Chapter 4
Northern Prawn Fishery

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FIGURE 4.1 Fishing intensity in the Northern Prawn Fishery, 2021 fishing season

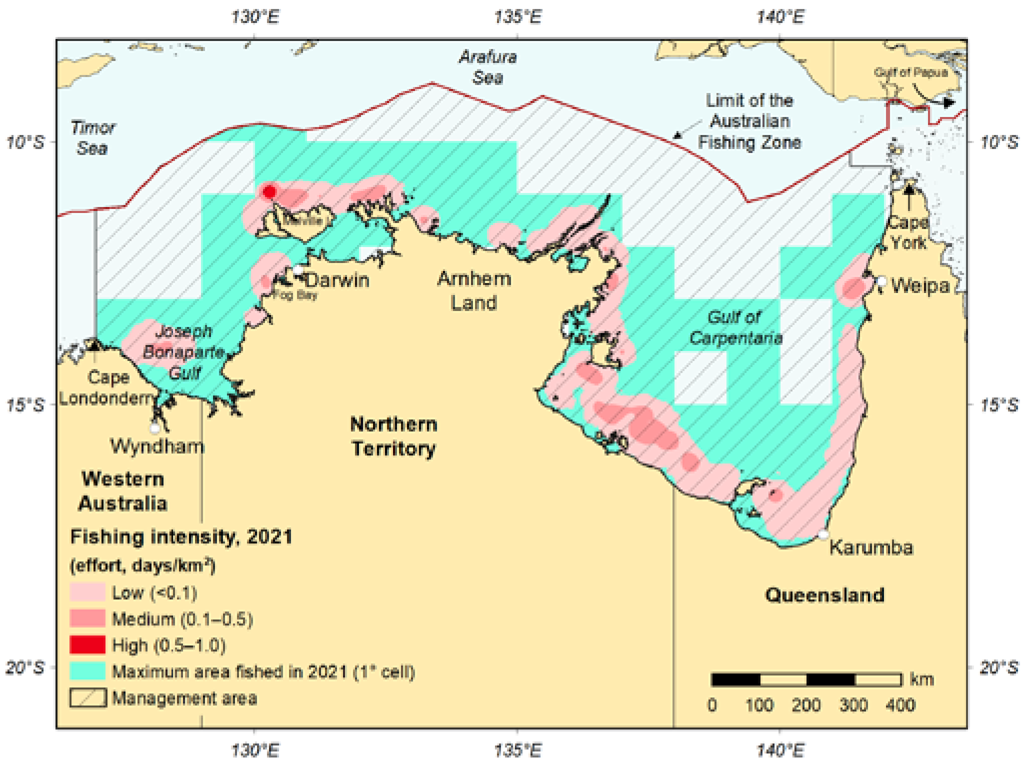


TABLE 4.1 Status of the Northern Prawn Fishery

Biological status					
Stock	2020		2021		Comments
	Fishing mortality	Biomass	Fishing mortality	Biomass	
Redleg banana prawn (*Penaeus indicus*)					Fishing mortality in 2021 is unlikely to drive the stock into an overfished state. Spawning stock size is estimated to be above the LRP.
White banana prawn (*Penaeus merguiensis*)					High natural recruitment variability. Harvest strategy aims to provide for adequate escapement/ spawning biomass and for fishing effort to approximate E_{MEY}.
Brown tiger prawn (*Penaeus esculentus*)					Fishing mortality in 2021 is unlikely to drive the stock into an overfished state. Spawning stock size is estimated to be above the LRP.
Grooved tiger prawn (*Penaeus semisulcatus*)					Fishing mortality in 2021 is unlikely to drive the stock into an overfished state. Spawning stock size is estimated to be above the LRP.
Blue endeavour prawn (*Metapenaeus endeavouri*)					Fishing mortality in 2021 is unlikely to drive the stock into an overfished state. Spawning stock size is estimated to be above the LRP.
Red endeavour prawn (*Metapenaeus ensis*)					No current reliable stock assessment.

Economic status

Most recent estimates of NER, though still positive, show a deterioration in economic returns. Tiger prawn stocks have become a watch point for the fishery, with the most recent estimates showing declining spawning sizes. The impact of the declining trend in tiger prawn catch since 2015 on future levels of NER is uncertain and warrants further monitoring. Individual transferable effort quotas for tiger prawns allow effort quota to flow to the highest-value use, and help the fishery adjust to challenging conditions.

Notes: **E_{MEY}** Effort that achieves maximum economic yield. **LRP** Limit reference point. **NER** Net economic returns.

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

4.1 Description of the fishery

Area fished, fishing methods and key species

The Northern Prawn Fishery (NPF) extends from Joseph Bonaparte Gulf (JBG) across the Top End to the Gulf of Carpentaria (Figure 4.1). White banana prawn (*Penaeus merguiensis*) is mainly caught during the day on the eastern side of the Gulf of Carpentaria, whereas redleg banana prawn (*P. indicus*) is caught day and night, mainly in JBG. White banana prawns form dense aggregations ('boils') that can be located using spotter planes which direct the trawlers to the aggregations. The highest catches of banana prawns are taken offshore from mangrove forests, which are their juvenile nursery areas. Tiger prawns (brown – *P. esculentus* and grooved – *P. semisulcatus*) are primarily taken at night (daytime trawling is prohibited during the tiger prawn season). Most catches of tiger prawns 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 (blue – *Metapenaeus endeavouri* and red – *M. ensis*) are mainly byproduct species, caught when fishing for tiger prawns.

The NPF uses otter trawl gear to target a range of tropical prawn species. Most vessels have transitioned from using 2 trawl nets to using 4 trawl nets, a configuration that is considered more efficient. White banana prawn and 2 species of tiger prawn (brown and grooved) account for around 80% of the landed catch. In 2021, byproduct species other than the species assessed for status accounted for 6% of the total landed catch. Byproduct species include black tiger prawn (*P. monodon*), scampi (*Metanephrops* spp.), bugs (*Thenus* spp.), cuttlefish, squids and saucer scallops (*Amusium* spp.).

A small number of NPF-licensed operators also target black tiger prawn to supply broodstock to the aquaculture industry. The Australian Fisheries Management Authority (AFMA) maintains a cap on the take of black tiger prawn for broodstock and issues up to 3 fishing permits for this purpose (AFMA, 2021, pers. comm.). Although demand for broodstock was initially high, demand has stabilised or decreased in recent years (AFMA 2022). AFMA commissioned a stock assessment of black tiger prawn in 2020, but the outcomes were uncertain due to limited historical data on black tiger prawn catches. A further assessment will be done in 2024 (AFMA, 2022, pers. comm.).

Management methods

The NPF has a key management objective of maximising net economic returns (NER), which is implemented through seasonal closures, trigger catch rates and individual transferable effort units. The NPF has 2 fishing seasons. The first season runs from 1 April to 15 June, in which white banana prawns are the main species targeted. A longer second season runs from 1 August to 30 November, in which tiger prawns are the key target species (AFMA & CSIRO 2021). The first season is commonly called the banana prawn season, and the second season the tiger prawn season, although catch of all species may occur (to varying degrees) in both seasons.

The fishery has 1 overarching harvest strategy with 3 component harvest strategies covering the key commercial species: redleg banana prawn (redleg banana prawn harvest strategy), white banana prawn (white banana prawn harvest strategy), and 2 species of tiger prawn and 2 species of endeavour prawn (all in the tiger prawn harvest strategy) (AFMA & CSIRO 2021). These harvest strategies are being reviewed and updated (AFMA 2022). They stipulate fixed input controls (for example, limited entry, individual transferable effort units) and flexible input controls (for example, total allowable effort, seasonal closures), and specify target and limit reference points (TRP; LRP). These harvest strategies also contain harvest control and decision rules, which specify how fishing may take place or determine actions that should be taken given a set of conditions in the fishery.

Fishing for redleg banana prawn primarily takes place in JBG, well away from most of the other fishing in the NPF, and so there are separate management arrangements for this species. The redleg banana prawn harvest strategy aims to keep spawning biomass above an LRP of 0.50 of the spawning biomass at maximum sustainable yield (that is, $0.5SB_{MSY}$). The TRP for this stock is a spawning biomass that will achieve a maximum economic yield (SB_{MEY}) proxy, calculated based on a period when there was good economic performance in the fishery (that is, 1999 to 2010). The fishery uses effort controls (for example, individual transferable effort units, limited entry) and area and time closures, as well as harvest control rules, to achieve the TRP. If spawning biomass of redleg banana prawn is calculated to be below the LRP for 2 successive fished years, then fishing for redleg banana prawns is not allowed for the next year. Control rules also stipulate reductions in effort based on proximity of the biomass in a given year to the biomass at MSY (B_{MSY}). The harvest strategy also includes a newly implemented (commenced in 2021) harvest control rule that closes fishing in JBG during the white banana prawn season. New decision rules also address robustness to climate variability (Blamey et al. 2021), as well as issues such as inconsistent effort. The harvest strategy for redleg banana prawn is under review and is expected to be finalised and in place for the first fishing season in 2023 (AFMA, 2022, pers. comm.). Stock assessments or updates are completed annually for this part of the fishery.

The harvest strategy for the white banana prawn stock includes the objective of maximising economic yield from the fishery. This is achieved by closing the fishing season when catch rates fall below a specified trigger level. This trigger level is the break-even point where average daily catch revenue is equal to the daily costs of fishing. If the catch rate drops below this predetermined trigger threshold at 3 key dates in the banana prawn season, then targeting of white banana prawn stops within 2 weeks of that date through a season closure. An assumed secondary benefit of the trigger catch rate is that it also allows enough escapement to ensure an adequate spawning biomass and subsequent recruitment the following year (AFMA & CSIRO 2021). The banana prawn fishery has very high annual natural variability in recruitment due to environmental drivers and, as a result, there are no annual stock assessments or monitoring to assess the fishery against biomass-based reference points.

The tiger prawn fishery harvest strategy, which also includes endeavour prawns, aims to meet the TRP of maintaining SB_{MEY}. The fishery also has an LRP to maintain the average spawning biomass above $0.5SB_{MSY}$ over the last 5-year period. This fishery uses a suite of gear (for example, head-rope length) and effort (for example, seasonal adjustments) controls to achieve these objectives. If spawning biomass of either tiger or blue endeavour species is calculated to be less than the LRP, then the tiger prawn fishing season will be closed in the subsequent fishing year. This harvest strategy is under review and is expected to be completed in 2022. Fishery-independent monitoring and stock assessments or updates are completed annually for the fishery.

The merits of input (effort) and output (total allowable catch) controls have been extensively evaluated in the NPF. In late 2013, mainly because of the difficulty in setting catch quotas for the highly variable white banana prawn fishery, AFMA determined that the fishery would continue to be managed through input restrictions and units of individual transferable effort quota.

Fishing activity

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 3 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, alongside management measures to unitise and control fishing effort. Total catches also fell during this period, but by a smaller percentage, illustrating the transformation of the fleet to more-efficient vessels.

Annual catches tend to be variable, mostly because of natural variability associated with the target species, especially banana prawn. Total landed catch in 2021 was 5,390 t, comprising 5,095 t of prawns and 295 t of byproduct species (predominantly squid, bugs and scampi) (Table 4.2).

Prawn trawler
Mike Gerner, AFMA

TABLE 4.2 Main features and statistics for the NPF

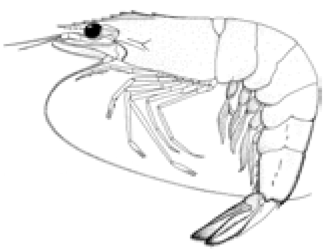
Fishery statistics a	2020 fishing season b		2021 fishing season b	
Stock	**Catch (t)**	**GVP (2019–20)**	**Catch (t)**	**GVP (2020–21)**
Redleg banana prawn	145	$30.8 million	503	$41.2 million
White banana prawn	2,760		3,115	
Brown tiger prawn	409	$45.7 million	341	$29.7 million
Grooved tiger prawn	957		673	
Blue endeavour prawn	233	$5.0 million	266	$3.5 million
Red endeavour prawn	125		170	
Total	**4,629**	**$81.5 million**	**5,068**	**$74.4 million**
Other spp. (prawns)	24	$1.3 million	27	$0.4 million
Other spp. (not prawns)	114	$2.1 million	295	$1.8 million
Total fishery	**4,767**	**$84.9 million**	**5,390**	**$76.6 million**
Fishery-level statistics				
Effort	Banana season: 1,852 shots Tiger season: 5,450 shots		Banana season: 2,211 shots Tiger season: 5,572 shots	
Fishing permits	52		52	
Active vessels	52		54	
Observer coverage	Crew member observers: 1,028 days (14.2%) Scientific observers: 83 days (1.1%)		Crew member observers: 1,099 days (15.5%) Scientific observers: 213 days (3%)	
Fishing method	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 and China – frozen			
Management plan	Northern Prawn Fishery Management Plan 1995 (amended 2012)			

a Fishery statistics are provided by fishing season, unless otherwise indicated. 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: notionally 1 April to 15 June; predominantly for tiger prawns: notionally 1 August to 30 November; actual season length depends on catch-per-unit-effort maximum economic yield triggers.

Note: **GVP** Gross value of production.

4.2 Biological status

Redleg banana prawn (*Penaeus indicus*)



Line drawing: FAO

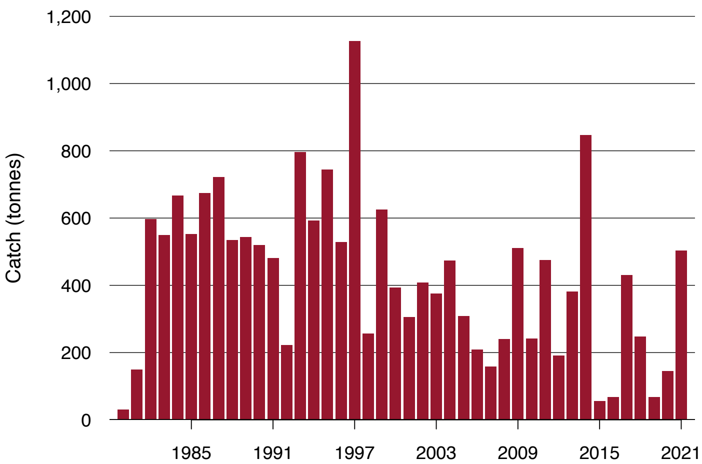
Stock structure

Redleg banana prawns are widely distributed across the Indo-West Pacific Ocean. In JBG, a single separate stock is assumed for assessment and management purposes. The redleg stock in the JBG is used for status determination purposes.

Catch history

The redleg banana prawn fishery developed in the early 1980s. Effort and catch peaked during the 1990s but have since decreased (Figure 4.2). Most of the redleg banana prawn catch in the NPF is taken in JBG, with a small amount taken from Colville–Melville (area just north of Melville Island) and Fog Bay (Figure 4.1). Effort targeted at redleg banana prawn is concentrated around neap tides, because JBG has large tidal flows (7 m). The catch of redleg banana prawn usually contributes a relatively small component of the total banana prawn catch in the NPF. The highest catch reported in the fishery was 1,005 t in 1997. Over the past decade, annual catches have averaged 284 t, but with high variability. Catches were particularly low in 2015 (56 t) and 2016 (66 t). Total redleg banana prawn catch in the NPF in 2021 was 503 t, up from 145 t in 2020 (Figure 4.2). Effort for redleg banana prawn in 2021 was 438 fishing days, up from 211 days in 2020 (AFMA 2021; Plagányi et al. 2022). Historically, redleg banana prawn has been caught in both the banana prawn and tiger prawn seasons, but, in 2021, AFMA restricted fishing to the tiger prawn season. As a result of this closure in JBG, catch of redleg banana prawn was concentrated in the third quarter of 2021 (that is, the first half of the second season). Redleg banana prawn catch-per-unit-effort (CPUE) in this third quarter was above average for fishing in those months (Plagányi et al. 2022).

FIGURE 4.2 Redleg banana prawn catch, 1980 to 2021 seasons



Source: CSIRO

Stock assessment

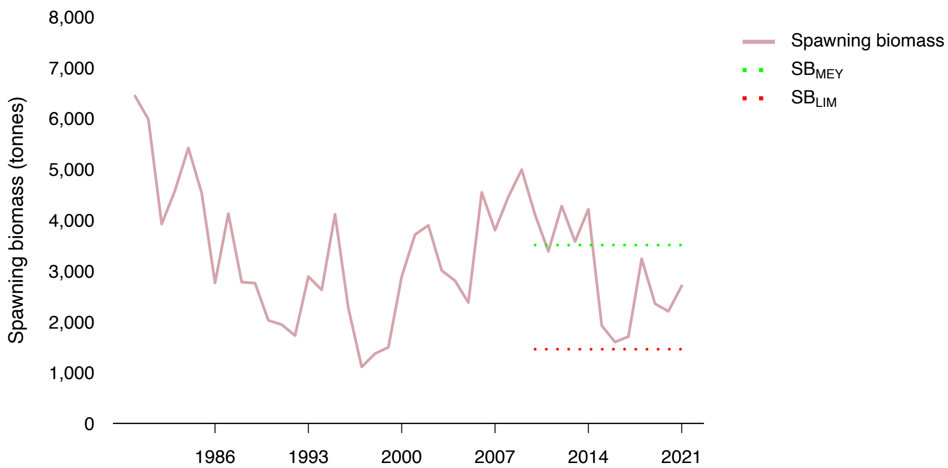
For this short-lived, highly variable stock, annual yield is determined largely by the strength of annual recruitment, which fluctuates widely according to environmental factors such as rainfall and the El Niño Southern Oscillation (Plagányi et al. 2020). Effort in the redleg banana prawn fishery is also highly variable from year to year (partly for economic reasons) and is substantially reduced when revenue-per-unit-effort is higher in the Gulf of Carpentaria than in JBG (Pascoe et al. 2020).

The most recent stock assessment of redleg banana prawn was completed in early 2022. It included fishing data up to and including the 2021 season and then projected total allowable effort for 2022 (Plagányi et al. 2022). This assessment updates previous assessments, and now includes updated stock assessment parameters and methodology (for example, fishing power, first season closure). It assesses redleg banana prawn only in JBG. The assessment model uses a Beverton–Holt stock–recruitment function and quarterly time steps of catch and effort across the 2 fishing seasons (though currently only 1 season is fished) in each calendar year to assess spawning biomass up to the most recent completed fishing year, and then estimates the future effort required to maintain the spawning biomass at SB_{MEY}. Average historical recruitment adjusted for stock biomass is assumed for predicting future total allowable effort and associated catch. The naturally variable recruitment from year to year presents challenges in comparing predicted effort and catch with actual catch and effort after the end of the season. The harvest strategy has been updated to account for the new first season closure. This will again be reviewed in a few years once data are available based on the shift to fishing in the second season only.

Using the 2022 assessment, the biomass of the redleg banana prawn spawning stock in JBG at the end of 2021 (SB_{2021} = 2,708 t) was estimated to be 0.93 of the spawning stock biomass at MSY (SB_{2021}/SB_{MSY}), 0.77 of the spawning stock biomass at MEY (SB_{2021}/SB_{MEY}) and 1.85 of the spawning stock biomass LRP (SB_{2021}/SB_{LIM}) (Plagányi et al. 2022). Spawning biomass has remained above SB_{LIM} (1,463 t) but below SB_{MSY} (2,925 t) since 2019, and below SB_{MEY} (3,510 t) since 2014 (Figure 4.3).

Before the start of the 2021 season, the 2020 fishing season assessment was used to project effort and associated catch in JBG for 2021 to achieve the SB_{MEY} target. These projections were 160 days (56–264 days, 90% confidence interval – CI), corresponding to a catch of 173 t (32–314 t, 90% CI) (AFMA 2021). Actual effort (415 days) and catch (479 t) substantially exceeded those values. Because of the large difference between the predicted and actual values, a reanalysis was undertaken in mid-2022 using the now-updated assessment parameters and methodology. This produced an updated total allowable effort for 2021 of 300 days (105–496 days, 90% CI) and a projected catch of 307 t (59–556 t, 90% CI). Actual effort and catch exceeded these retrospective estimates but were well within the 90% CI (CSIRO, 2022, pers. comm.). These updated projections were also based on historical average recruitment adjusted for stock biomass. The above-average CPUE in 2021 suggests that a higher-than-average recruitment may have supported the higher catch and effort.

FIGURE 4.3 Estimated spawning biomass for redleg banana prawn, 1980 to 2021



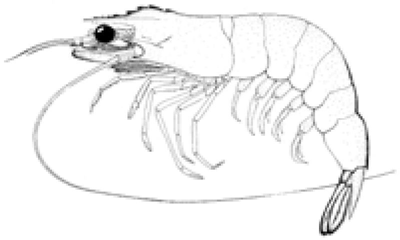
Notes: **SB_{LIM}** Spawning biomass limit reference point. **SB_{MEY}** Spawning biomass at maximum economic yield.
Source: Plagányi et al. 2022

Stock status determination

Since the most recent estimate of biomass for redleg banana prawn in the NPF (0.93) is above SB_{LIM}, the stock is classified as **not overfished**.

Effort and catch in 2021 of 415 days and 479 t, respectively, were much higher than the original forecasts before the start of the season of 160 days and 173 t, respectively. As a result, in 2022, a retrospective analysis of the 2021 season was made using the updated model. Although high, the updated projections were within the 90% CI of this analysis. Additionally, CPUE in 2021 was above average, indicating relatively high recruitment. On this basis, the stock is classified as **not subject to overfishing**.

White banana prawn (*Penaeus merguiensis*)



Line drawing: FAO

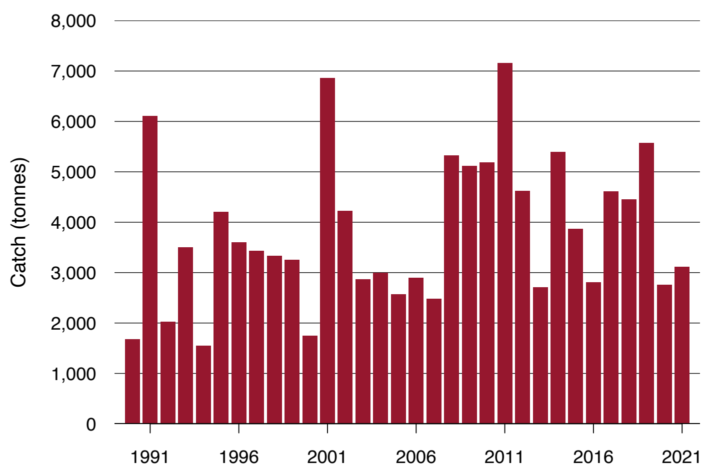
Stock structure

The stock structure of white banana prawn is uncertain. Substock structuring could be associated with significant river catchments and their annual flow regimes. However, with no clear evidence for biological stock structure, a single fishery-level stock is assumed for management and assessment purposes. A single fishery-level stock is assumed for status determination purposes.

Catch history

Catch of white banana prawn has varied over the years from around 1,500 t (1994) to above 7,000 t (2011). Seasonal catch is highly variable and is often associated with rainfall in some areas (van der Velde et al. 2021). Catch in 2021 was 3,115 t (Figure 4.4), up from 2,760 t in 2020. Most of the catch comes from the Gulf of Carpentaria.

FIGURE 4.4 White banana prawn catch, 1990 to 2021 seasons



Source: CSIRO

Stock assessment

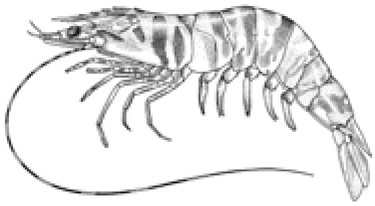
There is no formal stock assessment for this stock. The environmentally driven, high variability of this resource means that developing a robust stock–recruitment relationship is difficult. This is because annual yields are largely dependent on annual recruitment and recruitment has a complex association with seasonal rainfall, oceanographic conditions and availability of food (van der Velde et al. 2021). To determine whether next year's catch could be predicted based on the most recent wet-season rainfall, the relationship between historical catch and rainfall was modelled. Unfortunately, large uncertainties remained because the model could not accurately predict catch levels in some years (Buckworth et al. 2013).

Harvest rates for white banana prawn in the fishery are high (>90% of available biomass) in some years (Buckworth et al. 2013), but the stock has so far been resilient to these levels of fishing pressure.

Stock status determination

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

Brown tiger prawn (*Penaeus esculentus*)



Line drawing: FAO

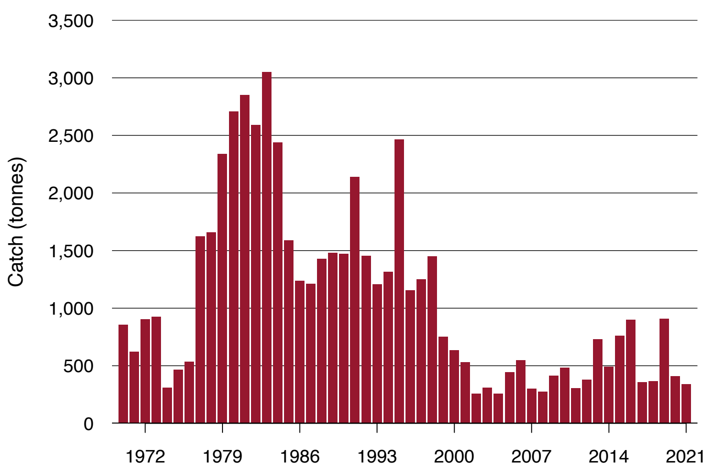
Stock structure

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 of Australia (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 assessment and management purposes. A single fishery-level stock is assumed for status determination purposes.

Catch history

Brown tiger prawns are caught primarily in the southern and western Gulf of Carpentaria, but also in waters westward towards JBG. Catch has been variable since the fishery began in the 1970s, with annual catches up to 3,000 t through the early 1980s, but mostly less than 500 t in recent decades. Catch of brown tiger prawn in 2021 was 341 t, down from 409 t in 2020 (Figure 4.5). The corresponding fishing effort in 2021 of 1,345 days, was slightly higher than that in 2020 (1,309 days) (Deng et al. 2022).

FIGURE 4.5 Brown tiger prawn catch, 1970 to 2021 seasons



Source: CSIRO

Stock assessment

The stock assessment for the tiger prawn fishery uses a multispecies approach, with a weekly, sex- and size-structured population model for brown and grooved tiger prawns, and a Bayesian hierarchical production model for blue endeavour prawn (Punt et al. 2011). This bio-economic stock assessment model provides annual estimates of MSY and MEY (Punt et al. 2010). The model looks 7 years ahead towards the MEY and MSY targets, using updated spawning/recruitment survey results, catch/effort data and fishery economic information, but dampens year-to-year effort changes that may arise from high recruitment variability or fishing constraints. Species-level components of MSY and MEY, based on estimated effort for each species, are taken from this overall model.

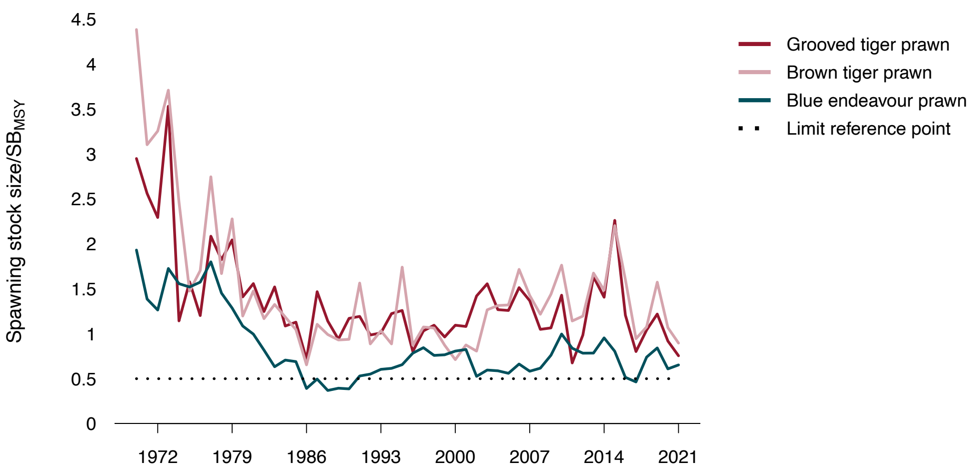
Full stock assessments are undertaken every 2 years, with logbook data collected continuously in intervening years. In addition, annual fishery-independent monitoring in the Gulf of Carpentaria provides prawn size data and indices of abundance by species that are input to the assessment (Kenyon et al. 2021). The most recent tiger prawn fishery assessment, which covers catch and effort up to 2021 (Deng et al. 2022), also included a 4-species model to include red endeavour prawn as an additional sensitivity to the base-case model.

The base-case estimate of the brown tiger prawn spawning stock size at the end of 2021 as a proportion of spawning stock size at MSY (SB_{2021}/SB_{MSY}) was 0.90, with a range across sensitivities of 0.66–0.90 (Deng et al. 2022) (Figure 4.6). Further, the 5-year average (2017 to 2021) of spawning stock size as a proportion of spawning stock size at MSY was 1.11 and well above the agreed LRP of $0.5SB_{MSY}$. The base-case estimate of the size of the brown tiger spawning stock as a proportion of stock size at MEY (SB_{2021}/SB_{MEY}) was 0.66 (range across sensitivities 0.62–0.72; Deng et al. 2022), a decrease from 1.25 in the previous stock assessment (Deng et al. 2020) (Figure 4.7).

Estimated effort in 2021 as a proportion of effort that achieves MSY (E_{2021}/E_{MSY}) from the base case was 0.45, while estimated effort in 2021 as a proportion of effort that achieves MEY (E_{2021}/E_{MEY}) from the base case was 0.49. Estimated catch at MSY in 2021 along the modelled path to the 7-year MSY target for brown tiger prawn was 1,053 t, while estimated catch at MEY along the path towards the MEY target was 1,087 t (Deng et al. 2022).

The Integrated Monitoring Program's 2022 preseason recruitment surveys indicate low relative post-recruitment abundance for brown tiger prawns, the fourth lowest in the data series and part of a 4-year decline in the index (2003 to 2022) (AFMA 2022).

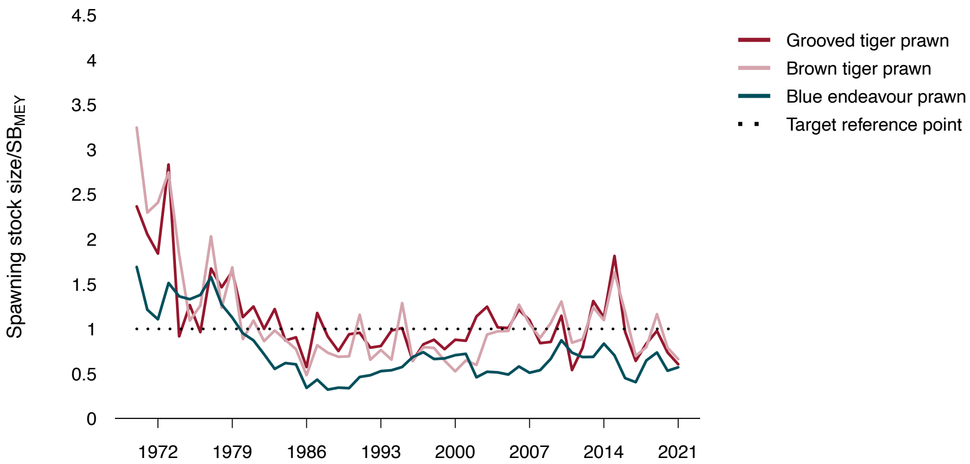
FIGURE 4.6 Spawning stock size as a proportion of SB_{MSY} for brown and grooved tiger prawns and blue endeavour prawn, 1970 to 2021



Note: **SB_{MSY}** Spawning stock size at maximum sustainable yield.

Source: Deng et al. 2022

FIGURE 4.7 Spawning stock size as a proportion of SB_{MEY} for brown and grooved tiger prawn and blue endeavour prawn, 1970 to 2021



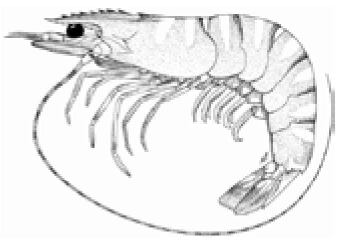
Note: **SB_{MEY}** Spawning stock size at maximum economic yield.

Source: Deng et al. 2022

Stock status determination

The spawning stock size of brown tiger prawn in 2021 was 0.90 of spawning stock size at MSY. Additionally, the latest 5-year average of spawning stock size SB/SB_{MSY} (1.11) was well above the LRP ($0.5SB_{MSY}$). On this basis, the stock is classified as **not overfished**. Catch in 2021 (341 t) was well below MSY and unlikely to drive the stock into an overfished state. On this basis, the stock is classified as **not subject to overfishing**.

Grooved tiger prawn (*Penaeus semisulcatus*)



Line drawing: Karina Hansen

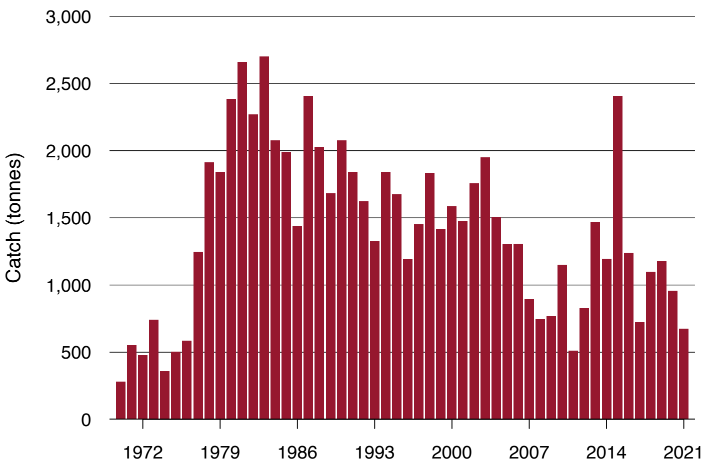
Stock structure

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 in the Gulf of Carpentaria is assumed to be a single stock for assessment and management purposes. A single fishery-level stock is assumed for status determination purposes.

Catch history

The annual catch of grooved tiger prawn peaked in the early 1980s at more than 2,500 t and has shown a declining trend since then, except for the 2015 catch of 2,405 t. Catch in 2021 was 673 t, down from 957 t in 2020 (Figure 4.8) and the second lowest catch on record since the 1970s (AFMA 2022). The corresponding fishing effort in 2021 was 3,320 days, down from 4,080 days in 2020.

FIGURE 4.8 Grooved tiger prawn catch, 1970 to 2021 seasons



Source: CSIRO

Stock assessment

Refer to 'Brown tiger prawn (*Penaeus esculentus*)' for a description of the multi-stock assessment.

For the most recent assessment, which covers catch and effort up to 2021 (Deng et al. 2022), the base-case estimate of the size of the grooved tiger prawn spawning stock at the end of 2021 as a proportion of spawning stock size at MSY (SB_{2021}/SB_{MSY}) was 0.75 (range across sensitivities 0.66–0.82) (Deng et al. 2022) (Figure 4.6). Further, the 5-year average of spawning stock size as a proportion of spawning stock size at MSY (0.95) was well above the agreed LRP of $0.5SB_{MSY}$. The base-case estimate of the size of the grooved tiger spawning stock as a proportion of spawning stock size at MEY (SB_{2021}/SB_{MEY}) was 0.61 (range across sensitivities 0.52–0.61), a decrease from 0.99 in the previous stock assessment (Deng et al. 2022) (Figure 4.7).

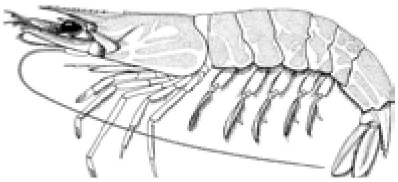
Estimated effort in 2021 as a proportion of effort that achieves MSY (E_{2021}/E_{MSY}) was 0.48, while estimated effort in 2021 as a proportion of effort that achieves MEY (E_{2021}/E_{MEY}) was 0.76. Estimated catch at MSY for 2021 along the modelled path to the 7-year MSY target for grooved tiger prawn was 1,582 t, while estimated catch at MEY along the path to the MEY target was 1,402 t (Deng et al. 2022).

The Integrated Monitoring Program's 2022 preseason recruitment surveys indicate low relative post-recruitment abundance for grooved tiger prawns, equivalent to the lowest seen in the data series (2003 to 2022) (AFMA 2022).

Stock status determination

The spawning stock size in 2021 was 0.75 of spawning stock size at MSY. Additionally, the latest 5-year average of spawning stock size SB/SB_{MSY} (0.95) was well above the LRP ($0.5SB_{MSY}$). On this basis, the stock is classified as **not overfished**. Catch in 2021 (673 t) was well below MSY and unlikely to drive the stock into an overfished state. On this basis, the stock is classified as **not subject to overfishing**.

Blue endeavour prawn (*Metapenaeus endeavouri*)



Line drawing: FAO

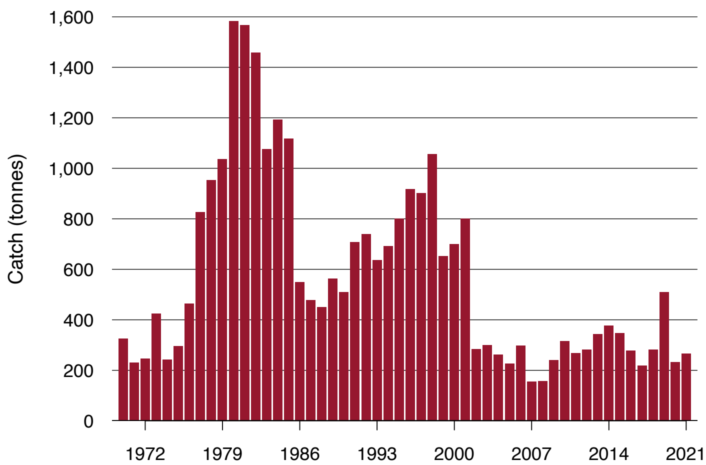
Stock structure

Blue endeavour prawn ranges across northern Australian waters and the Gulf of Papua. The biological stock structure is uncertain, but the population in the NPF is assumed to be a single stock for assessment and management purposes. A single fishery-level stock is assumed for status determination 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 4.9). Since 2002, annual catches have averaged around 280 t. Catch in 2021 was 266 t, up from 233 t in 2020. Blue endeavour prawn is a byproduct of fishing for tiger prawns, and so catches are linked to changes in effort targeting tiger prawns.

FIGURE 4.9 Blue endeavour prawn catch, 1970 to 2021 seasons



Source: CSIRO

Stock assessment

Refer to 'Brown tiger prawn (*Penaeus esculentus*)' for a description of the multi-stock assessment.

The base-case estimate of the size of the blue endeavour prawn spawning stock at the end of 2021 as a proportion of spawning stock size at MSY (SB_{2021}/SB_{MSY}) was 0.65 (range across sensitivities 0.61–0.82) (Figure 4.6). Further, the 5-year average of spawning stock size as a proportion of spawning stock size at MSY was 0.66 and above the agreed LRP of $0.5SB_{MSY}$. The base-case estimate of the size of the spawning stock as a proportion of spawning stock size at MEY (SB_{2021}/SB_{MEY}) was 0.57 (range across sensitivities 0.52–0.76), a decrease from 0.86 in the last stock assessment (Deng et al. 2022) (Figure 4.7).

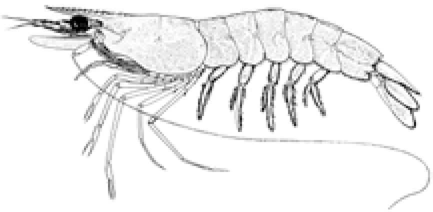
Catch at MSY along the modelled path to the 7-year MSY target for blue endeavour prawn was estimated to be 787 t (Deng et al. 2022), while catch at MEY along the path to the MEY target was estimated to be 659 t (Deng et al. 2022). Effort in terms of MEY or MSY is not estimated for blue endeavour prawn because this species is a byproduct of targeting tiger prawns.

The Integrated Monitoring Program's 2022 preseason recruitment surveys indicate low relative post-recruitment abundance for blue endeavour prawn, the second lowest seen in the data series (2003 to 2022) (AFMA 2022).

Stock status determination

The spawning stock size in 2021 was 0.65 of spawning stock size at MSY. Additionally, the latest five-year average of spawning stock size SB/SB_{MSY} (0.66) was above the LRP ($0.5SB_{MSY}$). On this basis, the stock is classified as **not overfished**. Catch in 2021 (266 t) was well below MSY levels and unlikely to drive the stock into an overfished state. On this basis, the stock is classified as **not subject to overfishing**.

Red endeavour prawn (*Metapenaeus ensis*)



Line drawing: FAO

Stock structure

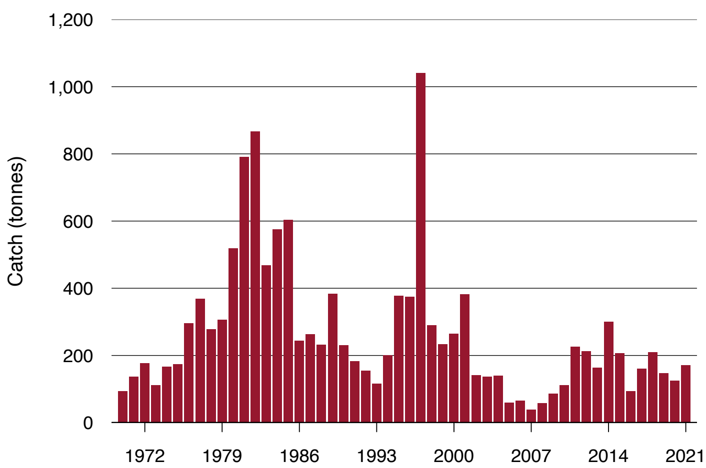
Red endeavour prawn ranges across northern Australian and parts of the Indo-West Pacific Ocean. The biological stock structure is uncertain, but the population within the NPF is assumed to be a single stock for assessment and management purposes. A single fishery-level stock is assumed for status determination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

Catch history

Annual catches of red endeavour prawn have been variable over the history of the fishery, with peak annual catches exceeding 800 t in 1982 and 1,000 t in 1997 (Figure 4.10). Since 1998, catches have averaged 167 t.

Catches of red endeavour prawn in recent years (170 t in 2021 and 125 t in 2020) have been low compared with historical highs. This is most likely related to the overall decline in fishing effort directed at tiger prawns, and area and time closures affecting historically targeted red endeavour prawn fishing areas, rather than being an indication of a fall in red endeavour prawn biomass.

FIGURE 4.10 Red endeavour prawn catch, 1970 to 2021 seasons



Source: CSIRO

Stock assessment

Refer to 'Brown tiger prawn (*Penaeus esculentus*)' for a description of the multi-stock assessment.

In 2021, an assessment of the NPF red endeavour prawn stock was included as part of a 4-species sensitivity to the tiger prawn assessment base case. The estimate of SB_{2021}/SB_{MSY} was 0.87, with an average over the last 5 years of 0.92; however, the results are preliminary, and the model still requires development and testing, so the results are not considered reliable for determining the stock status.

Stock status determination

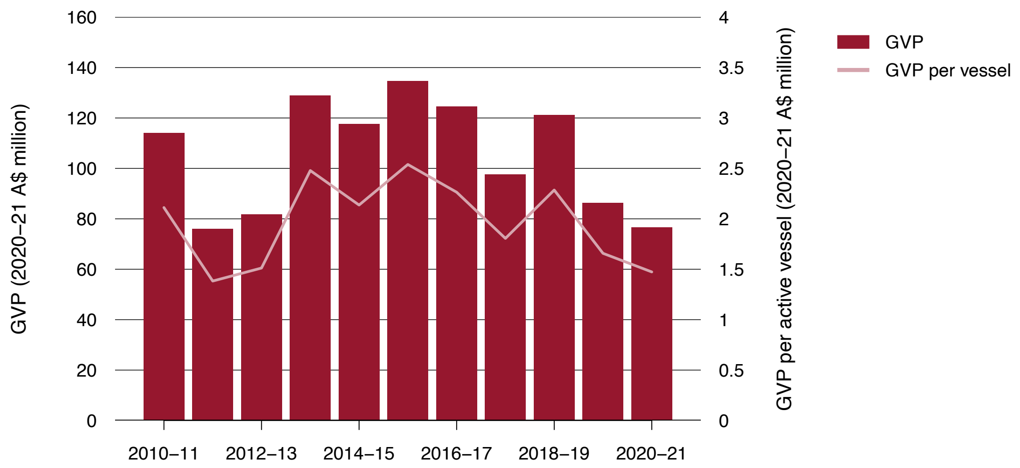
Because of the exploratory nature of the 2021 stock assessment, the fishing mortality and biomass status of red endeavour prawn are classified as **uncertain**.

4.3 Economic status

Key economic trends

The gross value of production (GVP) for the NPF fluctuated during the decade to 2020–21. Real GVP (in 2020–21 dollars) peaked at $135 million in 2015–16 and reached a low of $76 million in 2011–12 (Figure 4.11). GVP declined by 28% between 2018–19 and 2019–20, largely because of a large fall in banana prawn catch. A further, but more modest, decline in GVP in 2020–21 was driven by lower tiger prawn catch. Real GVP per active vessel also varied between 2010–11 and 2020–21, reflecting GVP fluctuation during this period while vessel numbers remained relatively steady.

FIGURE 4.11 Real GVP and GVP per active vessel for the NPF, 2010–11 to 2020–21

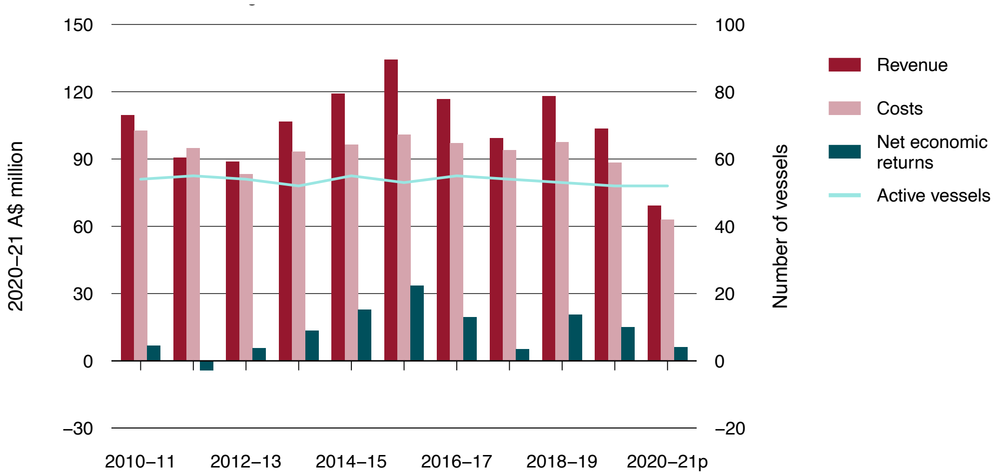


Note: **GVP** Gross value of production.

Since the early 1990s, ABARES has used data from economic surveys of the NPF to estimate the NER earned in the fishery. The most recent (2021) survey provided survey-based estimates of NER for the 2018–19 and 2019–20 financial years, and forecasts for 2020–21 (Dylewski & Curtotti 2022).

Real NER (in 2020–21 dollars) in the NPF varied considerably during the period 2010–11 to 2020–21 (Figure 4.12). Between 2011–12 and 2015–16, real NER followed an increasing trend, from –$4.2 million to a peak of $33.5 million, supported by a strong increase in tiger prawn catch and good prices. More recently, real NER have shown a persistent downward trend, falling from a 2015–16 peak to a non-survey-based estimate of $6.2 million in 2020–21. The estimated NER decrease in 2020–21 reflects a significant reduction in fishing revenue – driven largely by a 34% decrease in catch of tiger prawn (a relatively high unit value species), in that year – which outweighed the fall in operating costs.

FIGURE 4.12 Real revenue, costs, NER and active vessel numbers for the NPF, 2010–11 to 2020–21



Notes: **NER** Net economic returns. **p** Preliminary non-survey-based estimates. NER include management costs.

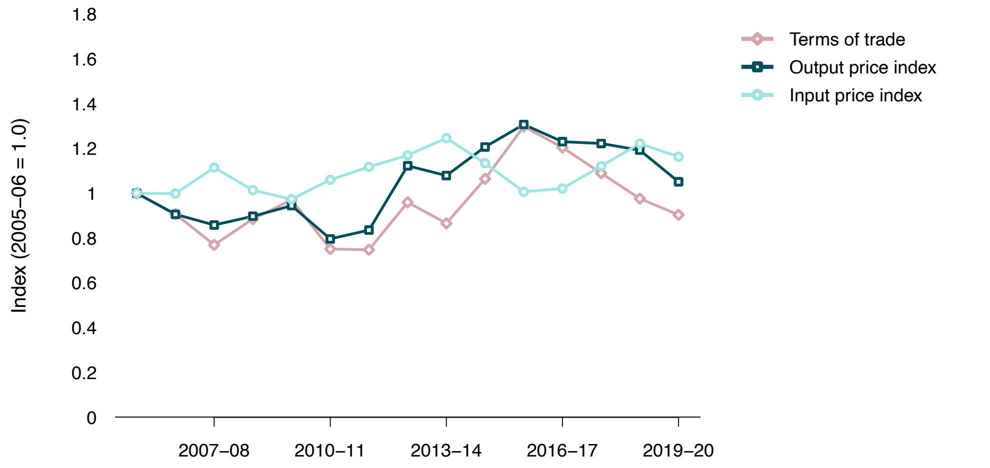
Source: Dylewski & Curtotti 2022

Together, changes in total factor productivity (TFP) and fisher terms of trade (TOT) can help to explain the trend in a fishery's NER. TFP measures fishers' ability to convert inputs into outputs over time and TOT analysis examines changes in the price of inputs relative to output prices received by fishers over time.

The reduction in NER since 2015–16 has coincided with a period of falling TOT, driven by both increasing input prices and reducing output prices (Figure 4.13). The 2 largest input costs in the NPF are crew and fuel costs, followed closely by repairs and maintenance. These cost categories combined accounted for 76% of total cash costs in 2019–20. Crew costs tend to move in line with total seafood receipts because crew may be paid a proportion of receipts. The NPF typically has higher fuel use because of the fishing methods used, and so fuel costs are mainly influenced by fishing effort and fuel prices. Repairs and maintenance costs can be significant because trawling tends to increase wear and tear on main and auxiliary engines and gear. Between 2015–16 and 2019–20, output prices received by fishers for tiger prawns, banana prawns and endeavour prawns all decreased.

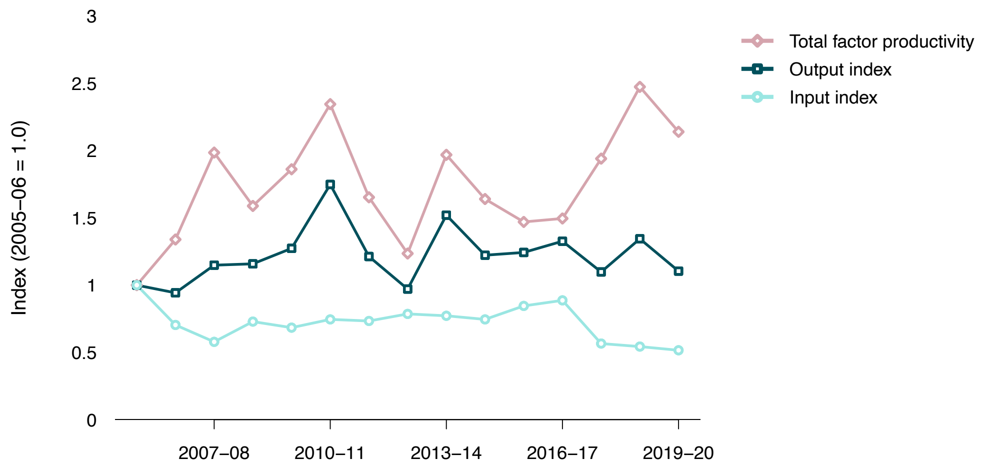
Decreasing NER since 2015–16 have also coincided with a period of growth in TFP (Figure 4.14). The growth in TFP between 2005–06 and 2019–20 can be attributed mainly to a reduction in inputs used in the fishery coinciding with a period of growth in outputs. In the early part of this period, a reduction in vessels operating in the fishery is likely to have resulted in a more-efficient fleet structure. In the later part of this period, improved conversion of inputs to outputs played a greater role in improving TFP. Since 2015–16, the growth in TFP has been significant, but not enough to offset the dampening effects of declining TOT on NER.

FIGURE 4.13 Terms of trade index, 2005–06 to 2019–20



Source: Dylewski & Curtotti 2022

FIGURE 4.14 Total factor productivity index, 2005–06 to 2019–20



Source: Dylewski & Curtotti 2022

Performance against economic objective

The tiger prawn component of the fishery has explicit MEY targets (across 2 tiger prawn stocks and 1 endeavour prawn stock), and a bio-economic model is used to estimate annual fishing effort required to move towards SB_{MEY} over a 7-year period. The targets can change with every assessment because of changes in biological and economic parameters. Targeting MEY of the tiger prawn component of the fishery began in 2004–05 and is consistent with the economic objective of maximising economic returns.

Overall, positive NER and TFP have been supported by stable fish stocks over the reporting period for the main target prawn species, indicating that resource rents from the fishery have been realised and not dissipated through overcapitalisation or liquidation of the fish stock. Although the status of red endeavour prawn stock is uncertain, this poses little risk to the economic performance of the fishery because the species makes a minor contribution to the GVP of the fishery.

However, an emerging issue for the fishery is the declining spawning sizes of both tiger prawn stocks at the end of the 2021 season (Deng et al. 2022). Stock sizes for these 2 species have been variable for the past decade but generally fluctuated around their respective MEY targets over most of this period. In addition, there is a declining trend in catch rates for tiger prawns since 2015 (Figs. 4.5, 4.8) and the preseason recruitment surveys indicate low relative post-recruitment abundance for many stocks. The impact of this trend on overall levels of NER is unclear and requires future monitoring.

4.4 Environmental status

EPBC Act approvals

The NPF was accredited under part 13 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) on 9 January 2019. The NPF also has export approval under part 13A of the EPBC Act until 6 January 2024. The strategic assessment that accompanied the export approval included 3 recommendations relating to the management and monitoring of sawfish and sea snake species (see Fry et al. 2021). Based on these recommendations, AFMA is required to facilitate research and monitoring programs that increase knowledge on the interactions between fishing gears and sawfish and sea snake species; facilitate research and monitoring programs that investigate the population dynamics of sawfish within the areas fished by the NPF; and implement mitigation measures that increase the survival of sawfish and sea snake species.

Ecological risk assessments

Tiger prawn subfishery

A scale, intensity, consequence analysis (SICA) for the tiger prawn subfishery of the NPF in 2021 identified that one or more species within the byproduct and bycatch and protected species categories may be at moderate or higher risk from the direct impact of fishing (Sporcic et al. 2021a), requiring either direct management of identified risks or further risk assessment. Habitats and communities were also assessed in 2021. Results indicate habitats may be at moderate or higher risk from the direct impact of fishing.

In 2021, a productivity susceptibility analysis (PSA) considered 11 byproduct, 177 bycatch, and 41 protected species (Sporcic et al. 2021a). Of these, 132 bycatch and 7 protected species were categorised at high risk, with the remainder at medium (3 byproduct, 29 bycatch and 32 protected species) and low (8 byproduct, 16 bycatch and 2 protected species) risk. In 2021, a residual risk assessment on the high-risk species, which took into account the mitigating effect of management measures, indicated that narrow sawfish (*Anoxypristis cuspidate*) and dwarf sawfish (*Pristis clavata*) may remain at high risk (Sporcic et al. 2021a). The overall risk scores for green sawfish (*Pristis zijsron*) and freshwater sawfish (*Pristis pristis*) also increased from medium to precautionary high risk.

In 2021, a base sustainability assessment for fishing effects (SAFE) for the tiger prawn subfishery found that, of the 352 species assessed, no species were identified as being at ≥ high risk from the level of fishing effort considered (Sporcic et al. 2021a).

Banana prawn subfishery

A SICA for the banana prawn subfishery of the NPF in 2021 identified that 1 or more species within the byproduct and bycatch and protected species categories may be at moderate or higher risk from the direct impact of fishing (Sporcic et al. 2021b) requiring either direct management of identified risks or further risk assessment. Habitats and communities were also assessed in 2021. Results indicate habitats may be at moderate or higher risk from the direct impact of fishing.

In 2021, a PSA considered 14 byproduct, 97 bycatch and 39 protected species (Sporcic et al. 2021b). Of these, 66 bycatch and 9 protected species were categorised at high risk, with the remainder at medium (4 byproduct, 19 bycatch and 29 protected species) and low (10 byproduct, 12 bycatch and 1 protected species) risk. In 2021, a residual risk assessment on the high-risk species, which took into account the mitigating effect of management measures, indicated that narrow sawfish (*Anoxypristis cuspidate*) and dwarf sawfish (*Pristis clavata*) may remain at high risk (Sporcic et al. 2021b). The overall risk scores for green sawfish (*Pristis zijsron*) and freshwater sawfish (*Pristis pristis*) also increased from medium to precautionary high risk.

In 2021, a base SAFE for the banana prawn subfishery found that, of the 237 species assessed, no species were identified as being at ≥ high risk from the level of fishing effort considered (Sporcic et al. 2021b).

Redleg banana prawn subfishery (JBG region)

In 2015, a base SAFE of the JBG region of the redleg banana prawn subfishery found that, of the 150 species considered, no species had an estimated fishing mortality rate (F) either at or higher than the minimum F required to drive the stock below the maximum sustainable mortality level (F_{MSM}) (Zhou et al. 2015).

Ecological risk management

In managing the ecological risks identified for its fisheries, AFMA implements ecological risk management (ERM) strategies for species identified as being at high risk. Fishery-specific ERM strategies can be found on the AFMA website.

Threatened, endangered and protected species interactions

In accordance with accreditation under the EPBC Act (see Chapter 1), AFMA publishes and reports quarterly on interactions with protected species on behalf of Commonwealth fishing operators to the Department of Climate Change, Energy, the Environment and Water (DCCEEW). During 2021, 15,462 interactions with protected species were reported in the NPF: 13,926 unspecified sea snakes (11,405 alive, 2,416 dead, 50 injured and 55 released in an unknown condition), 188 unspecified sawfish (137 alive, 33 dead, 9 injured and 9 released in an unknown condition), 81 green sawfish (Pristis zijsron; 46 alive, 31 dead and 4 injured), 995 narrow sawfish (*Anoxypristis cuspidata*; 553 alive, 399 dead, 34 injured and 9 released in an unknown condition), 65 freshwater sawfish (*P. pristis*; 41 alive, 21 dead and 3 injured), 17 dwarf sawfish (P. clavata; 14 alive and 3 dead), 12 unspecified seahorses and pipefish (4 alive and 8 dead), 1 unspecified dolphin (alive), 68 green turtles (*Chelonia mydas*; 67 alive and 1 released in an unknown condition), 2 leatherback turtles (*Dermochelys coriacea*; both alive), 34 flatback turtles (*Natator depressus*; 32 alive, 1 dead and 1 injured), 9 hawksbill turtles (*Eretmochelys imbricata*; all alive), 9 loggerhead turtles (*Caretta caretta*; all alive) and 6 olive ridley turtles (*Lepidochelys olivacea*; all alive).

These reported interactions with protected species form part of the ongoing monitoring by DCCEEW of the performance of fisheries within their accreditation under the EPBC Act.

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Prawns
Mike Gerner, AFMA