Chapter 5
Northern Prawn Fishery

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FIGURE 5.1 Relative fishing intensity in the Northern Prawn Fishery, 2017

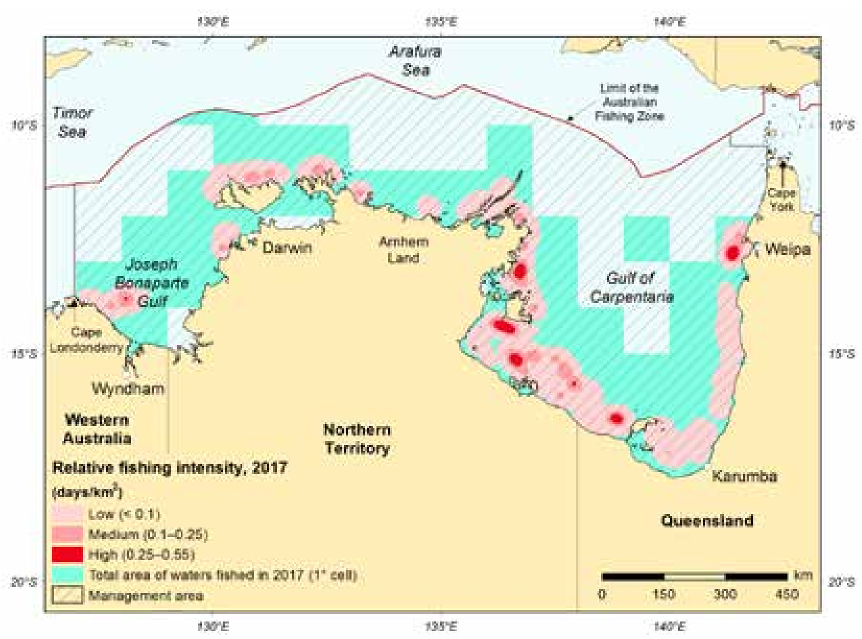


TABLE 5.1 Status of the Northern Prawn Fishery

Status	2016		2017		Comments
Biological status	**Fishing mortality**	**Biomass**	**Fishing mortality**	**Biomass**	
Red-legged banana prawn (*Fenneropenaeus indicus*)					Low recruitment and declining catch rate; management is unable to constrain fishing effort. Spawning biomass is above the LRP of $0.5B_{MSY}$.
White banana prawn (*Fenneropenaeus merguiensis*)					High natural recruitment variability is primarily linked to environmental factors. Harvest strategy aims to provide for adequate escapement and for fishing effort to approximate E_{MEY}.
Brown tiger prawn (*Penaeus esculentus*)					Effort is below E_{MSY}, and catch is below MSY. Spawner stock size is above the LRP of $0.5S_{MSY}$.
Grooved tiger prawn (*Penaeus semisulcatus*)					Effort is near E_{MSY}, and catch is below MSY. Spawner stock size is above the LRP of $0.5S_{MSY}$.
Blue endeavour prawn (*Metapenaeus endeavouri*)					Catch is below the estimate of MSY. Spawner stock biomass is above the LRP of $0.5S_{MSY}$.
Red endeavour prawn (*Metapenaeus ensis*)					No current stock assessment.
Economic status	NER reached a high of $31.4 million in 2015–16, supported by a strong increase in tiger prawn catch, marking a fourth consecutive annual increase in NER. The strong performance in 2015–16 is forecast to be repeated in 2016–17, following a strong increase in banana prawn catch in 2016–17.				

Notes: $\mathbf{B_{MSY}}$ Biomass at MSY. $\mathbf{E_{MEY}}$ Effort that achieves maximum economic yield. $\mathbf{E_{MSY}}$ Effort that achieves MSY. **LRP** Limit reference point. **MSY** Maximum sustainable yield. **NER** Net economic returns. $\mathbf{S_{MSY}}$ Spawner stock size at MSY.

Fishing mortality	Not subject to overfishing	Subject to overfishing	Uncertain
Biomass	Not overfished	Overfished	Uncertain

5.1 Description of the fishery

Area fished

The Northern Prawn Fishery (NPF) extends from Joseph Bonaparte Gulf across the top end to the Gulf of Carpentaria. White banana prawn (*Fenneropenaeus merguiensis*) is mainly caught during the day on the eastern side of the Gulf of Carpentaria, whereas red-legged banana prawn (*F. indicus*) is mainly caught in Joseph Bonaparte Gulf (Figure 5.1). White banana prawns form dense aggregations ('boils') that can be located using spotter planes, which direct the trawlers to the aggregations. The highest catches are taken offshore from mangrove forests, which are the juvenile nursery areas. Tiger prawns (*Penaeus esculentus* and *P. semisulcatus*) are primarily taken at night (daytime trawling has been prohibited in some areas during the tiger prawn season). Most catches come from the southern and western Gulf of Carpentaria, and along the Arnhem Land coast. Tiger prawn fishing grounds may be close to those of banana prawns, but the highest catches come from areas near coastal seagrass beds, the nursery habitat for tiger prawns. Endeavour prawns (*Metapenaeus endeavouri* and *M. ensis*) are mainly a byproduct, caught when fishing for tiger prawns.

Fishing methods and key species

The NPF uses otter trawl gear to target a range of tropical prawn species. White banana prawn and two species of tiger prawn (brown and grooved) account for around 80 per cent of the landed catch. Byproduct species include endeavour prawns, scampi (*Metanephrops* spp.), bugs (*Thenus* spp.) and saucer scallops (*Amusium* spp.). In recent years, many vessels have transitioned from using twin gear to mostly using a quad rig comprising four trawl nets—a configuration that is more efficient.

Management methods

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 6–12-week predominantly banana prawn season starting in April, and a longer tiger prawn season, running from August to November. Two distinct components of the NPF harvest strategy are used to manage the two seasons of the fishery, because only a few tiger prawns are landed in the first season. Both operate within the management system of input controls (Dichmont et al. 2012), and use 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 (DAFF 2007).

The merits of two NPF management systems—input (effort) and output (total allowable catch)—have been intensively evaluated for several years. In late 2013, mainly because of the difficulty in setting catch quotas for the highly variable white banana prawn fishery, the Australian Fisheries Management Authority (AFMA) determined that the fishery would continue to be managed through input restrictions and units of individual transferable effort. The harvest strategies will be reviewed every five years.

Fishing effort

The NPF developed rapidly in the 1970s, with effort peaking in 1981 at more than 40,000 fishing days and more than 250 vessels. During the next three decades, fishing effort and participation were reduced to the current levels of around 8,000 days of effort and 52 vessels. This restructuring of the fishery was achieved through a series of structural adjustment and buyback programs, and the implementation of management measures to unitise and control fishing effort. Total catches also fell during this period, but by a much smaller percentage, illustrating the clear transformation of the fleet to more efficient vessels.

Catch

Total NPF catch in 2017 was 6,602 t, comprising 6,512 t of prawns and 90 t of byproduct species (predominantly squid, bugs and scampi). Annual catches tend to be quite variable from year to year because of natural variability in the banana prawn component of the fishery.

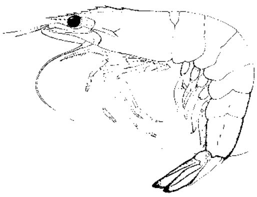
TABLE 5.2 Main features and statistics for the NPF

Fishery statistics a	2016 fishing season		2017 fishing season b	
Stock	**Catch (t)**	**Real value (2015–16)**	**Catch (t)**	**Real value (2016–17)**
Banana prawns	2,877	$41.0 million	5,045	$62.1 million
Tiger prawns	2,139	$74.9 million	1,080	$46.1 million
Endeavour prawns	373	$7.1 million	380	$4.4 million
Other catch (prawns)	30	$0.7 million	7	$0.5 million
Other catch (not prawns)	375	$2.4 million	90	$5.0 million
Total fishery	**5,794**	**$126.1 million**	**6,602**	**$118.1 million**
Fishery-level statistics				
Effort	Banana season: 2,302 shots Tiger season: 5,579 shots		Banana season: 2,304 shots Tiger season: 5,219 shots	
Fishing permits	52		52	
Active vessels	52		52	
Observer coverage	Crew member observers: 893 days (11.3%) Scientific observers: 103 days (1.3%)		Crew member observers: 1,169 days (15.8%) Scientific observers: 152 days (2.1%)	
Fishing methods	Otter trawl			
Primary landing ports	Darwin (Northern Territory); Cairns and Karumba (Queensland). Much of the catch is offloaded onto motherships at sea.			
Management methods	Input controls: individual tradeable gear units, limited entry, gear restrictions			
Primary markets	Domestic: fresh and frozen International: Japan—frozen			
Management plan	Northern Prawn Fishery Management Plan 1995 (amended 2012)			

a Fishery statistics are provided by fishing season, unless otherwise indicated. Real-value statistics are by financial year. Therefore, changes in catch may appear to be inconsistent with changes in value. **b** Fishing season predominantly for banana prawns: 1 April – 15 June; predominantly for tiger prawns: 1 August – 30 November.

5.2 Biological status

Red-legged banana prawn (*Fenneropenaeus indicus*)



Line drawing: FAO

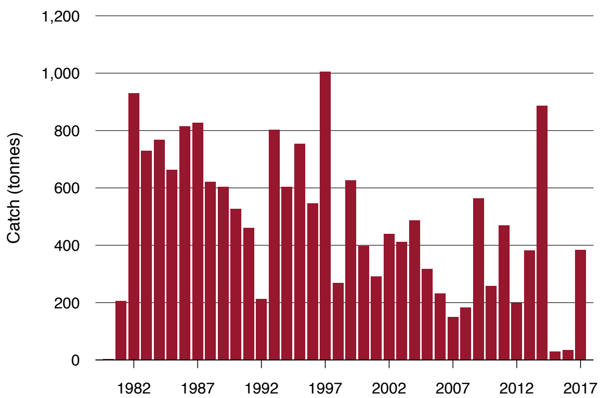
Stock structure

Red-legged banana prawn is widely distributed across the Indo-West Pacific Ocean. In Joseph Bonaparte Gulf, a single stock is assumed for assessment purposes.

Catch history

Most of the NPF red-legged banana prawn catch is taken in Joseph Bonaparte Gulf, with a smaller proportion taken in the wider NPF to the east. A small amount of catch is also taken in regions adjacent to the NPF. The catch of red-legged banana prawn is usually a relatively small component of the total banana prawn catch in the NPF. Catch was 886 t in 2014, which was the highest since 1997, but dropped substantially to less than 50 t in both 2015 and 2016, before increasing to 383 t in 2017 (Figure 5.2).

FIGURE 5.2 Red-legged banana prawn catch, 1980–2017



Source: CSIRO

Stock assessment

Estimates of maximum sustainable yield (MSY) and its corresponding spawning biomass level (B_{MSY}) are difficult to derive for short-lived, variable stocks such as red-legged banana prawns. Typically, yield is determined largely by the strength of annual recruitment, and therefore annual sustainable yields can be expected to fluctuate widely around deterministic estimates (Plagányi et al. 2009).

The most recent accepted assessment for the stock was undertaken in 2018 (Plagányi et al. 2018). Catch rates (the index of abundance) for 2015 and 2016 were excluded from the base-case model because of very low and poorly representative levels of fishing effort in these years. Data from 2017 (when effort increased again) are included. The assessment model uses quarterly time steps of catch and effort. As a result, outputs from the model depend on the distribution of effort across fishing seasons, and sensitivity to this has been explored in the past.

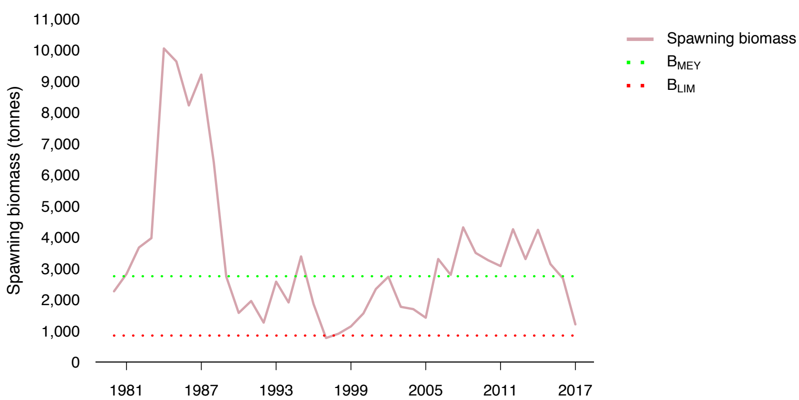
The updated assessment showed that spawning biomass declined substantially between 2014 and 2017 to below B_{MEY} (biomass at maximum economic yield) (Figure 5.3), before increasing slightly at the end of 2017 to a level below the B_{MEY} target but above the biomass limit ($0.5B_{MSY}$). The assessment concluded that the biomass declines were likely due to the combined impact of fishing and major environmental anomalies (discussed further below). Model-estimated recruitment was not available for 2015 or 2016, but was very low in 2017.

The Northern Prawn Resource Assessment Group (NPRAG) analysed the anomalously low Joseph Bonaparte Gulf catches of red-legged banana prawn in 2015 and 2016 (Plagányi et al. 2017). One hypothesis is that recruitment or availability was lower in 2015 and 2016 as a result of anomalous environmental factors. Preliminary work by Plagányi et al. (2017) found an association between catch rates and different combinations of El Niño conditions (Southern Oscillation Index) and seasonal rainfall. The model predicted low catch rates in both 2015 and 2016 as a result of El Niño conditions and below-median rainfall.

Another hypothesis for the low Joseph Bonaparte Gulf catch and effort is the potential existence of more favourable fishing opportunities in other parts of the multispecies NPF, particularly for tiger prawn in the Gulf of Carpentaria, thereby leading to low fishing effort in Joseph Bonaparte Gulf. Predictably, preliminary analysis found that, when revenue per unit effort is lower in Joseph Bonaparte Gulf than in the Gulf of Carpentaria, operators will preferentially fish the Gulf of Carpentaria (AFMA 2017a). This would contribute to low effort in Joseph Bonaparte Gulf during years of unfavourable environmental conditions, as explained above. Thus, low Joseph Bonaparte Gulf effort and catches may result from a combination of poor environmental conditions in Joseph Bonaparte Gulf and better fishing opportunities elsewhere.

The red-legged banana prawn harvest strategy uses a proxy limit reference point (LRP) based on $0.5B_{MSY}$, which correlates with a catch of 390 kg per vessel per day. The LRP is deemed to have been breached if catch rates fall below 390 kg per vessel per day in August, September and October, and there has been at least 100 days fishing over the full fishing year. In this scenario, the fishery will be closed for the first three-month 'season' the following year. The fishery will also be closed if catch rates fall below 390 kg per vessel per day in each of two consecutive years and there has been at least 100 days fishing activity in the fishery in each year. In this scenario, the fishery would be closed for all of the following year. Under the harvest strategy, when effort is below 100 days, the fishery remains open in both seasons of the following year, regardless of whether catch rates fall below 390 kg per vessel per day in August, September and October. There is no precedent for two consecutive years with such low fishing effort. Consequently, in late 2016, NPRAG recommended reviewing the decision rules for red-legged banana prawn under the NPF harvest strategy (AFMA 2016), including potentially modifying the season opening for years with fewer than 100 fishing days and considering environmental conditions (AFMA 2017b). The harvest strategy requires two full years of very low catch rates (effectively two overfished years) together with sustained fishing effort before there is a management response of closing the fishery for a whole year. The current harvest strategy has no mechanism to adjust catch or effort levels to achieve the B_{MEY} target, or to progressively reduce catch or effort as biomass approaches the limit. The harvest strategy is under review.

FIGURE 5.3 Estimated spawning biomass for red-legged banana prawn, 1980–2017



Notes: B_{LIM} Biomass limit reference. B_{MEY} Biomass at maximum economic yield.
Source: Plagányi et al. 2017

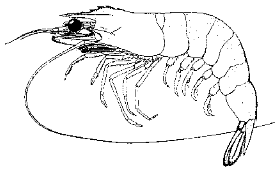
Stock status determination

The most recent assessment (2018) estimated that biomass had declined substantially between 2014 and 2017. Although this decline is a cause of concern, the estimated biomass remained above the LRP in 2017. The biomass status of the red-legged banana prawn stock is therefore **not overfished**.

The harvest strategy for red-legged banana prawn is poorly suited to the current low-biomass level of the stock, providing no direction for a progressive reduction in effort as the stock approaches the LRP. Although management has advocated to the fishing industry that effort be constrained in the red-legged banana prawn fishery in 2018, any such response would be voluntary. A lack of control over fishing effort, together with the recent variability in annual recruitment and declines in catch rates, makes it difficult to determine whether current fishing mortality will result in the biomass falling below the LRP. As a result, red-legged banana prawn is classified as **uncertain** with regard to the level of fishing mortality.

Prawn trawling gear
AFMA

White banana prawn (*Fenneropenaeus merguiensis*)



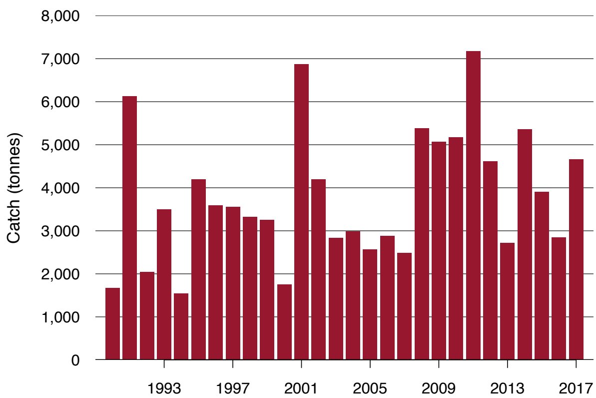
Line drawing: FAO

The stock structure of white banana prawn is uncertain. In the NPF, there is some evidence of substock structuring associated with significant river mangrove areas, but, in the absence of clear information on biological stock structure, status is reported at the fishery level.

Catch history

Catch in 2017 was 4,662 t (Figure 5.4). Seasonal catch is highly variable and is associated with rainfall in some areas (Venables et al. 2011).

FIGURE 5.4 White banana prawn catch, 1990–2017



Source: CSIRO

Stock assessment

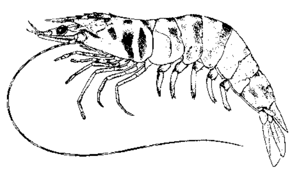
The environmentally driven variability of this resource means that a robust stock–recruitment relationship cannot be determined. Because annual yields are largely dependent on annual recruitment and recruitment is closely associated with seasonal rainfall, it has not been possible to develop a stock assessment for white banana prawn. To explore the possibility of implementing total allowable catches for the fishery, CSIRO modelled the relationship between historical catch and rainfall, to investigate whether it is possible to predict the next year's catch based on the most recent wet-season rainfall. Unfortunately, large uncertainties remain because in some years the model cannot accurately predict catch levels, particularly in recent years (Buckworth et al. 2013).

Harvest rates for white banana prawn in the fishery are understood to have been high (>90 per cent of available biomass) in some years (Buckworth et al. 2013), but banana prawns are believed to be resilient to fishing pressure, and recruitment appears to be more closely associated with seasonal rainfall than with fishing mortality. The harvest strategy for the stock includes, inter alia, an objective to allow sufficient escapement to ensure an adequate spawning biomass and to allow subsequent recruitment. This is achieved by closing the season when catch rates fall below a trigger level, associated with permitting sufficient prawns to escape to ensure an adequate spawning biomass for subsequent recruitment (based on an analysis of historical data; Dichmont et al. 2012). In addition, the trigger is designed to achieve an economic outcome by closing fishing when catch rates fall to an uneconomical level.

Stock status determination

With the adoption of the harvest strategy, a relatively small fleet and a lack of evidence of recruitment overfishing, this stock is classified as **not subject to overfishing** and **not overfished**.

Brown tiger prawn (*Penaeus esculentus*)



Line drawing: FAO

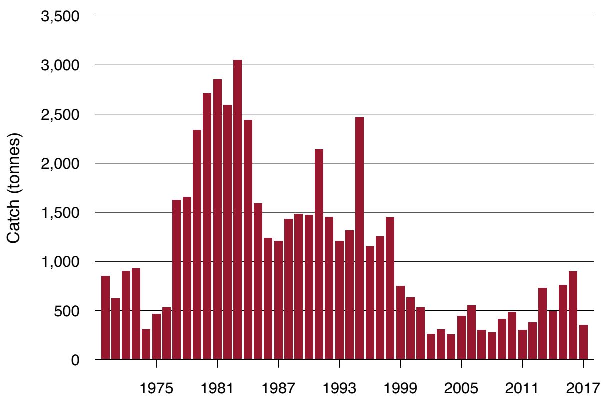
Stock structure

Brown tiger prawn appears to be endemic to tropical and subtropical Australian waters. Some genetic evidence indicates that there are separate stocks on the east and west coasts (Ward et al. 2006). However, the biological stock structure in the NPF is uncertain, and the population in the Gulf of Carpentaria is assumed to be a single stock for management purposes.

Catch history

Brown tiger prawns are caught primarily in the first season in the southern and western Gulf of Carpentaria, but also in waters westward towards Joseph Bonaparte Gulf. Catch of brown tiger prawn in 2017 was 356 t (Figure 5.5).

FIGURE 5.5 Brown tiger prawn catch, 1970–2017



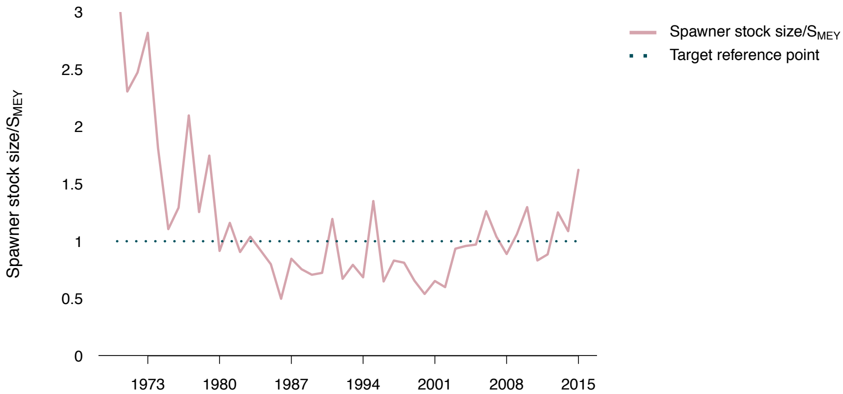
Source: CSIRO

Stock assessment

The stock assessment for the tiger prawn fishery uses a multispecies (covering brown and grooved tiger prawns, and blue endeavour prawn), weekly, sex- and size-structured population model, combined with a Bayesian hierarchical production model for blue endeavour prawn. It is integrated with an economic model that calculates MEY. Full assessments are made every two years, with data collected continuously in intervening years. For the most recent assessment (Buckworth et al. 2016), the base-case estimate of the size of the brown tiger prawn spawner stock at the end of 2015 as a percentage of spawner stock size at MSY (S_{2015}/S_{MSY}) was 175 per cent (range across sensitivities 151–178 per cent). The base-case estimate of the size of the spawner stock as a percentage of stock size at MEY (S_{2015}/S_{MEY}) was 162 per cent (Figure 5.6) (range across sensitivities 136–162 per cent).

For the most recent assessment, the estimate of effort in 2015 as a percentage of effort at MSY (E_{2015}/E_{MSY}) was 36 per cent. The estimate of effort in 2015 as a percentage of effort at MEY (E_{2015}/E_{MEY}) was 35 per cent. Catch of brown tiger prawn has remained substantially below the base-case estimate of MSY (1,186 t) since the assessment and was 356 t in 2017 (Figure 5.5).

FIGURE 5.6 Spawner stock size as a proportion of S_{MEY} for brown tiger prawn, 1970–2015



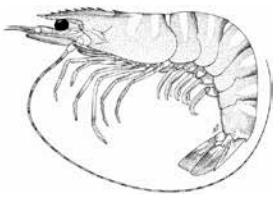
Note: S_{MEY} Spawner stock size at maximum economic yield.
Source: Buckworth et al. 2016

Stock status determination

Effort in recent years has been less than the level associated with MSY and MEY, catches in recent years have been less than MSY, and the estimate of biomass (five-year moving average) for the base-case model (and all other sensitivities) was above the limit reference point ($0.5S_{MSY}$) in the most recent assessment. Brown tiger prawn in the NPF is therefore classified as **not subject to overfishing** and **not overfished**.

Unloading prawns
AFMA

Grooved tiger prawn (*Penaeus semisulcatus*)



Line drawing: Karina Hansen

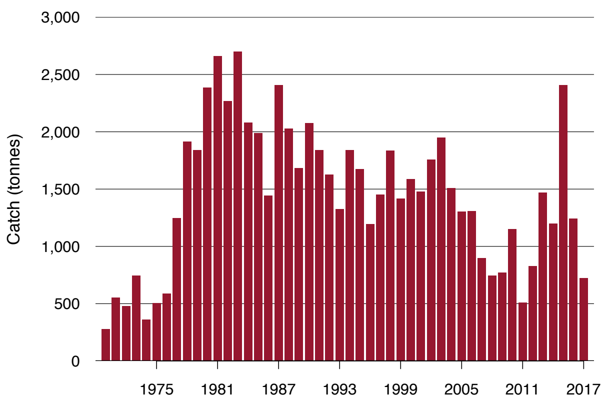
Stock structure

Grooved tiger prawn ranges across northern Australian waters, the Indo-West Pacific Ocean and the Mediterranean Sea. The biological stock structure is uncertain, but the population near the Gulf of Carpentaria is assumed to be a single stock for management purposes.

Catch history

Annual catches of grooved tiger prawn, which is primarily taken in the second season, peaked in the early 1980s at more than 2,500 t and have shown a declining trend since then (Figure 5.7). Catch of grooved tiger prawn in 2017 was 724 t, which was a substantial decrease from the 2015 catch of 2,405 t—the highest catch of this species since the 1980s.

FIGURE 5.7 Grooved tiger prawn catch, 1970–2017



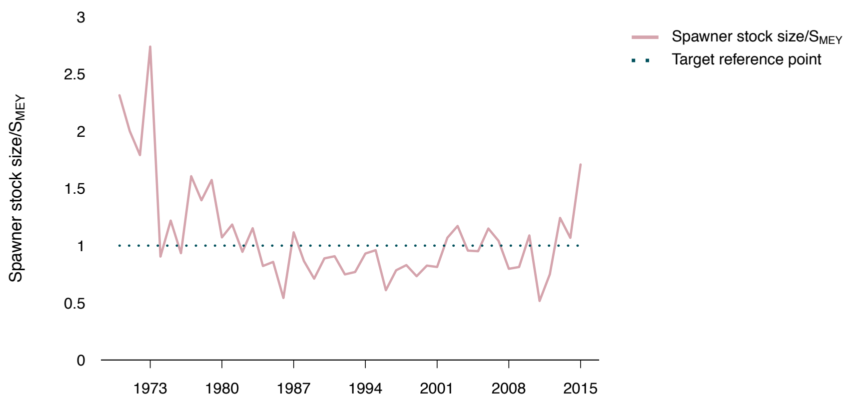
Source: CSIRO

Stock assessment

For the most recent assessment (Buckworth et al. 2016), the base-case estimate of the size of the grooved tiger prawn spawner stock at the end of 2015 as a percentage of spawner stock size at MSY (S_{2015}/S_{MSY}) was 185 per cent (range across sensitivities 177–235 per cent). The base-case estimate of the size of the spawner stock as a percentage of spawner stock size at MEY (S_{2015}/S_{MEY}) was 171 per cent (Figure 5.8) (range across sensitivities 152–171 per cent).

For the most recent assessment, the estimate of effort in 2015 as a percentage of effort at MSY (E_{2015}/E_{MSY}) was 83 per cent. The estimate of effort in 2015 as a percentage of effort at MEY (E_{2015}/E_{MEY}) was 101 per cent. The catch of grooved tiger prawn in 2017 was 724 t (Figure 5.7), which was below the base-case estimate of long-term average MSY (1,605 t).

FIGURE 5.8 Spawner stock size as a proportion of S_{MEY} for grooved tiger prawn, 1970–2015

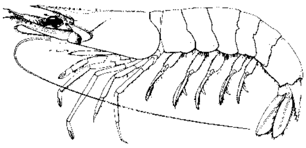


Note: S_{MEY} Spawner stock size at maximum economic yield.
Source: Buckworth et al. 2016

Stock status determination

Although the 2015 catch of grooved tiger prawn exceeded the estimated long-term MSY, the catch was supported by higher than average levels of recruitment in 2015. Additionally, catches in 2016 and 2017 were below MSY. The spawning stock biomass for the base-case model (and all other sensitivities) is estimated to be well above the biomass levels associated with MSY and MEY, and therefore also above the LRP ($0.5S_{MSY}$). Grooved tiger prawn in the NPF is therefore classified as **not subject to overfishing** and **not overfished**.

Blue endeavour prawn (*Metapenaeus endeavouri*)



Line drawing: FAO

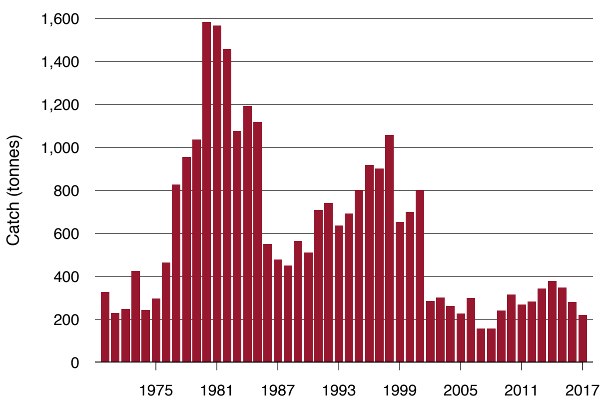
Stock structure

Blue endeavour prawn ranges across northern Australia waters and parts of the Indo-West Pacific Ocean. The biological stock structure is uncertain, but the population in the NPF is assumed to be a single stock for management purposes.

Catch history

Annual catches of blue endeavour prawn peaked in the early 1980s at more than 1,500 t, and again in the late 1990s at 1,000 t (Figure 5.9). Since 2002, annual catches have averaged around 300 t, and the 2017 catch was 219 t. Blue endeavour prawn is a byproduct of the tiger prawn fishery, and so catches are linked to changes in effort targeting tiger prawns.

FIGURE 5.9 Blue endeavour prawn catch, 1970–2017



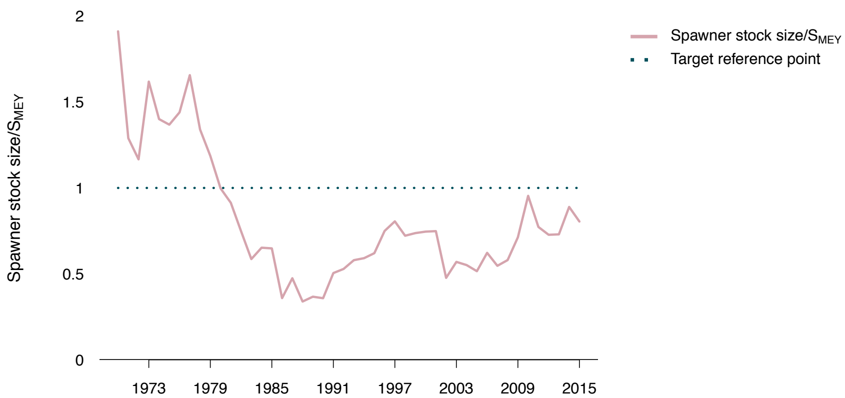
Source: CSIRO

Stock assessment

Stock size is assessed using a Bayesian hierarchical biomass dynamic model, within the same overall bio-economic model system used for the two tiger prawn species (Buckworth et al. 2016).

The base-case estimate of the size of the blue endeavour prawn spawner stock at the end of 2015 as a percentage of stock size at MSY (S_{2015}/S_{MSY}) was 77 per cent (range across sensitivities 77–97 per cent). The base-case estimate of the size of the spawner stock as a percentage of stock size at MEY (S_{2015}/S_{MEY}) was 80 per cent (Figure 5.10) (range across sensitivities 72–84 per cent). The catch of blue endeavour prawn was 219 t in 2017 (Figure 5.9), substantially less than the base-case estimate of MSY (813 t).

FIGURE 5.10 Spawner stock size as a proportion of S_{MEY} for blue endeavour prawn, 1970–2015

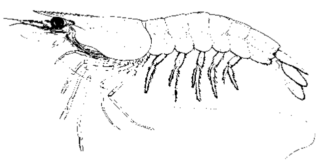


Note: S_{MEY} Spawner stock size at maximum economic yield.
Source: Buckworth et al. 2016

Stock status determination

The catch in 2017 was well below the estimated MSY, and the estimate of spawner stock size (five-year moving average) for the base case was above the LRP ($0.5S_{MSY}$). Blue endeavour prawn in the NPF is therefore classified as **not subject to overfishing** and **not overfished**.

Red endeavour prawn (*Metapenaeus ensis*)



Line drawing: FAO

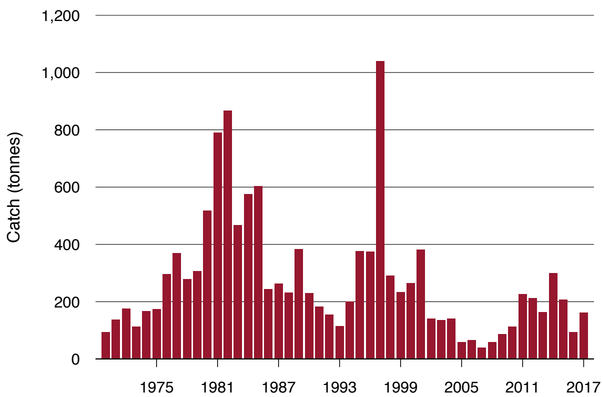
Stock structure

Red endeavour prawn ranges across northern Australian waters and parts of the Indo-West Pacific Ocean. The biological stock structure is uncertain, but the population within the NPF is assumed to be a single stock for management purposes.

Catch history

Annual catches of red endeavour prawn have been variable over the history of the fishery, with peak annual catches in excess of 800 t in 1982 and 1997 (Figure 5.11). Since 1998, catches have been below 400 t, and the 2017 catch was 161 t. Red endeavour prawn is a byproduct of the tiger prawn fishery.

FIGURE 5.11 Red endeavour prawn catch, 1970–2017



Source: CSIRO

Stock assessment

Although attempts have been made to assess red endeavour prawn, no reliable assessment is available to determine stock status. Catches during recent years have been quite low compared with historical highs. This is most likely related to the overall decline in fishing effort directed at tiger prawn and closure of some areas where red endeavor prawn was targeted, rather than being an indication of a fall in red endeavour prawn biomass. A sensitivity that includes red endeavor prawn within the tiger prawn assessment is being undertaken during 2018.

Stock status determination

Given the absence of information on the sustainability of catches or the state of the biomass, the red endeavour prawn stock is classified as **uncertain** with regard to the level of fishing mortality and biomass.

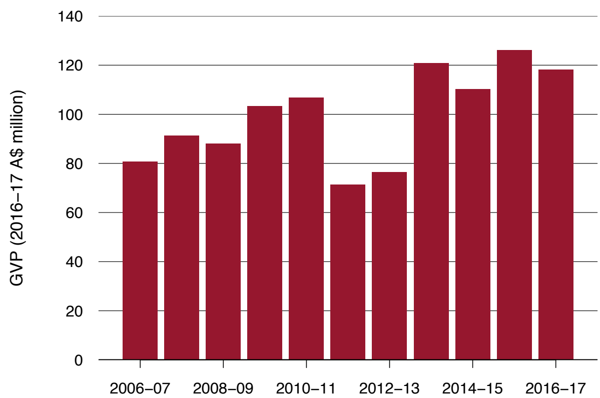
Endeavour prawns
AFMA

5.3 Economic status

Key economic trends

The gross value of production (GVP) for the NPF fluctuated during the decade to 2016–17, peaking at $126 million in 2015–16 and reaching a low of $71 million (in 2016–17 dollars) in 2011–12 (Figure 5.12). Despite this variability, the GVP increased by 46 per cent during the decade, and the average GVP per active vessel increased by 37 per cent, to $2.27 million (in 2016–17 dollars).

FIGURE 5.12 GVP and GVP per active vessel for the NPF, 2006–07 to 2016–17



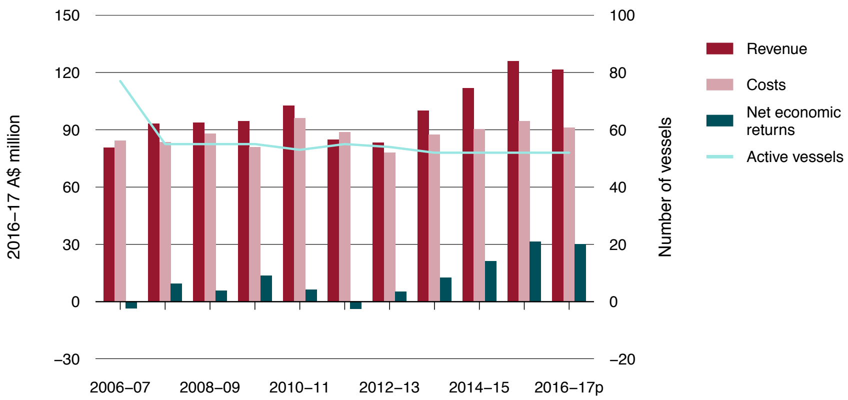
Notes: **GVP** Gross value of production. 2016–17 data are preliminary.

Since the early 1990s, ABARES has used data from economic surveys of the NPF to estimate the net economic returns (NER) earned in the fishery. The most recent survey in 2017 provided survey-based estimates of NER for the 2014–15 and 2015–16 financial years, and forecasts for 2016–17 (Bath, Curtotti & Mobsby 2018).

Real NER in the NPF have varied considerably during the period 2006–07 to 2016–17 (Figure 5.13). In 2006–07 and 2011–12, real NER were negative, estimated at –$3.6 million and –$3.9 million (in 2016–17 dollars), respectively. NER have followed an increasing trend since 2011–12, reaching a peak of $31.4 million in 2015–16, supported by a strong increase in tiger prawn catch in that year. The NER improvement in 2015–16 is the fourth consecutive annual increase in NER. The strong performance in 2015–16 is forecast to be repeated in 2016–17, following a strong increase in banana prawn catch in 2016–17. Increasing profitability during this period is likely to stem from a combination of factors, including favourable market conditions and management changes that have occurred in the fishery in recent years. Favourable market conditions include a lowering of the Australian dollar exchange rate and fuel prices in the period after 2012–13. Management changes include targeting of MEY in the tiger prawn component of the fishery from 2004–05; implementation of the Securing our Fishing Future structural adjustment program (which concluded in 2006–07), resulting in a 50 per cent reduction in the fleet; and the adoption of quad trawl gear. The structural adjustment program removed 43 class B statutory fishing rights from the fishery, reducing the already declining active vessel numbers from 86 in 2005–06 to 55 in 2007–08. Since then, active vessel numbers have declined slightly, to 52 in the 2017 fishing season. Together, these changes are likely to have improved the economic performance of the fishery during the decade.

NER in 2016–17 are forecast to decline slightly from 2015–16 levels ($30.3 million). The negative effect of lower catch levels of tiger prawns on fishery revenue was largely offset by a strong increase in the catch of banana prawns, resulting in a 3.5 per cent decline in fishing revenue. Fishing costs are also forecast to decline in 2016–17, but slightly less than revenue.

FIGURE 5.13 Real revenue, costs, NER and active vessel numbers for the NPF, 2006–07 to 2016–17

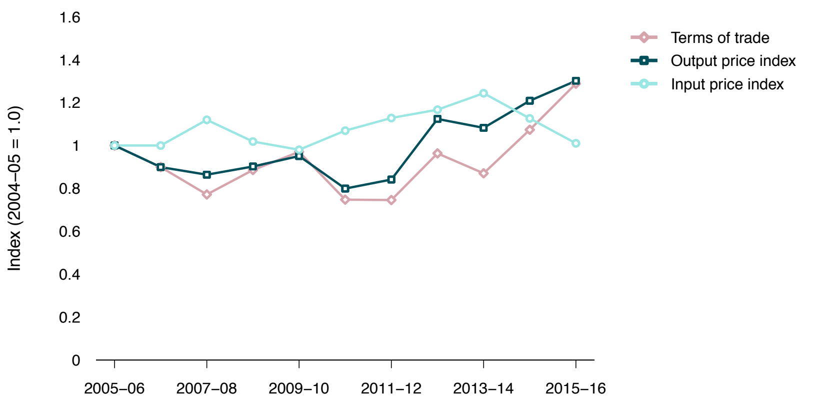


Notes: **NER** Net economic returns. **p** Preliminary non-survey-based estimates.
Source: Bath, Curtotti & Mobsby 2018

Total factor productivity (a measure of fishers' ability to convert inputs into outputs over time) in the fishery increased from 2005–06 to 2010–11, at a rate robust enough to offset declining terms of trade from declining prices and high fuel costs (Bath, Curtotti & Mobsby 2018; Figures 5.14 and 5.15). This trend was largely driven by growth in outputs and a slightly declining inputs index. Most of the increase in the outputs index coincides with increases in banana prawn catch per vessel; however, targeting MEY in the tiger prawn component of the fishery would also have supported this improved productivity at a time of declining terms of trade. Because the productivity index was not adjusted for stock effects, productivity growth also reflects favourable environmental conditions that allowed increases in catch, particularly for banana prawns, rather than just changes in efficiency measures and technology adopted by fishers. From 2010–11 to 2015–16, total factor productivity generally declined, but the negative impact of this on NER has been more than offset by a strongly positive trend in terms of trade, largely as a result of improved prices for banana and tiger prawns, and lower fuel costs since 2013–14. The positive trend in terms of trade has largely driven the steady rise in NER during the period.

FIGURE 5.14 Total factor productivity index, 2005–06 to 2015–16

FIGURE 5.15 Terms of trade index, 2005–06 to 2015–16



Management arrangements

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

An assessment of the impact of the structural adjustment program by Vieira et al. (2010) suggested that, for the benefits of the program to be preserved, management arrangements in fisheries targeted by the program need to be set in ways that prevent a repeated build-up of fishing capacity. In recent years, AFMA has sought to better align banana prawn catch levels with the MEY objective. In 2014, an MEY catch-rate trigger for banana prawn was introduced to the fishery (AFMA 2015).

Performance against economic objective

The tiger prawn component of the fishery has explicit MEY targets (across two tiger prawn species and one endeavour prawn species), and a bio-economic model is used to estimate annual fishing effort required to move towards S_{MEY}. Stocks are assessed every two years. Spawning stock sizes of both species of tiger prawn were above S_{MEY} at the end of the 2015 season (Buckworth et al. 2016). Spawner stock size of blue endeavour prawn for the same period was estimated to be below S_{MEY}. Effort levels as a proportion of effort at MEY for brown tiger prawn and grooved tiger prawn were estimated to be at or below effort at MEY. Current effort limits in the fishery are based on outputs from the fishery's bio-economic model, and are designed to achieve an MEY (optimal profit at the fleet level) target across a seven-year projection period (noting that the target changes with every assessment because of changes in biological and economic parameters).

Recruitment for all species is variable, particularly for white banana prawn, for which recruitment is closely associated with rainfall. Therefore, no B_{MEY} target is defined for white banana prawn. Instead, an MEY-based catch-rate trigger was implemented for the 2014 banana prawn season, with mechanisms in place to adjust total annual effort levels to ensure that the fishery remains sustainable and profitable (AFMA 2015).

Red-legged banana prawn, primarily caught in Joseph Bonaparte Gulf, was assessed in 2015 (Buckworth et al. 2015), using data up to and including 2014. Spawning stock biomass was estimated to be well above biomass associated with the proxy MEY in the 2014 season. Because of low levels of catch during the 2015 and 2016 fishing seasons, reliable assessments of the stock status could not be undertaken.

Targeting MEY in the fishery is consistent with the economic objective of maximising economic returns, and could be expected to increase NER in the fishery. Targeting MEY of the tiger prawn component of the fishery began in 2004–05. Despite declining terms of trade from 2004–05 to 2010–11, productivity and NER improved. Although the targeting of MEY over this period is likely to have supported these improvements, other factors, such as the structural adjustment program and improved banana prawn catch, also contributed. The banana prawn catch trigger targeting MEY has only been in place since 2014, so it is too early to determine its effect on NER.

5.4 Environmental status

The NPF was reaccredited under part 13 of the *Environment Protection and Biodiversity Conservation Act 1999* on 20 December 2013. The current approval of a wildlife trade operation (part 13A) expires on 9 January 2019. Four recommendations accompanied the strategic assessment, including improvement of the monitoring systems for byproduct and refinement of bycatch mitigation measures.

The NPF was certified as a sustainable fishery by the Marine Stewardship Council in November 2012 and recertified in January 2018.

Ecological risk assessment of the NPF has assessed 9 target species, 135 byproduct species, 516 discard species (chondrichthyans and teleosts only), 128 protected species, 157 habitats and 3 communities (AFMA 2008). Following review of the level 2 Productivity Susceptibility Analysis (PSA) risk rankings, using residual risk guidelines (AFMA 2008), 26 species remained at high risk. During and following the level 2 PSA work, selected taxonomic groups were the subject of level 2.5 studies (Brewer et al. 2007). Milton et al. (2008) estimated temporal trends in abundance of sea snakes in the NPF to provide a quantitative assessment of trawling on populations. Although most populations had been relatively stable, two species (spectacled seasnake [*Hydrophis kingii*] and large-headed seasnake [*H. pacificus*]) showed evidence of decline on the trawl grounds. Results from a level 3 Sustainability Assessment for Fishing Effects analysis of elasmobranchs in the NPF (Zhou & Griffiths 2011) indicate that, of the 51 species considered, fishing impacts may have exceeded the maximum sustainable fishing mortality harvest rate for 19 species, although these estimates were highly uncertain. Based on these risk assessments, three species are currently considered to be at high risk in the NPF: porcupine ray (*Urogymnus asperrimus*) and two species of mantis shrimp (*Dictyosquilla tuberculata* and *Harpiosquilla stephensoni*).

AFMA publishes quarterly logbook reports of interactions with protected species on its website. In the NPF in the 2017 calendar year, 63 turtle interactions were reported, and all but 3 of these turtles were released alive; 506 sawfish were caught, of which 350 were released alive and the remainder were dead; and 9,051 sea snakes were caught, of which 6,825 were released alive, 2 were injured, 45 had an unknown life status and the remainder were dead. Reports also indicate that 49 seahorses or pipefish were caught—23 were dead, 25 were released alive and 1 was released in an unknown condition.

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