawns, represent the largest component of gross value of production (GVP). Banana prawn catch levels are volatile because of the species' short life cycle and sensitivity to seasonal conditions, particularly rainfall in Northern Australia. To a large extent volatility in the real gross value of production (Figure 2) and net economic returns (Figure 3) has reflected volatility in the banana prawn catch.

The real gross value of production (GVP) in the NPF during 2014–15 declined to $107 million. However, that was still one of the highest value years in the fishery since the early 2000s. The GVP in the fishery fluctuated over the decade to 2014–15, peaking at $117 million (in 2014–15 dollars) in 2013–14 and falling to a low of $69 million in 2011–12 (Figure 2). Trends in NER of the fishery have tended to follow the trend in GVP (Figure 3). This is discussed further in chapter 3. Lower levels of GVP in the 2000s reflect several factors, including a higher Australian dollar exchange rate (Figure 4), which has dampened unit export prices; structural adjustment in the fishery in the late 2000s, which led to boats exiting the fishery; and declines in catch during the early 2000s.

Figure 1 Landed catch of key species, Northern Prawn Fishery, 1996–97 to 2014–15

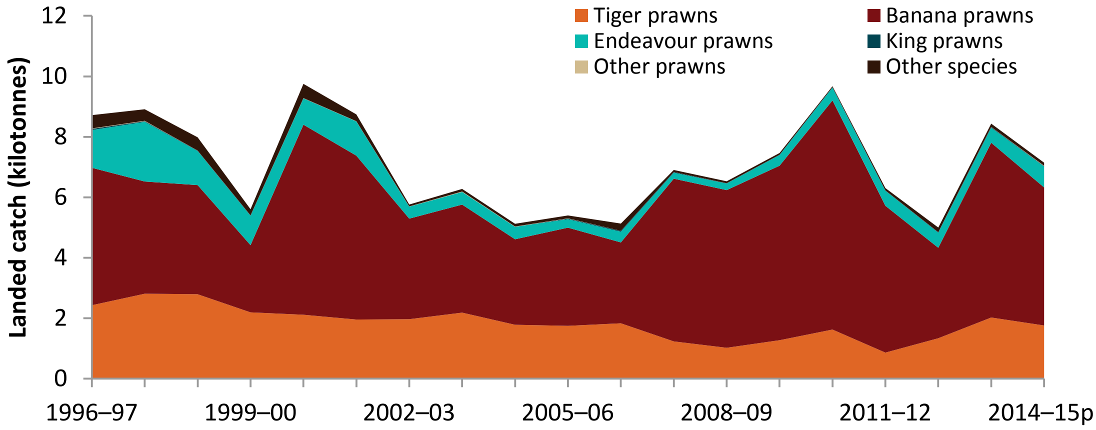


Figure 2 Gross value of production, Northern Prawn Fishery, 1996–97 to 2014–15

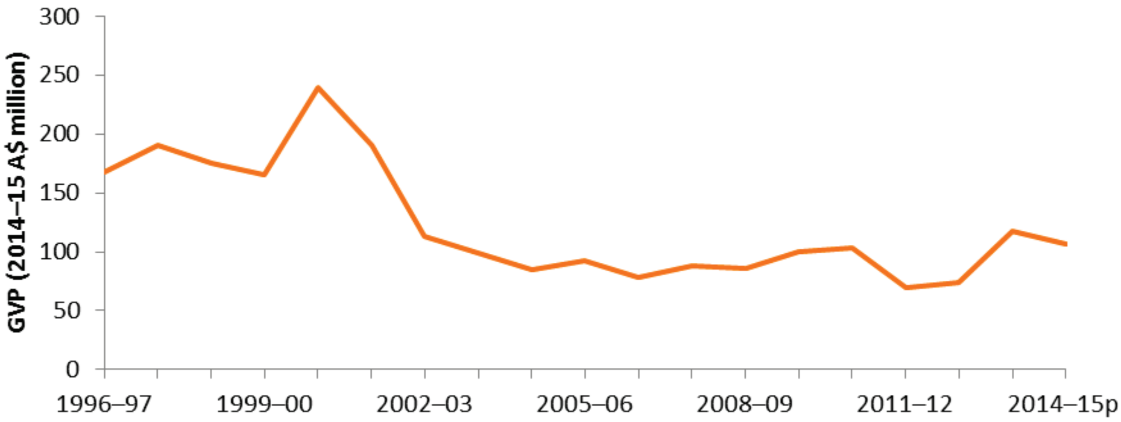
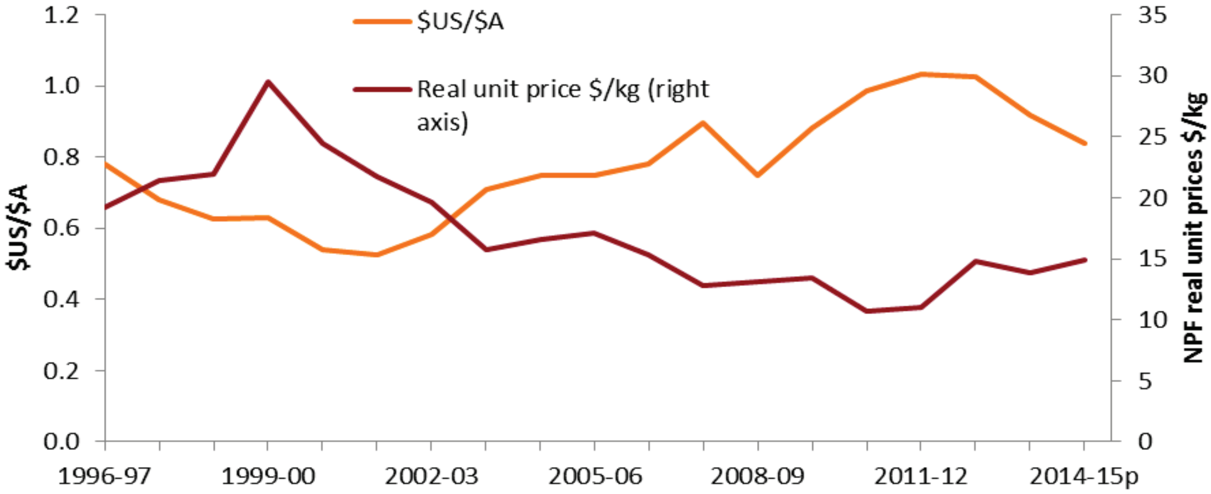


Figure 3 Net economic returns, Northern Prawn Fishery, 1996–97 to 2014–15

p Preliminary.
Note: Time series tables of financial and economic performance data are available at the ABARES website.

Figure 4 Exchange rate and average real unit price, Northern Prawn Fishery, 1996–97 to 2014–15p



p Preliminary.

Management arrangements

The NPF is managed through a series of input controls—including limited entry to the fishery, individual transferable effort units, gear restrictions, bycatch restrictions—and a system of seasonal and spatial closures. The fishery has two seasons: a six to 12 week banana prawn season, which starts in April; and a longer tiger prawn season, which runs from August to November. Two distinct components of the NPF harvest strategy are used to manage the two seasons of the fishery. Both components use input controls (Dichmont et al. 2012) and season length controls that are informed by the real-time monitoring of catch and catch rates. The harvest strategies have been subjected to management strategy evaluation testing (Buckworth et al. 2013; Dichmont et al. 2006), to assess their performance against the objectives of the Commonwealth Fisheries Harvest Strategy policy and guidelines (DAFF 2007).

Major events in the NPF history of management arrangements are shown in Figure 5. These include the structural adjustment package buyback of 2006–07, which resulted in the removal of 43 boat statutory fishing rights and 18 365 gear statutory fishing rights from the industry and a reduction in the number of boats operating in the fishery (Figure 6).

The tiger prawn component of the fishery (tiger and endeavour prawns) has an explicit biomass target of MEY, and a bio-economic model is used to estimate annual fishing effort required to move towards spawning stock sizes at MEY (S_{MEY}) across the stocks. Stock assessments are undertaken every two years. In 2014 an annually updated catch-rate trigger for banana prawns was introduced to the fishery (AFMA 2015). The trigger level is variable and calculated in-season on the basis of prawn prices, catch and costs provided by the Northern Prawn Fishing Industry (NPFI). Restrictions on the trigger prevent large changes in allowable effort from existing levels. Since the 2014 fishing season, the banana prawn catch trigger has been set at between 425 kilograms per boat per day and 575 kilograms per boat per day. Throughout stages of the banana prawn season, catch data are used to determine whether closures should occur according to the trigger.

Catch data are used throughout the banana prawn season to determine whether the fishery will close. The banana prawn resource is variable due to environmental factors, so a strong stock–

recruitment relationship cannot be determined (Larcombe & Green 2015). A stock assessment model has not been developed because annual recruitment has varied widely to date. The catch trigger system is therefore designed to allow fishing to continue only while catch rates are at profitable levels (Buckworth et al. 2015).

Demographic profile of fishers operating in the Northern Prawn Fishery

The average age of skippers in the fishery was 43 years old in 2013–14. On average the skippers had 26 years of fishing experience and had spent 20 years of that in the NPF.

Figure 5 Management changes time line, Northern Prawn Fishery, 1996–97 to 2014–15

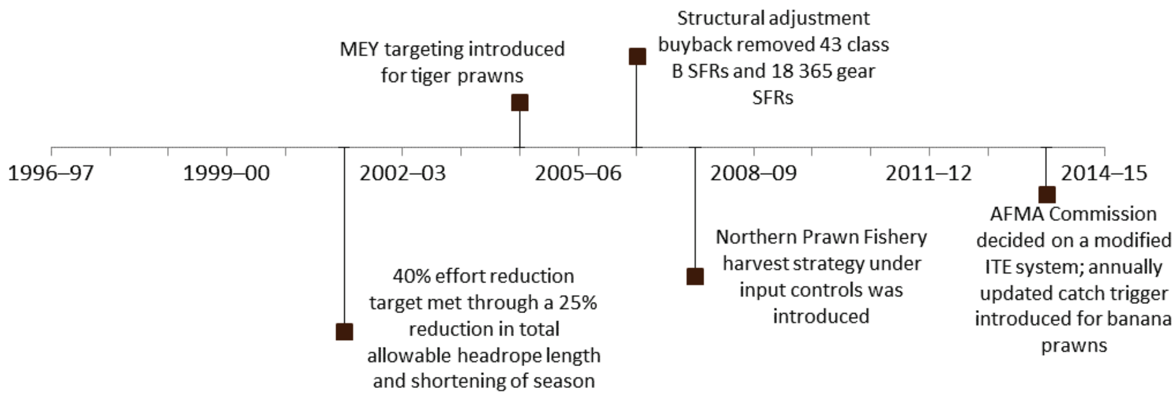
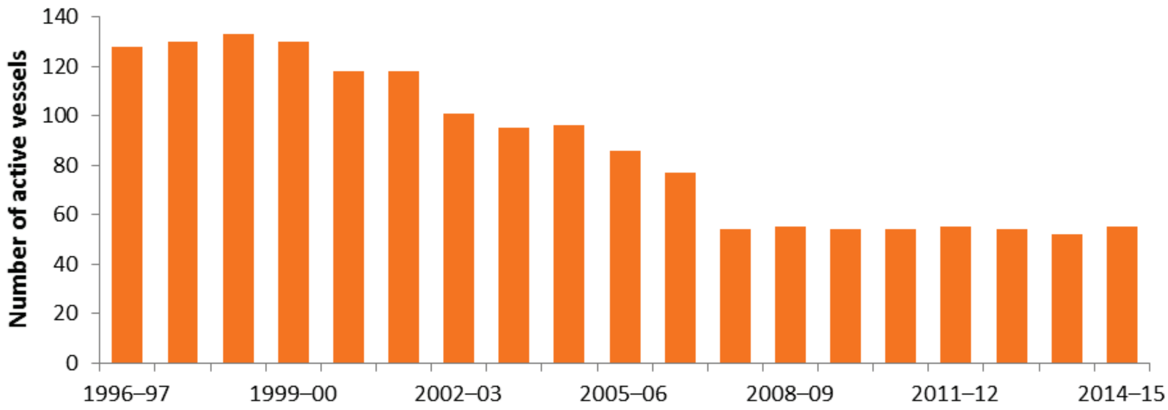


Figure 6 Number of boats operating, Northern Prawn Fishery, 1996–97 to 2014–15



3 Financial and economic performance

Financial performance

The survey population for a given year is the boats that recorded more than one tonne of catch in the Northern Prawn Fishery (NPF). The survey sample represented 57 per cent and 62 per cent of the population in 2012–13 and 2013–14, respectively (Table 3). The survey method is provided in Appendix B.

Only a single boat surveyed also operated in a fishery other than the NPF during the survey period. The receipts and costs associated with operating in fisheries other than the NPF are included in the average boat financial performance results.

Between 2012–13 and 2013–14 financial performance of boats in the NPF improved (Table 3 and Figure 7). Total cash receipts increased by 31 per cent but total cash costs increased by a comparatively smaller amount (27 per cent). As a result, average boat cash income was 80 per cent higher in 2013–14 than in 2012–13.

Fuel costs accounted for the largest share of cash costs (at 40 per cent) in 2012–13. In 2013–14 fuel costs increased by 7 per cent but accounted for a smaller proportion of total cash costs (33 per cent) because crew costs grew faster in that year. Crew costs were the second-largest contributor to cash costs, making up 25 per cent and 29 per cent of total cash costs in 2012–13 and 2013–14, respectively.

Profit at full equity for the average NPF boat increased from 2004–05 to 2010–11 but declined (by 71 per cent) in 2011–12 due to smaller volumes of banana prawns landed. Improved prices for banana prawns from 2012–13 saw profits increase by 160 per cent from $91 867 in 2011–12 to $239 066 in 2012–13. These prices combined with great catch volumes saw profits continue to increase, to $382 939 (up 60 per cent) in 2013–14.

Table 3 Financial performance of boats operating, Northern Prawn Fishery, 2012–13 and 2013–14

boat-level average

Revenue	**Unit**	**2012–13**		**2013–14**	
		Value	**RSE**	**Value**	**RSE**
Fishing receipts	$	1 398 156	(6)	1 862 448	(4)
Non-fishing receipts **a**	$	123 264	(6)	138 074	(4)
Total cash receipts	$	1 521 421	(6)	2 000 522	(4)
Costs					
Administration	$	14 065	(19)	10 016	(11)
Crew costs	$	313 669	(5)	454 528	(5)
Freight and marketing expenses	$	51 107	(6)	81 269	(5)
Fuel	$	495 606	(5)	527 944	(3)
Insurance	$	35 183	(6)	38 444	(4)
Interest paid	$	6 083	(33)	4 283	(22)
Licence fees and levies	$	52 041	(6)	54 231	(6)
Packaging	$	32 488	(7)	47 003	(5)
Repairs and maintenance	$	220 938	(6)	264 991	(5)
Other costs **b**	$	33 432	(108)	105 130	(7)
Total cash costs	$	1 254 613	(5)	1 587 839	(2)
Boat cash income	$	229 175	(20)	412 683	(13)
– less depreciation **c**	$	37 632	(8)	39 769	(7)
Boat business profit	$	229 175	(25)	372 913	(13)
– plus interest leasing rent	$	9 891	(22)	10 025	(12)
Profit at full equity	$	239 066	(24)	382 939	(13)
Capital (excluding quota and licences)	$	1 118 452	(5)	1 203 336	(5)
Capital (including quota and licences)	$	3 884 275	(2)	3 848 803	(3)
Rate of return to boat capital **d**	%	21	na	32	na
Rate of return to full equity **e**	%	6	na	10	na
Population	no.	54	na	52	na
Sample	no.	31	na	32	na

a Includes fuel rebates, charter hire, quota leasing revenue and other non-fishing receipts. **b** Includes quota lease payments. **c** Depreciation adjusted for profit or loss on capital items sold. **d** Excludes value of quota and licences. **e** Includes value of quota and licences. **na** Not available. **RSE** Relative standard error.

Note: Figures in parentheses are relative standard errors (RSEs). An RSE will be higher for estimates closer to zero. A guide to interpreting RSEs is included in Appendix B.

Figure 7 Financial performance, Northern Prawn Fishery, 2000–01 to 2013–14

Note: Error bands are equal to two standard errors, approximating the 95 per cent confidence interval.

Economic performance

Net economic return (NER) of the fishery is estimated to have increased from $5.2 million in 2012–13 to $12.3 million in 2013–14 (Table 4 and Figure 8). The preliminary NER estimate for 2014–15 shows that it will remain similar to 2013–14. The increase in NER from 2012–13 to 2013–14 was primarily driven by faster growth in fishing income (20 per cent) than in fishing costs (13 per cent). The growth in fishing income was driven by increased landings of tiger prawns (up 51 per cent) and banana prawns (up 93 per cent) offsetting slightly lower beach prices for each. In 2014–15 fishing income is forecast to increase by 3 per cent due to improving prices for banana and endeavour prawns, despite reduced levels of catch. Increased trawling hours in the fishery over 2014–15 contributed to increased operating costs, which are estimated to rise by 4 per cent. However, this is partially offset by lower fuel prices over 2014–15.

The level of real NER in the NPF varied considerably over the 15 years to 2014–15. In 2000–01 real NER was estimated at $86 million but fell sharply in the following years to reach a low of -$17 million in 2004–05 (in 2014–15 dollars) as real unit prices, effort and catch declined. Negative NER continued in the fishery until 2006–07. Targeting of MEY in the tiger prawn component of the fishery began in 2004–05. The Securing our Fishing Future structural adjustment programme removed 43 class B statutory fishing rights from the fishery, further reducing active boat numbers from 86 in 2005–06 to 55 in 2007–08. The programme concluded in 2006–07. Real NER in the fishery remained positive from 2007–08 onwards, except in 2011–12 (where both catch and prices fell), peaking at $13 million in 2009–10. This improvement was mainly driven by increasing revenue from higher landings of banana prawns, (Skirtun, Stephan & Mazur 2014), as well as a likely improvement in the fleet's efficiency after structural adjustment.

Table 4 Cash profit and net economic returns, Northern Prawn Fishery, 2012–13 to 2014–15

total fishery 2014–15 $ million

Category	**2012–13**		**2013–14**		**2014–15p**
	Value	RSE	Value	RSE	Value
Receipts					
Fishing income	81.2	(5)	97.8	(4)	100.9
Cash costs					
Operating costs	72.9	(5)	82.6	(3)	85.5
Fishery cash profit	8.3	(40)	15.2	(17)	15.2
Less					
– owner and family labour	0.6	(33)	0.8	(31)	0.8
– opportunity cost of capital	1.5	(8)	1.4	(6)	1.4
– depreciation	2.2	(7)	2.0	(6)	2.1
plus interest, leasing and management fees	3.5	(6)	3.4	(5)	3.7
Net return (excluding management costs)	7.6	(43)	14.3	(17)	14.7
Management costs	2.4	na	2.0	na	2.5
Net return (including management costs)	5.2	na	12.3	na	12.3

p Preliminary non-survey based estimates. For estimation method see Appendix C. **na** Not applicable.
Note: Figures in parentheses are relative standard errors (RSEs). RSEs are not available for 2014–15 results because of estimation method used (Appendix C).

Figure 8 Economic performance, Northern Prawn Fishery 2000–01 to 2014–15

p Preliminary non-survey based estimates. For estimation method see Appendix C.
Note: Error bands are equal to two standard errors, approximating the 95 per cent confidence interval.

4 Other key performance indicators

Total factor productivity

Total factor productivity (TFP) analysis shows trends in fishers' economic productivity. TFP analysis is used to examine the ability of fishers to convert inputs into outputs over time (for index calculation method see Appendix D). TFP analysis can indicate the factors in a fishers' operating environment that affect productivity and assist in evaluating changes in NER over time. These factors may include changes in management settings that regulate fishers' technology choices, changes in market conditions and changes in the mix of outputs produced. Market conditions include variations in input costs, import competition and the value of the Australian dollar. With other factors held constant, an increase in the ratio of outputs to inputs (productivity) will increase NER and a decrease in the ratio will reduce NER. Managers have some influence over productivity through management settings.

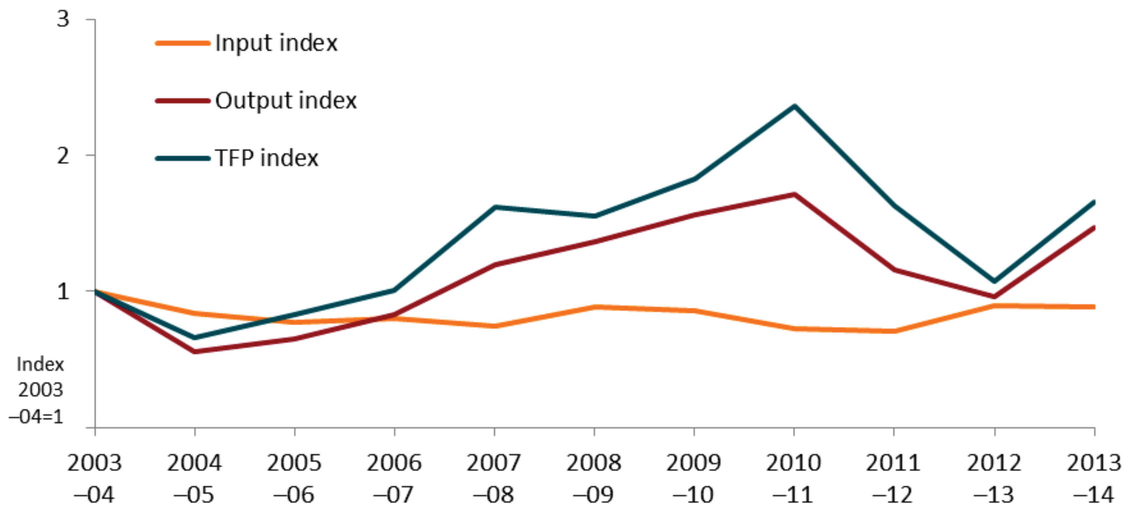
Changes to the fishers' operating environment can be an incentive for them to pursue boat-level productivity improvements. For example, fishers may keep the business financially viable in response to adverse market conditions (such as increasing input costs or competition) by investing in improvements to enhance productivity. Adverse market conditions can also help drive autonomous structural adjustment in the industry. This can include the movement of fishing rights to the most profitable fishers and the exit from the industry of the least efficient or least profitable boats, resulting in a more productive fleet.

TFP in the NPF is driven almost entirely by changes in landed catch. The index rose robustly (by 136 per cent) in the eight years to 2010–11 (Figure 9), especially after structural adjustment and the introduction of the harvest strategy policy in 2007. The input index declined (by 27 per cent) in the same period, while outputs grew by 71 per cent due to increased catches of banana prawns. The improvement in NER in the same time frame can largely be attributed to these higher catches, driven by favourable seasonal conditions.

The TFP index fell significantly between 2010–11 and 2012–13, driven by falls in banana prawn catch over the same period (a decline from 5 755 tonnes to 2 990 tonnes). This led to negative NER in 2011–12, but changes in the terms of trade (see Terms of trade section) supported positive NER in 2012–13. Seasonal conditions improved in 2013–14, leading to improvement in TFP and NER.

There is little variation in input use year to year, despite the substantial variation in output. From 2003–04 to 2007–08, the input index declined, however since that time has remained steady. Landed catch rose post 2007–08 and a level of steady inputs could be expected to support this increased output. Recent management changes, including the introduction of an annually updated catch trigger for banana prawns in 2014, are intended to prevent excessive effort in years where stocks are low. More explicit MEY biomass targets for banana prawns, or the development of methods for forecasting seasonal conditions (if possible), would potentially increase productivity. However, this may also increase management costs, so costs and benefits should be analysed before developing this capacity.

Figure 9 Productivity indexes, Northern Prawn Fishery, 2003–04 to 2013–14

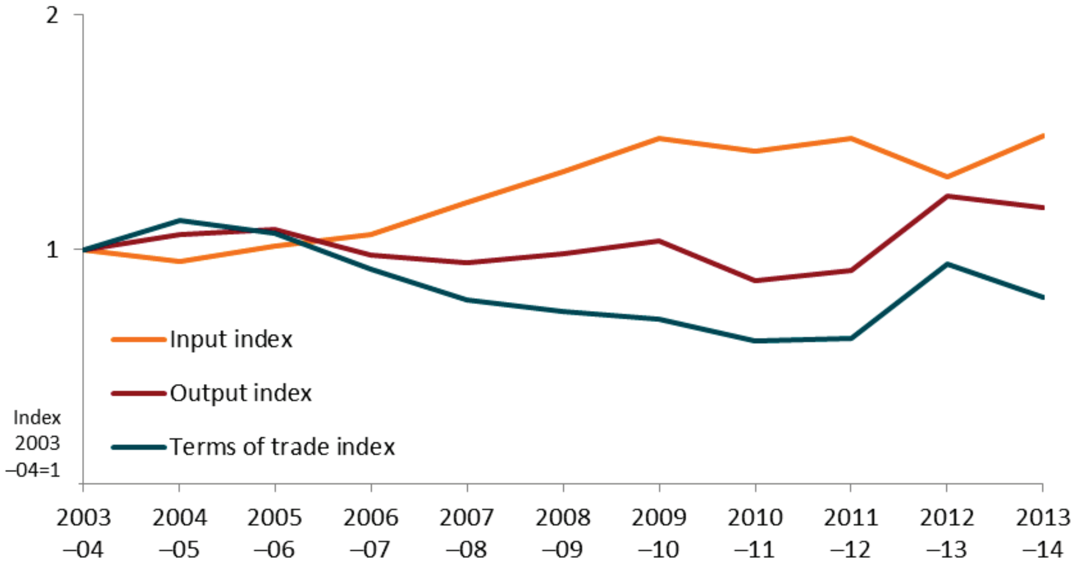


Terms of trade

The terms of trade trends show the change in input prices relative to output prices and can indicate whether improvements in NER are driven by productivity increases or favourable terms of trade conditions (for index calculation method see Appendix D). With other factors held constant, an increase in prices received relative to prices paid will increase NER and a decrease will reduce NER. Managers have little or no control over the terms of trade. However, significant changes in the terms of trade can have implications for estimation of MEY (maximum economic yield). For example, the banana prawn trigger is based on costs of fuel, capital depreciation, gear, variable repairs and maintenance, marketing, crew share of catch revenue and beach price data (Dichmont et al. 2014).

Changes in the terms of trade in the NPF are driven mainly by prices for fuel and banana prawns. From 2003–04 to 2011–12 the terms of trade index largely followed a declining trend, falling 38 per cent over the period (Figure 10). However, robust growth in TFP allowed increases in NER over this period. The decline in the terms of trade index in this period is largely attributable to increased fuel prices (especially to 2009) and to a lesser extent low prices for banana prawns caused by a high Australian dollar. In 2012–13 a 42 per cent increase in the terms of trade index, caused largely by decreases in labour and repair costs and a recovery in banana prawn prices, allowed NER to recover despite further declines in productivity. Higher fuel prices and lower banana prawn prices drove a 14 per cent reduction in the terms of trade index in 2013–14. However, this was offset by a recovery in TFP. Overall the terms of trade index was still 22 per cent below what it was in 2003–04, highlighting the importance of productivity growth in driving increases in NER.

Figure 10 Terms of trade, Northern Prawn Fishery, 2003–04 to 2013–14



Management costs

Management costs are incurred so the fishery can operate. Managers directly control the level of management costs. Fishery management costs remained between $1.6 million and $3.4 million (in 2014–15 dollars) from 1996–97 to 2014–15 (Figure 11). Decreases and increases in management costs contributed slightly to NER but this was outweighed by stronger effects of productivity growth and terms of trade.

Management costs per active boat (Figure 12) increased most significantly between 2005–06 and 2007–08, from $28 066 to $49 557, as the number of boats in the fishery declined as a result of structural adjustment. The number of boats in the industry remained steady from 2007–08 and management costs per boat were high relative to the late 1990s and early 2000s.

Management costs as a proportion of GVP declined steadily from 2006–07, when they accounted for just over 5 per cent of GVP. The proportion in the 1990s had been as low as 1 per cent. However, this had increased as a result of lower GVP and increased total management costs. From 2006–07 the proportion settled in a range of around 2 per cent to 3 per cent as total management costs declined and stabilised, and higher levels of GVP were recorded. The NPF has a lower ratio of management costs to GVP than most Commonwealth fisheries. This can be partly attributed to the lower costs of input based controls (Department of Agriculture and Water Resources 2016).

Management costs can vary year to year depending on the management cycle of the fishery—for example, on whether new assessments or research have been undertaken. Management costs may also be increased through implementation of mechanisms to improve productivity and therefore NER (such as estimating MEY biomass targets or introducing new methods of forecasting seasonal conditions). With other factors held constant, an increase in management costs reduces NER and a decrease increases NER—at least in the short term. In the longer term, however, extra expenditure on management could increase NER if that expenditure results in better management of the fishery.

Figure 11 Total management costs, Northern Prawn Fishery, 1996–97 to 2014–15

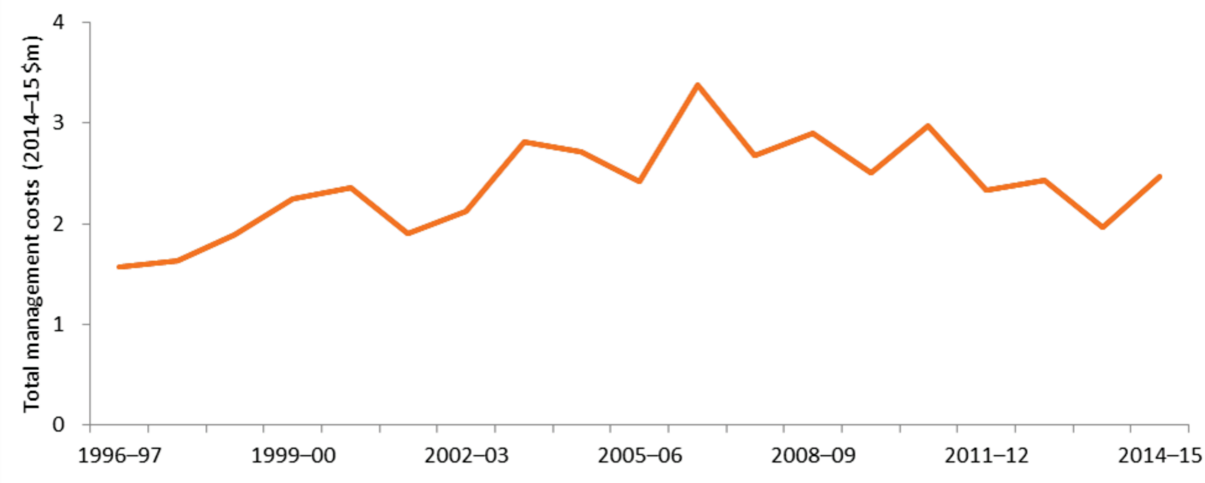
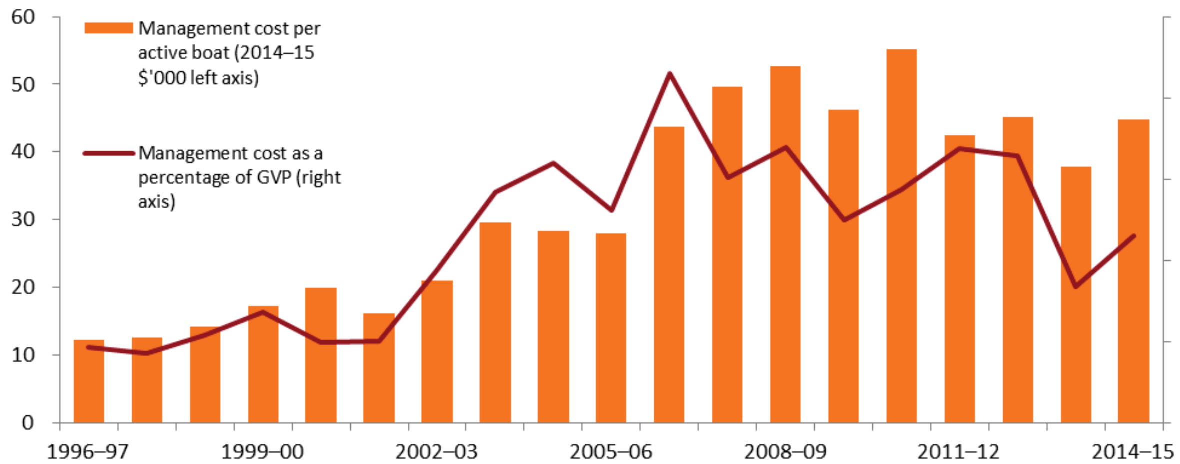


Figure 12 Average management cost per active boat and as a share of gross value of production, Northern Prawn Fishery, 1996–97 to 2014–15



Entitlement values

Under the Northern Prawn Fishery Management Plan 1995, fishers must have two types of statutory fishing rights (SFRs) to operate in the NPF: class B SFR (or boat SFR) and gear SFR. A class B SFR permits commercial use of a trawl boat in the fishery, and the gear SFR entitles fishers to use a prawn trawl net with a certain head rope and footrope length. Entitlement values are estimated from valuations that fishers operating in the NPF place on the two types of SFR. These valuations cannot be measured directly because of confidentiality in trading prices. Therefore, values estimated by fishers are usually subjective and may differ from operator to operator. ABARES started collecting estimated individual gear and boat SFR entitlement values in the 2011–12 NPF survey (Table 5). Values of gear SFRs remain relatively steady across the years, however the value of B SFRs increased since 2011–12. A longer time series of entitlement values will provide more information about fisher's expected profitability or confidence in the fishery.

Table 5 Average entitlement values, Northern Prawn Fishery, 2011–12 to 2013–14

Average value	Unit	2011–12	2012–13	2013–14
Sale price of individual gear units	$	3 758	3 773	3 742
Gear units held per boat	no.	714	685	685
Sale price of class B SFR units	$	185 185	264 545	264 545

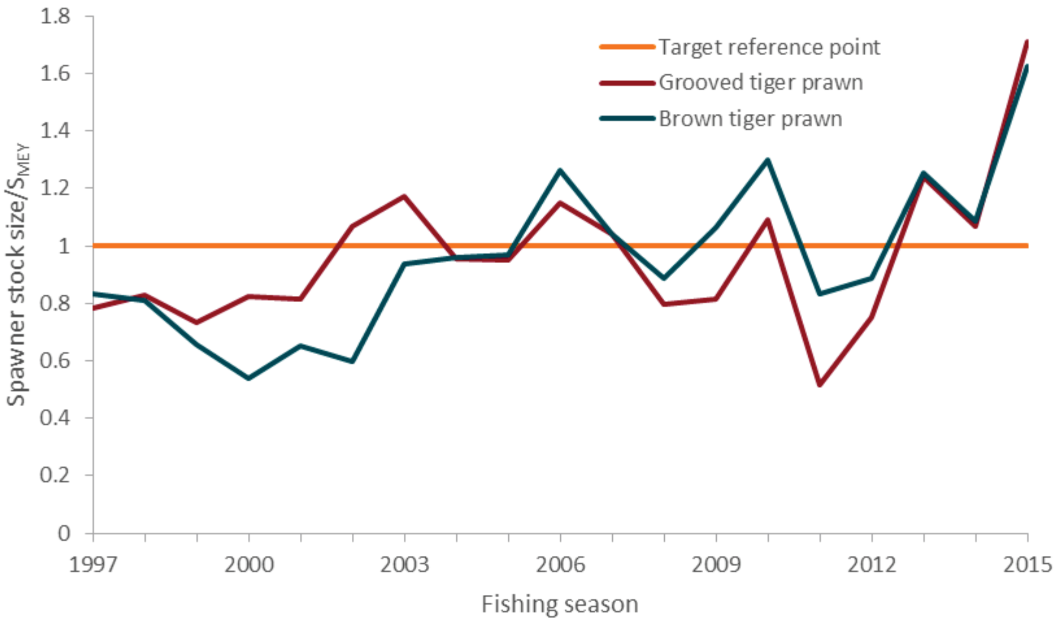
Maximum economic yield targets

Many factors influence the level of NER in a fishery. Many of these are outside the control of fishery managers, for example fuel prices. Fishery managers do, however have some control over the stock level. Therefore, two important indicators are whether or not managers have implemented MEY targets consistent with the Commonwealth Fisheries Harvest Strategy Policy and whether stocks are at (or moving towards) the desired level. Given the dynamic nature of fisheries it is extremely unlikely that stocks will always be exactly at their desired level—some variation around targets should be deemed acceptable.

The tiger prawn fishery has explicit MEY targets (three species level biomass MEY (B_{MEY}) targets for brown and grooved tiger prawns, and blue endeavour prawns). A bio-economic model is used to estimate annual fishing effort required to move towards spawning stock sizes at MEY (S_{MEY}) across the stocks. Endeavour prawns are included in the model as an economic bycatch—that is, effort is not directed at the species but catches provide revenue and attract costs depending on the amount caught. An MEY target is also set for the red-legged banana prawn catch taken in the Joseph Bonaparte Gulf, which makes up a relatively small component of the total banana prawn catch in the NPF. A bio-economic model has not been developed for the Joseph Bonaparte Gulf fishery, so the MEY target for the red-legged banana prawns is the Commonwealth Harvest Strategy Policy and Guidelines proxy for B_{MEY} (1.2 of the estimated maximum sustainable yield, B_{MSY}) (Buckworth et al. 2015).

Targeting of S_{MEY} in the tiger prawn fishery began during 2004. The most recent assessment (Buckworth 2016), shows both brown tiger and grooved tiger are now significantly above S_{MEY} in the base-case modelling scenario. From 2005, and particularly from 2011, spawner stock size for both species of tiger prawn fluctuated above and below the target S_{MEY} reference point.

Figure 13 Spawner stock size as a proportion of S_{MEY} for grooved and brown tiger prawns, Northern Prawn Fishery, 1997 to 2015



Source: Buckworth 2016

5 Performance against management objectives

Since 2004-05 both productivity and NER have improved. While many other factors influence these indicators, there have been many changes to the management arrangements for the fishery that are expected to have brought the fishery closer towards meeting the management objective of maximising returns to the Australian community.

One significant change was the adoption of an explicit MEY target biomass in 2005 for the tiger prawn component of the fishery. A bio-economic model is used to estimate annual fishing effort required to move towards spawning stock sizes at MEY (S_{MEY}) across the stocks. Since around 2005 tiger prawn stocks have fluctuated around this target level. The white banana prawn resource is highly variable and it has not been possible to develop a robust stock–recruitment relationship and in turn estimate the biomass associated with MEY. Instead, an annually updated catch-rate trigger, based on profitable in-season effort levels was introduced in 2014. It is too early to determine whether this change has affected fishery-level NER.

Prior to the adoption of MEY for the tiger prawn component of the fishery management adopted an effort reduction target of 40 per cent in 2001–02 by reducing allowable head rope length and shortening the fishing season. The structural adjustment package (completed in 2006–07) further removed excess capital by removing boat and gear statutory fishing rights (SFRs) from the industry and the fishery harvest strategy introduced in 2007–08 has enabled clear management responses to changes affecting the fishery.

Overall the fishery appears to be moving towards meeting the management objective of maximising returns to the Australian community. However, in the absence of output controls for the fishery, continued monitoring of fishing power will be important to determine whether or not effort creep, that is, the increased use over time of unregulated inputs by fishers, is occurring. If effort creep is detected it may be possible to adjust the level of effort to effectively limit the catch to desirable levels by adjusting allowable inputs. However, the problem with this approach is that it risks forcing fishers to use suboptimal combinations of inputs, leading to lower productivity and profitability. Hence careful consideration by management would be required to address the issue if it arises.

The adoption of a more explicit MEY biomass target for white banana prawns, or methods of forecasting seasonal conditions (if possible), would potentially increase productivity. However, such gains would need to be balanced against increased management costs resulting from the additional research required to establish an explicit target.

It is important to continue to monitor the economic performance of the fishery and identify reasons for change in NER trends, especially during implementation of key management changes. Fishery managers can use the estimation of NER for the fishery together with the other economic indicators presented in this report to better apply management controls to achieve economic objectives.

Appendix A: Survey definitions

This appendix provides definitions of key financial performance variables, net economic return (NER) and the ABARES method of calculating NER. Use of NER as an indicator of economic performance is briefly discussed.

Financial performance

ABARES used these definitions of key variables in the analysis of boat-level financial performance.

Total cash receipts represent returns from sale of fish, from non-fishing activities (including charter operations and rebated fuel excise) 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 most operators, this information is readily available from their own records. However, different operators record their fishing income in different ways. Where fish are sold through a cooperative, some operators may only record payments received from the cooperative. These payments may be net of commissions, freight and other purchases made through the cooperative.

In other cases, the cooperative or agency pays the crew directly for the catch; the owner's financial records might include only the revenues received after the crew's share has been deducted.

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

Total cash costs include payments made for both permanent and casual hired labour and for materials and services—including payments on capital items subject to leasing, rent, interest, licence fees, fuel (inclusive of excise) 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 to process fisheries products.

On many boats, the costs of labour are reflected in 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, payments made can be low or even nil. This 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 are 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. ABARES uses this method of calculating depreciation in other industry surveys.

Boat business profit is boat cash income less depreciation and accounting for any profit or loss on the sale of capital.

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

Capital is the value placed on the assets employed by the business that owns 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. However, 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).

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

Net economic returns

Net economic returns are the long-run profits from a fishery after all costs have been met. 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 returns for a given period can be defined as:

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

Where:

NR	=	net returns
R	=	total cash receipts attributable to sale of fish from the fishery
CC	=	total cash costs attributable to the fishery, including recovered management costs
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') because these costs at the fishery level represent revenues that have been redistributed to external investors in the fishery.

Survey-based estimation of net economic returns

Fish sale receipts

Fish sale receipts are usually taken from fishers' financial accounts. Where a fisher operates in more than one fishery, they are asked to indicate the proportion of total fish sales 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 price received for fish at its first landing point (beach price).

Income received from leasing out quota and licences is 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 generates. Therefore, including leasing revenue would result in double counting. Rebated fuel excise, along with any other non-fishing income, is also excluded (see Box A1).

Operating costs

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 (inclusive of excise), 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. Owners and their families are often involved in operating a boat, either as skippers and crew or onshore as accountants and shore managers. Some will be paid market value for their labour, some will not be paid at all and others will be paid very high amounts (for example, 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' for explanation.

Box A1 Fuel excise and net economic return

Fuel in Australia attracts an excise of approximately 38 cents a litre. However, fishers are entitled to a rebate for the full amount of excise they have paid. This is because the stated purpose of such excise is to pay for the construction and maintenance of roads, which fishers do not use.

When ABARES surveys fishers, it records fuel expenditure and excise rebates as separate items. Fuel costs are the wholesale price of fuel, including excise. Rebates of excise are recorded under non-fishing income. If a fisher's account includes only fuel expenditure net of excise that has been rebated, then it is altered to account for excise and a balancing item is added to other income.

For financial performance both these items appear. The total expenditure on fuel, including excise, is incorporated into total cash costs. The excise that is rebated is incorporated into non-fishing income.

For net economic return (NER), only the total expenditure of fuel (including excise) is included. NER does not incorporate non-fishing income, whether in the form of rebated excise, charter revenue or anything else.

NER is intended to show the economic returns to the community, incorporating all costs of the fishery. Rebated excise is a cost borne by the government as forgone revenue—revenue it would have received if the rebate policy was not in place.

The effect of excluding rebated excise on NER varies by fishery. Trawl fisheries are more dependent on fuel. Their NER is lowered by the inclusion of excise in costs (but not in income) to a larger extent than line or gillnet fisheries, which use less fuel.

In the Northern Prawn Fishery before 2010–11 some operators provided fuel costs net of the excise rebate, and this was not recognised or corrected at the time. As such these years have had NER overstated by an uncertain amount. Variables that include fuel in the years 2010–11 and 2011–12 have been adjusted to the updated methodology, and the survey years 2012–13 and 2013–14 presented in this report have been calculated under the correct methodology.

Capital costs

To calculate capital costs, an estimate of the value of capital is needed. 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.

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 had been invested elsewhere. 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 annual depreciation of boats based on the capital inventory list collected during the surveys and predetermined depreciation rates for each capital item type.

Management costs

Management costs are those costs associated with harvesting fish in the fishery. They are incurred to ensure the fishery continues operating. Management costs comprise two components: recovered management costs and non-recovered management costs. Recovered management costs (recMC) are recovered from fishers and appear in the accounts of fishers as payments of management fees or levies. Non-recovered management costs are 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. This estimate of recovered management costs is based only on a sample of the fishery, so it may not be consistent with the actual value of management costs recovered from the entire fishery. AFMA provides 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). Total management costs (totM) supplied by the Australian Fisheries Management Authority (AFMA) are then used to estimate net economic returns.

Net economic returns and economic performance

Fishery managers, policymakers and decision-makers use information on fisheries' performance to achieve the objective of maximising net economic return (NER) from fish stocks—an objective commonly referred to as MEY. Effort, catch and stock levels in a fishery operating at MEY are optimised so that the difference between 'discounted' revenues and costs, and therefore profits, is maximised. Revenues and costs are discounted when the value of a dollar earned today relative to the value of a dollar earned in the future is accounted for. Estimates of NER do not reveal how a fishery is performing relative to its maximum potential, but positive trends in NER together with other indicators can suggest that the MEY objective is closer to being met.

Appendix B: Survey methods

Collecting economic survey data

ABARES has undertaken economic surveys of selected Commonwealth fisheries since the early 1980s and regularly for particular fisheries since 1992. ABARES surveys major Commonwealth fisheries every two years or more frequently if the fishery is undergoing major changes and monitoring is particularly important. The surveys aim to develop a consistent time series of economic information for each fishery. This information, in conjunction with scientific assessments of each fishery, is vital for assessing fisheries' economic performance.

Survey information is made publicly available so the performance of fisheries and the effect of management policies can be assessed independently.

Sample design

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

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

In practice, this sample is seldom fully realised. Non-response is relatively high across fishery surveys, reflecting the difficulty of contacting some operators and the reluctance of others to participate. This may bias the results—for example, if profitability of respondents and non-respondents differs significantly. ABARES uses sample design and weighting systems that reduce the non-response effect, but survey information must be interpreted carefully.

Between February and August in the year that the fishery is surveyed, an ABARES officer visits the owner of each boat selected in the sample. The officer interviews the boat owner to obtain physical and financial details of the fishing business for the survey years. The skipper of the boat may also be interviewed. ABARES subsequently obtains further information from accountants, selling agents and marketing organisations on the signed authority of survey respondents.

ABARES reconciles the information obtained from various sources to produce the most accurate description possible of the financial characteristics of each sample boat in the survey.

Sample weighting

Estimates of financial and economic performance presented in this report were calculated based on weighted survey data of sampled boats. ABARES calculates a weight for each sampled boat based on how representative that boat is of the population. This report uses a regression model of gross value of production on catch for each boat in the fleet population to estimate sample weights. The individual estimated weights for sampled boats in the fleet population are then standardised to meet two conditions: the sum of sample weights is equal to the population and the weighted sum of the sample catch approximates the total catch of the fleet.

That is,

$\Sigma w_i = P$ and $\Sigma w_i x_i = X$

where:

w_i is the weight for the i^{th} boat

P is the number of boats in the fleet population

x_i is the catch for the i^{th} boat

X is the total catch for the fleet population.

Reliability of estimates

ABARES generally surveys a relatively small number of boats out of the total number in a particular fishery. Estimates derived from these boats are likely to be different from those that would have been obtained if information had been collected from a census of all boats. The number of boats in the sample, the variability of boats in the population, the design of the survey and the estimation procedures used influence how closely the survey results represent the population.

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

Use of relative standard errors

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

The chance that the census value (the value that would have been obtained if all boats in the target population had been surveyed) is within one standard error of the survey estimate is roughly two in three. The chance that the census value is within two standard errors of the survey estimates is roughly 19 in 20. Therefore, in this example, the chance that the census value is between $94 000 and $106 000 is two in three and the chance that the census value is between $88 000 and $112 000 is 19 in 20.

Comparing estimates

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

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

$$\sqrt{(0.06 * \$100\,000)^2 + (0.06 * \$125\,000)^2} = \$9\,605$$

The relative standard error of the difference is:

$$(\$9\,605/\$25\,000) * 100 = 38\%$$

The population of a fishery may change from one year to the next. If these population changes are substantial, differences in estimates may be caused more by changes in population than by changes in the variables themselves.

Non-sampling errors

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

ABARES survey staff are generally experienced and undergo rigorous pre-survey training to minimise non-sampling errors. However, when drawing inferences from estimates derived from sample surveys, users should be aware that both sampling and non-sampling errors occur.

Appendix C: Non-survey based estimation of net economic returns

ABARES has developed a non-survey based method of estimating net economic returns for financial years where survey data are not yet available. It allows more timely reporting of net economic return estimates to better inform industry and government decision-making. This method is intended to complement data collection and publication of results normally undertaken through the fisheries surveys.

Method

The method used to calculate non-survey based estimates of net economic returns for a non-survey year (a year for which no survey data are available) uses regression estimates for key components of net economic returns. Regression approaches use the most relevant variables for each fishery, given unique fishing methods and other characteristics. In all cases, each component is estimated based on an assumed sample of the population and a set of corresponding assumed weights. This assumed sample represents those boats that are expected to be sampled in the next survey. Key variables correlating with cash receipts and operating costs were used in the estimates. Results show that the same variables were used to estimate both cash receipts and operating costs. See Table C1 and Table C2 for full regression results.

Reliability of estimates

Estimates from the regression analysis are subject to uncertainties. First, relationships estimated between surveyed values of receipts and costs and other more readily available data rely on the historical sample of boats surveyed. Boats that are consistently not included in a sample may be under-represented in the estimates.

Historical relationships will not necessarily hold each new survey year. Fishery operating conditions may change, resulting in changes in receipts and costs not foreseeable using this method.

Estimates should be used as an indication of the likely direction and magnitude of changes in net economic returns. For each receipt and cost category, the coefficient of determination (R2) indicates the extent to which the explanatory variables can explain variation in the dependent variable. Lower coefficients of determination suggest a greater level of uncertainty surrounding the estimates.

Cash receipts

Cash receipts are the primary component of net economic return calculations because all other costs are deducted from cash receipts. Cash receipts represent income from fishing operations in the surveyed fishery. For non-survey years, real gross value of production (GVP) is a good indicator for cash receipts because it is closely related to fishing income. Real GVP was estimated using average price data and catch data. Variables included are real GVP and a boat factor (Table C1).

Table C1 Regression model for average cash receipts, Northern Prawn Fishery, 2014–15

Variable	Estimate	Standard error	t value	Pr(>|t|)
(Intercept)	4.32E+05	9.39E+04	4.594	9.22E-06
GVP	7.10E-01	4.37E-02	16.247	< 2e-16
Boat dummy	5.66E+05	1.60E+05	3.538	0.000538
R^2	0.67	–	–	–
Prob(F Stat)	151.20	–	–	–

GVP Gross value of product.

Operating costs

Key drivers of operating costs in any fishery are fuel and labour. Therefore, accurately calculating operating costs for a non-survey year requires selecting variables that influence these two components. For labour, share payment systems imply a close relationship between fishery GVP and labour costs. Hours trawled is an indicator of fuel costs in the NPF. Preliminary estimates of operating cost were based on real GVP, hours trawled and year factors (Table C2).

Table C2 Regression model for average operating costs, Northern Prawn Fishery, 2014–15

Variable	Estimate	Standard error	t value	Pr(>|t|)
(Intercept)	1.87E+05	1.14E+05	1.645	0.10216
GVP	5.19E-01	3.53E-02	14.701	2.00E-16
Hours Trawled	2.15E+02	7.55E+01	2.848	0.00502
2012 dummy	1.68E+05	5.36E+04	3.134	0.00208
R^2	0.69	–	–	–
Prob (F Stat)	110.1	–	–	–

GVP Gross value of product.

Cash receipts and operating cost regressions were tested for model fit including residual normality, heteroskedasticity, multicollinearity and autocorrelation. Initially a larger set of variables was considered for all regressions but only variables that were statistically significant or improved model fit were kept in the final regression.

Interest, leasing and management fees

Interest and leasing fees represent a redistribution of profits to investors in the fishery. As such, they are not costs at the fishery level. They are estimated based on historical ratios and values.

Management fees for the purpose of the estimation are taken from the Australian Fisheries Management Authority (AFMA) (recovered and non-recovered) and include all costs for managing the fishery, not just those recovered from industry. Management fees are also estimated based on historical ratios and values.

Opportunity cost of capital and depreciation

Capital values, the opportunity cost of capital and depreciation expenses were estimated based on an implied capital rate of 7 per cent, assuming a depreciation rate equal to that in the most recent survey year and a capital upgrade rate (an assumed capital investment amount).

Management costs

Total management costs (recovered and non-recovered) for 2014–15 were based on AFMA's budgeted estimates.

Appendix D: Productivity and terms of trade methodology

Productivity measurement

Productivity is defined as the quantity of output produced with a given quantity of inputs. For example, a partial measure of productivity for a fishing boat would be kilos of a particular species of fish produced per hook used. A more complete measure of productivity would be the total catch per unit of all inputs used. This approach is preferred as a measure of productivity and is usually referred to as total factor productivity.

Various methods have been developed to quantitatively assess total factor productivity trends for industries and individual enterprises within industries (see Coelli et al. 2005 for discussion). A frequent approach to measuring productivity trends uses index number theory. In this report a Fisher quantity index is used to measure total factor productivity trends for key Commonwealth fisheries (Box D1Box D1 Fisher index). Fishery-level input, output and total factor productivity indexes were estimated for each of the Commonwealth fisheries analysed and for each year where data were available. The Fisher quantity index is well suited to handling the range of inputs and outputs recorded in ABARES fisheries economic survey data. For example, ABARES fisheries economic survey data contain many zero entries, which are well handled by the Fisher quantity index approach.

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 Laspeyres and Paasche index approaches. 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.

Terms of trade measurement

ABARES constructs a terms of trade analysis using the same process as is used for total factor productivity, except it constructs Fisher price indexes rather than Fisher quantity indexes. The price index accounts for the prices of labour and fuel—the major cost components—and the costs of repairing and maintaining capital.

Data

Data used for this total factor productivity analysis are sourced from the ABARES Australian fisheries surveys dataset. The surveys dataset comprises physical and financial survey data for a sample of boats operating in key Commonwealth fisheries. The inputs incorporated in the input indexes for each fishery are labour, fuel, repairs and capital. The output indexes for each fishery are described in the results section for each individual fishery. Population estimates are derived using sample boat data from this database and are calculated for each fishery analysed in this report. A weight is calculated for each boat in the sample, to represent its importance in the total unobserved population. The weight is generally based on the boat's catch representation. Weighted boat-level information is used to derive fishery level input and output indexes.

Box D1 Fisher index

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

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

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 or 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^{P}_{0t} is defined as:

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

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^{F}_{0t} is the geometric mean of Laspeyres and Paasche indexes, defined as:

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

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

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

The terms of trade index is constructed by the same means as the total factor productivity index, except with every instance of Q replaced by P and every instance of P replaced by Q.

Inputs and outputs

Total inputs can be split into three 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. For the TFP analysis capital inputs are estimated by annual days fished, weighted by the estimated daily opportunity cost of using boat capital.

For the terms of trade analysis the price is the cost of maintaining and repairing boat capital for the year.

Fuel costs—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 covers crew and onshore administration costs but does not cover the cost of onshore labour involved in processing fisheries products. Owner/partner, family and unpaid labour is included.

Outputs are the species caught by boats in each fishery. In the NPF, these species are banana prawns, tiger prawns, endeavour prawns, king prawns, other prawns and other non-prawn species. The price variable is the price received for the species caught and the quantity variable is the number of kilograms of each species caught by individual boats.

References

AFMA 2014, 'Objectives, functions and powers', Australian Fisheries Management Authority Canberra, available at afma.gov.au/about/objectives-functions-powers.

——2015, *Northern Prawn Fishery: directions and closures 2015*, Australian Fisheries Management Authority, Canberra, available at www.afma.gov.au/wp-content/uploads/2014/08/NPF-Directions-and-Closures-2015.pdf (4.17 MB).

Buckworth, RC 2016, *Northern Prawn Fishery assessment 2015–18*, milestone report to the Australian Fisheries Management Authority, AFMA research project 20135/0811, CSIRO, Brisbane.

Buckworth, RC, Deng, RA, Plagányi, EE, Punt, A, Upston, J, Pascoe, S, Miller, M, Hutton, T, Lawrence, E, & Venables W 2015, *Northern Prawn Fishery RAG assessments 2013–15*, final report to the Australian Fisheries Management Authority, research project 2013/0005, CSIRO, Brisbane, June.

Buckworth, RC, Ellis, N, Zhou, S, Pascoe, S, Deng, RA, Hill, FG & O'Brien, M 2013, *Comparison of TAC and current management for the White Banana Prawn Fishery of the Northern Prawn Fishery*, final report for project RR2012/0812 to the Australian Fisheries Management Authority, CSIRO, Canberra.

Coelli, TJ, Rao, DSP, O'Donnell, CJ & Battese, GE 2005, *An introduction to efficiency and productivity analysis*, 2nd edn, Springer, Berlin.

DAFF 2007, *Commonwealth Fisheries Harvest Strategy: policy and guidelines*, Australian Government Department of Agriculture, Fisheries and Forestry, Canberra.

Department of Agriculture and Water Resources 2016, 'ABARES input to the Department of Agriculture and Water Resources submission', *Productivity Commission—inquiry into regulation of the Australian marine fisheries and aquaculture sectors: submission from the Australian Government Department of Agriculture and Water Resources*, Canberra, April, available at pc.gov.au/inquiries/current/fisheries-aquaculture/submissions.

Dichmont, CM, Deng, A, Punt, A, Venables, W & Haddon, M 2006, 'Management strategies for short lived species: the case of Australia's Northern Prawn Fishery: 2—choosing appropriate management strategies using input controls', *Fisheries Research*, vol. 82, pp. 221–34.

Dichmont, CM, Jarrett, A, Hill, F & Brown, M 2012, *Harvest strategy for the Northern Prawn Fishery under input controls*, Australian Fisheries Management Authority and CSIRO, Canberra.

Dichmont, CM, Jarrett, A, Hill, F, and Brown, M 2014, *Harvest strategy for the Northern Prawn Fishery under input controls*, Australian Fisheries Management Authority and CSIRO, Canberra.

Gooday, P and Galeano, D 2003, *Fisheries management: a framework for assessing economic performance*, ABARE eReport 03.7, prepared for the Fisheries Resources Research Fund, Canberra, April, available at pandora.nla.gov.au/tep/32832.

Kompas, T & Che, TN 2004, *A bioeconomic model of the Australian Northern Prawn Fishery: management options under uncertainty*, Australian Bureau of Agricultural and Resource Economics, Canberra.

—— 2008, *Maximum economic yield in the Southern and Eastern Scalefish and Shark Fishery*, , Australian Bureau of Agricultural and Resource Economics, Canberra, February.

Kompas, T, Che, N, Chu, L, Klaer, N 2012, *Transition to MEY goals for the Great Australian Bight Trawl Fishery*, Australian Fisheries Management Authority, Canberra.

Larcombe, J & Green, R 2015 'Northern Prawn Fishery', in H Patterson, L Georgeson, I Stobutzki & R Curtotti (eds), *Fishery status reports 2015*, Australian Bureau of Agricultural and Resource Economics and Sciences, Canberra, October.

Skirtun, M, Stephan, M & Mazur, K 2014, *Economic indicators report for Commonwealth fisheries: financial and economic performance of the Northern Prawn Fishery 2013*, Australian Bureau of Agricultural and Resource Economics and Sciences, Canberra. Available at agriculture.gov.au/abares/publications.

Wessel, W.H. 1967, 'A note on economic rent', *American Economic Review*, vol. 57, no. 4, pp. 873–85.