Queensland rocky reef finfish harvest and catch rates

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Queensland Government

This publication has been compiled Joanne Wortmann of the Department of Agriculture and Fisheries, Queensland.

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1 Introduction

The Queensland rocky reef finfish fishery consists of prominent commercial, charter and recreational line fishing sectors. In general, about eight different fish species are harvested—snapper (*Chrysophrys auratus*), pearl perch (*Glaucosoma scapulare*), teraglin (*Atractoscion aequidens*), cobia (*Rachycentron canadum*), grass emperor (*Lethrinus laticaudis*), amberjack (*Seriola dumerili*), samsonfish (*Seriola hippos*) and yellowtail kingfish (*Seriola lalandi*). Fishers mainly target snapper and pearl perch.

Most of the rocky reef species are shared stocks between New South Wales and Queensland (Figure 1). For the purposes of this report we will only be focussing on the Queensland portion of the shared stock. Future stock assessments will model the entire stock in Queensland and New South Wales waters.

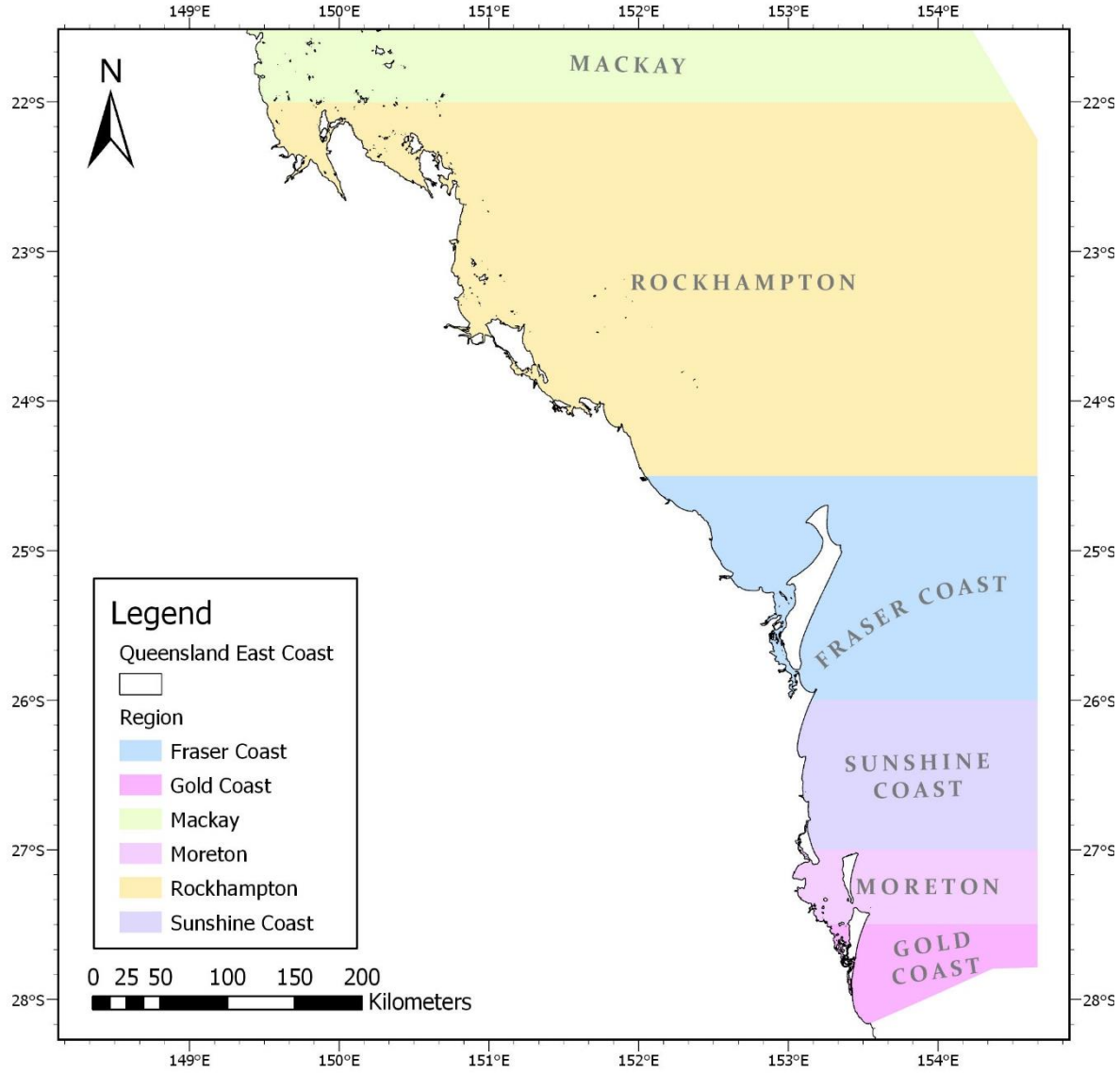

Figure 1: Map of Queensland waters and spatial stratifications for rocky reef finfish

A range of management rules have been implemented over the years and include minimum legal size, in-possession limits, licencing requirements, logbook requirements, apparatus restrictions, seasonal closures and total allowable commercial catch limits. In September 2019, Queensland introduced a new seasonal closure for snapper and pearl perch that applies to all fishing sectors from

15 July to 15 August each year, and a total allowable commercial catch limit of 42 t for snapper and 15 t for pearl perch.

Previous stock assessments for snapper were published in Allen et al. (2006), Campbell et al. (2009) and Wortmann et al. (2018). The stock assessment of snapper in Wortmann et al. (2018) used data up until 2016. The first stock assessment of pearl perch was published in Sumpton et al. (2016) and used data up until 2014. In the previous stock assessments, New South Wales and Queensland were considered. Updated results for Queensland are presented in this report. Updated results for New South Wales are shown in Appendix C.

The aim of this report is to:

- inform management and stake holders of the condition of the stocks in the years between stock assessments
- assess current harvest (commercial and charter) against previous target reference points for achieving maximum sustainable yield and yield for 60% unfished biomass—these yields were calculated for snapper (Wortmann et al. 2018) and pearl perch (Sumpton et al. 2016) for all fishing sectors and waters in Queensland
- determine relative long-term trends in fish abundance from the Queensland commercial logbook standardised catch rates for rocky reef finfish species—this index is of great importance as it informs proportionally on the magnitude of change in the fished (exploitable) population.

2 Methods

The fishing year is defined as a calendar year.

Commonly caught rocky reef fish were classified into a species for the purpose of this assessment (Table 1).

Table 1: Definitions for species groups

Group	Species common name	Species scientific name
Cobia	Kingfish – black	*Rachycentron canadum*
Grass emperor	Emperor – grass	*Lethrinus laticaudis*
Kingfish	Kingfish – unspecified	
Kingfish	Amberjack	*Seriola dumerili*
Kingfish	Samsonfish	*Seriola hippos*
Kingfish	Kingfish – yellowtail	*Seriola lalandi*
Pearl perch	Perch – pearl	*Glaucosoma scapulare*
Snapper	Snapper (squire)	*Chrysophrys auratus*
Teraglin	Teraglin	*Atractoscion aequidens*

2.1 Harvest

The most recent catch data from commercial and charter logbooks were provided (Table 2). Commercial logbook records were from 1988 to 2018. Pearl perch was not included in the logbooks until 2004. Data on the charter fishery have not been available for as long as the commercial fishery. The charter logs were initially voluntary, only being made compulsory from 1996 to July 2006, although there were some operators who did not submit logbooks. After 1 July 2006, only those operators in offshore waters were required to hold a licence and submit logbook data.

Table 2: List of data sources

Name	Description	Time period	Date supplied/sourced	Data collated
Queensland commercial logbooks	Daily catch and effort data	01.01.1988 – 31.12.2018	12.08.2019	Commercial harvest Commercial catch rate standardisation for line fishing methods
Queensland charter logbooks	Daily catch and effort data	19.12.1993 – 31.12.2018	12.08.2019	Charter harvest

2.2 Standardised catch rates

The datasets and methods for the catch rate standardisations were collated and developed from Wortmann et al. (2018). The catch rate standardisations used the statistical application of linear mixed models using restricted maximum likelihood. The analyses used daily logbook information. The catch rate standardisation was programmed in Genstat (VSN International 2017).

The approach used to standardise catch rates assumed that harvest depended on the probability of a catch multiplied by the catchability and the biomass caught and retained (Wortmann et al. 2018). Catch rates were standardised for latitude (defined by one degree latitude bands in Figure 1), lunar phases, wind speed and direction, seasonality to identify the time of year and fishing power to account for variation in gear technologies (the impact of GPS, colour sounders and four-stroke engine) on fishing (Table 3 and Appendix A).

Table 3: List of data sources used to determine catchability for standardised catch rates

Name	Description	Time period	Date supplied/source
Latitude band	One degree latitude bands (Figure 1)	1988–2018	This aimed to reduce bias introduced by systematic changes in the spatial distribution of fishing (Carruthers et al. 2011)
Lunar phase	A sinusoidal luminance (lunar) pattern	1988–2018	(Leigh et al. 2014)
Wind speed and direction	Recorded measures of wind speed (km hour^{-1}) and direction (degrees for where the wind blew from) for Queensland	1988–2018	12.09.2018 Data from bom.gov.au
Seasonality	Daily seasonal patterns corresponding to autumn, winter, spring and summer	1988–2018	Figure 5.4 from (Wortmann et al. 2018)
Fishing power	Annual time series of gear and technology use Four time series to account for: 1. no fishing power 2. reduced fishing power 3. actual fishing power as estimated by fishers 4. higher fishing power	1988–2016	Data from (Sumpton et al. 2013; Thurstan, Buckley, and Pandolfi 2016) Fishing power for the years 2017 and 2018 were assumed to be equal to the fishing power of 2016 Figure 3.7 of (Wortmann et al. 2018) shows the fishing power time series

The catch records from commercial logbooks were filtered for catch rate standardisation (Table 4) to produce daily catch records with no duplicate fisher-day combinations.

Table 4: Catch record data inclusions and exclusions for catch rate standardisation (no filters were applied to logbooks for harvest totals)

Data	Notes
Line methods of fishing	Included in the catch rate analysis— 99% of catch records for rocky reef finfish were for line methods of fishing
Any catch record that was over multiple fishing days	Excluded from the catch rate analysis—98% of line fishing records were on a single day
Boats that had fished for less than 1 year or more than 1 year but less than 20 days	Excluded from the catch rate analysis to get a useful time series of fisher-day records—85% of records fished for more than 1 year and more than 20 days.
30 by 30 minute logbook grids	Grids that included 95% of the harvest were included in the catch rate analysis

Four annual indices of fish abundance (1988–2018) were produced, corresponding to the four fishing power scenarios (Table 3). Standard errors or 95% confidence intervals were calculated for all predictions.

Catch rates were not standardised for the charter fishing sector. The charter logbook data were incomplete and had limited associated effort information and therefore may have underestimated the total number of fish caught (both retained and discarded) (Wortmann et al. 2018).

3 Results and discussion

3.1 Harvest

Over the 5-year periods (2004–2008, 2009–2013 and 2014–2018), average annual commercial harvest of rocky reef finfish declined from 346 t to 182 t to 126 t (Figure 2). Effort (boat days fished) decreased from 4899 days to 3648 days to 2974 days (Figure 2). For the individual groups, harvest generally peaked in 2005 and decreased thereafter (Figure 3). Annual average snapper and pearl perch harvest made up 75% and 60% of total harvest for the periods 2004–2013 and 2014–2018.

Over the 5-year periods (2004–2008, 2009–2013 and 2014–2018), average annual charter harvest of rocky reef finfish declined from 111 t to 94 t to 52 t (Figure 4). Effort (boat days fished) decreased from 4353 days to 3825 days to 2973 days (Figure 4). For the individual groups, harvest generally peaked in 2004–2008 and decreased thereafter (Figure 5). Annual average proportion of snapper and pearl perch out of total harvest was consistent over the last 15 years at around 60%.

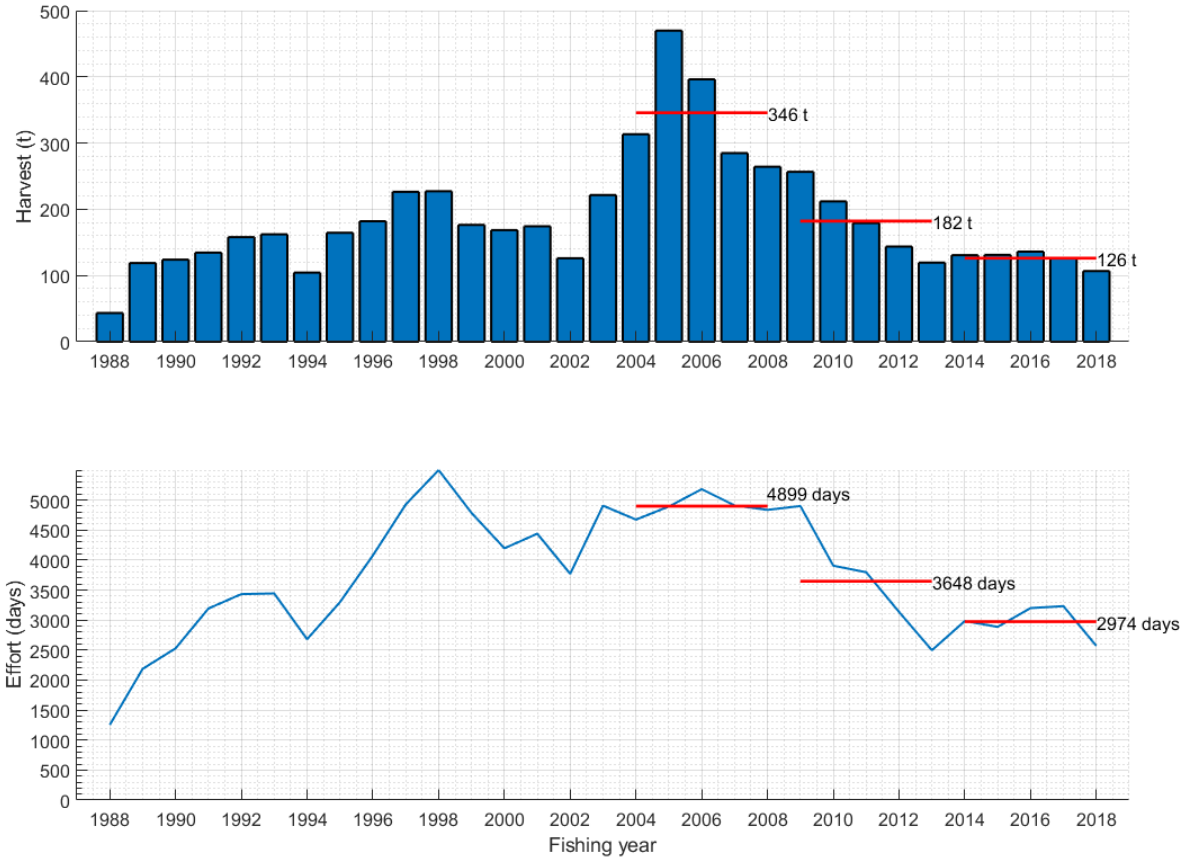

Figure 2: Annual commercial catch (tonnes) and effort (boat days fished) in the Queensland rocky reef finfish fishery (1988–2018)—the red lines show the average over 5 years

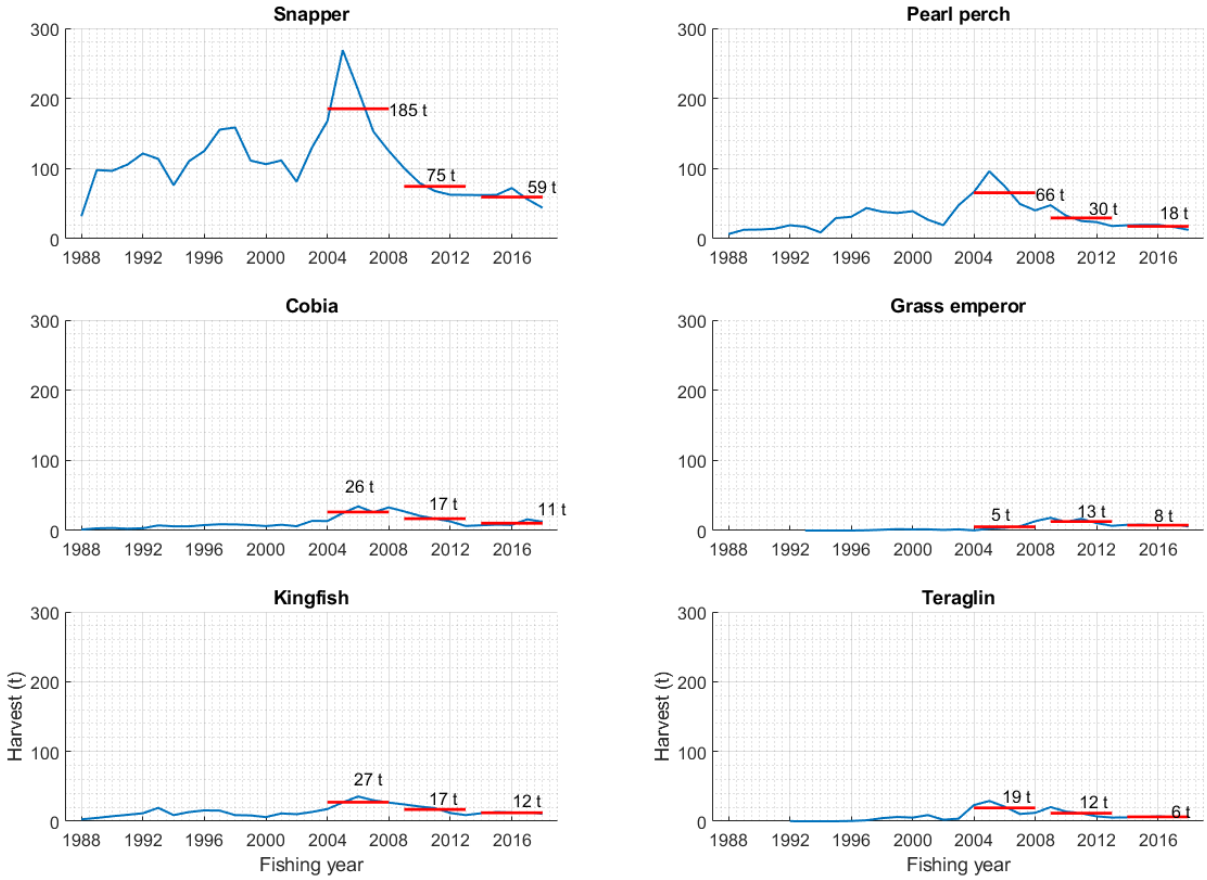

Figure 3: Annual commercial catch (tonnes) for the key species groups (1988–2018)—the red lines show the average over 5 years

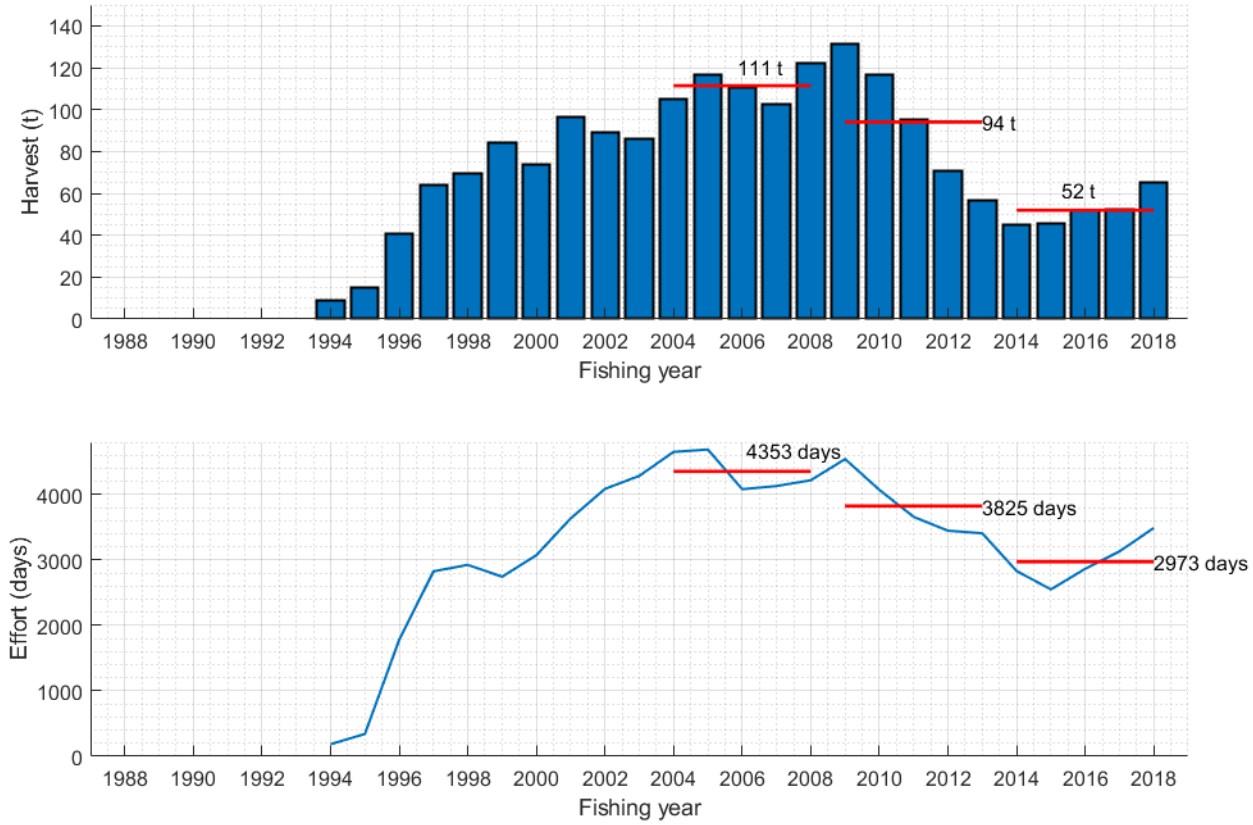

Figure 4: Annual charter catch (tonnes) and effort (boat days fished) in the Queensland rocky reef finfish fishery (1988–2018)—the red lines show the average over 5 years

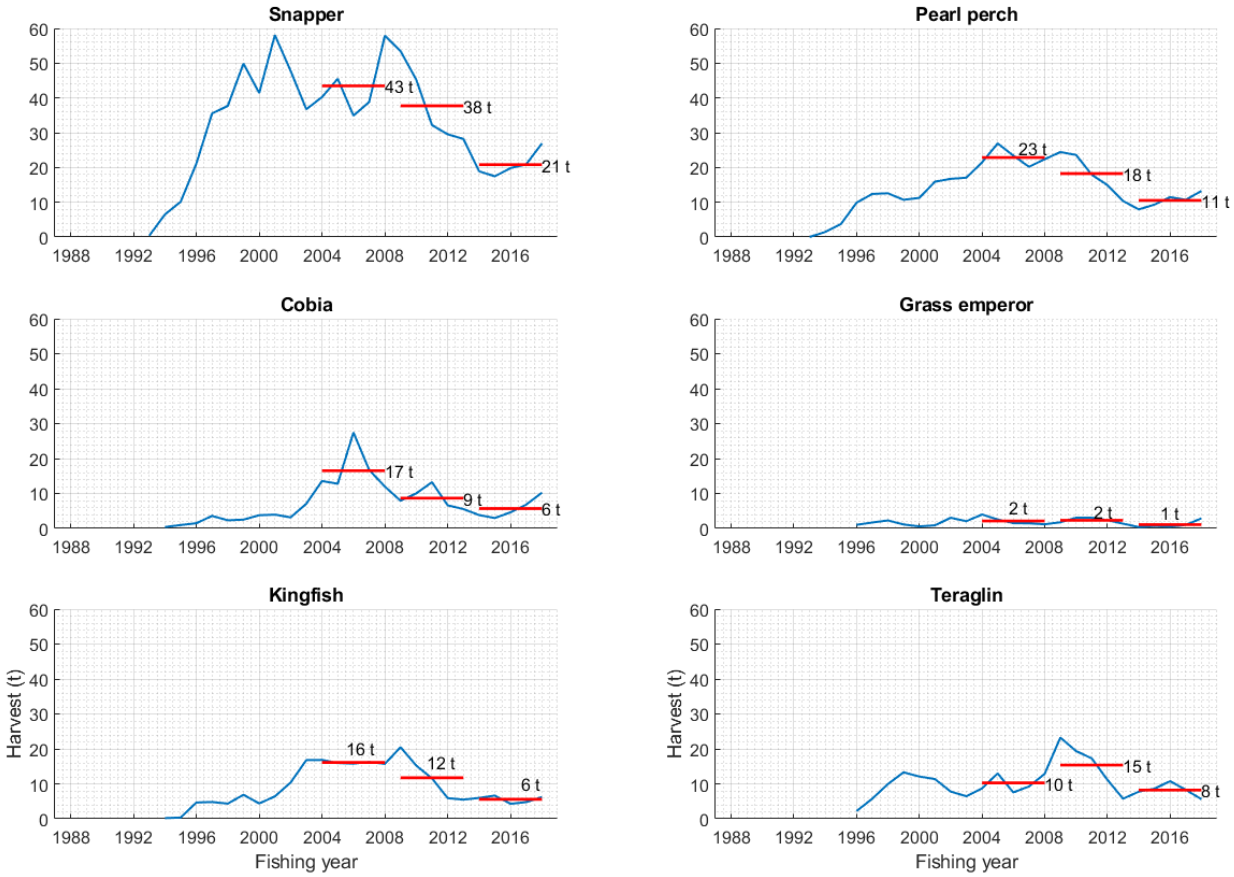

Figure 5: Annual charter harvest (tonnes) of the key species groups (1988–2018)—the red lines show the average over 5 years

3.2 Standardised catch rates

The catchability parameters of lunar phase, wind speed and wind direction did not influence catch rates. Region (defined by latitude band), seasonality and fishing power were significant factors, which influenced the catch rate standardisation (Figure 6):

- Latitude band—When catch rates were standardised to fishing all latitudes more equally, catch rates were higher than the reported or observed catch rate. This indicates that fishers had not been moving around to target areas with higher rocky reef catches and that fishing had not been spatially aggregated (clustered).
- Seasonality—When catch rates were standardised to fishing all seasons more equally, catch rates were higher than the reported or observed catch rate.
- Boat—When catch rates were standardised according to fishing with an average boat, catch rates were higher than the reported or observed catch rate, indicating that the better boats had left the rocky reef fishery.
- Fishing power—When catch rates were standardised according to technology (GPS, colour sounders and four-stroke engines), catch rates were lower than if fishing power had not been included in the standardisation. The adoption of colour sounders, GPS and four-stroke engines from 1990 are associated with higher catches.

Catch rates for snapper and pearl perch declined from 2005 onwards (Figure 7). Low levels of harvest in the last 5 years for snapper and pearl perch may have possibly influenced the increase in catch

rates from 2017 to 2018. Kingfish had relatively constant catch rates (Figure 7). Catch rates for cobia and grass emperor declined from 2008 onwards and showed a slight increase in recent years. The catch rates in Figure 7 are standardised for actual fishing power effects as estimated by fishers. The adjustment for the effect of the technology in the catch rate standardisation effectively increased the catch rates during the early part of the data series, but had little impact on the last 14 years of data—technological advances had virtually been fully adopted in the offshore fleets of commercial fishers by 2004 (Appendix B).

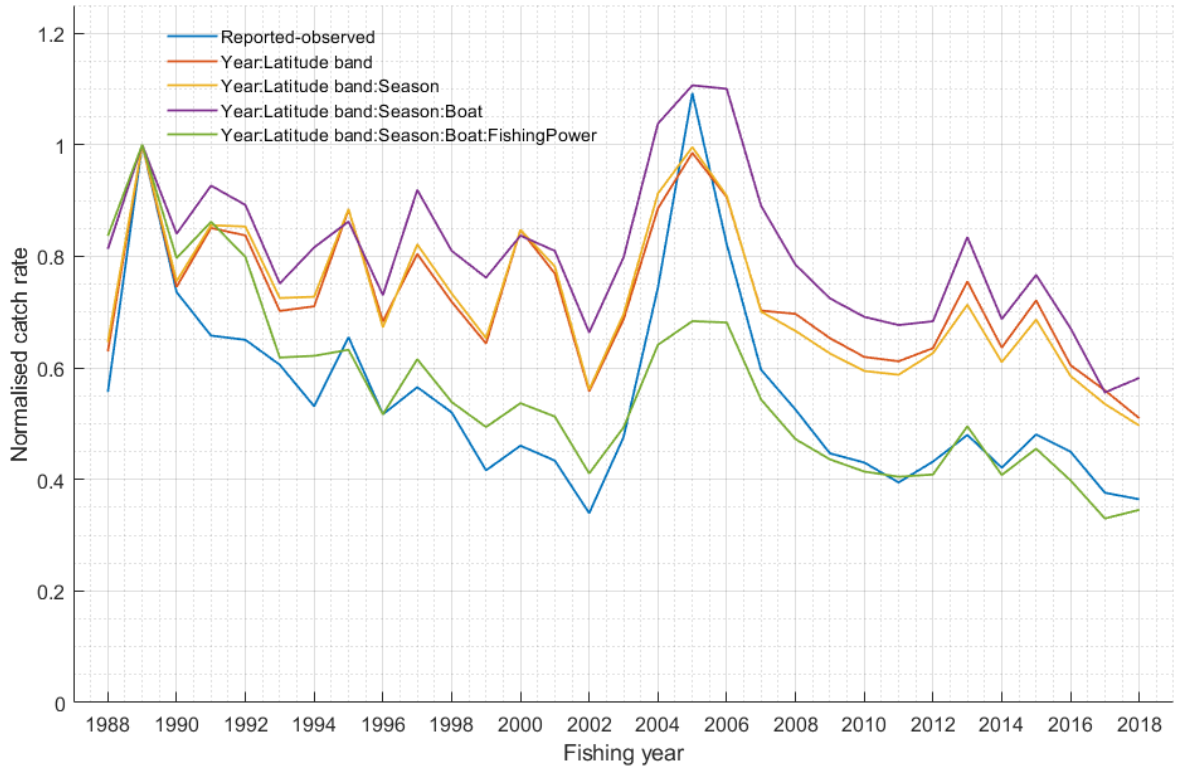

Figure 6: Influence of each factor in the commercial catch rate standardisation for snapper in Queensland (1988–2018)

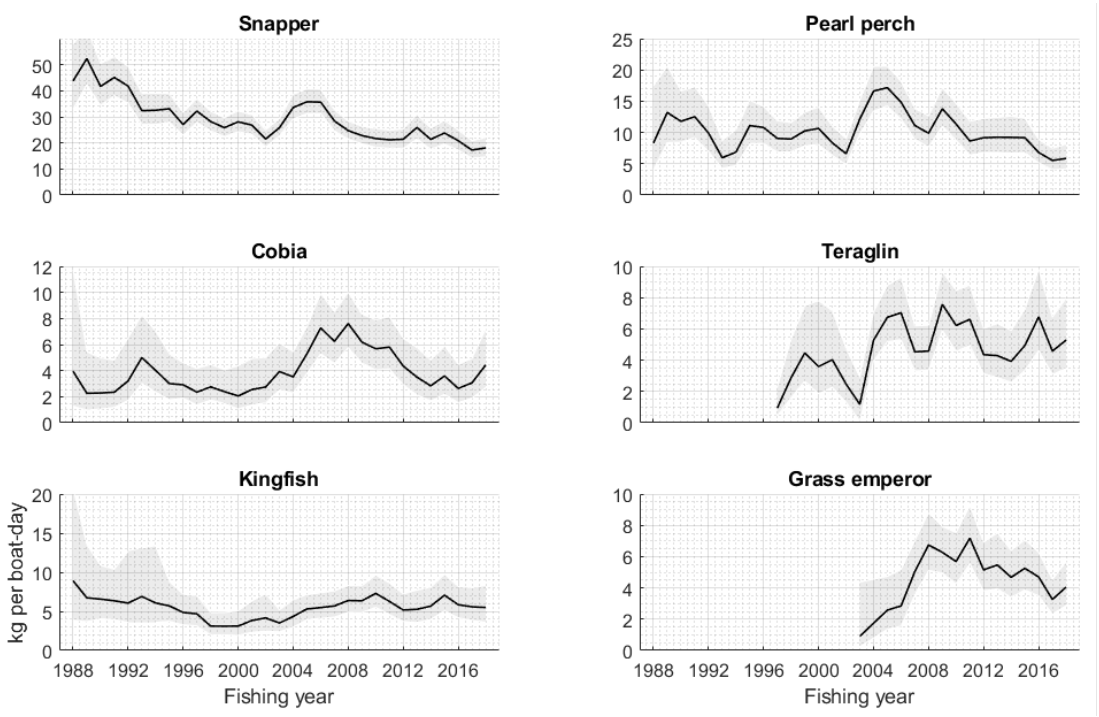

Figure 7: Standardised catch rates for key species groups for commercial line fishing for actual fishing power as estimated by fishers (with 95% CI)

3.3 Discussion

Although recent average annual commercial and charter catch were below sustainable levels, model outputs from Wortmann et al. (2018) estimated 2016 snapper biomass to be below 20% for all line fishing sectors. Catch rates declined further from 2016 to 2017, and showed a very small increase in 2018, indicating there is low abundance of snapper.

Estimated biomass in 2014 from the previous stock assessment for pearl perch was below 40% of virgin level (Sumpton et al. 2016). Since 2014, pearl perch catch rates have declined even further, indicating low abundance of pearl perch.

The management measures put in place in September 2019 for snapper and pearl perch of a commercial catch limit of 42 t and 15 t and a seasonal closure from 15 July to 15 August each year should remain to increase fish abundance and prevent further decline in catch rates.

The proportion of total commercial catch consisting of snapper and pearl perch has decreased over the last 10 years, indicating that snapper and pearl perch abundance is low.

The decline in catch rates for cobia and grass emperor is concerning, and further stock assessment analysis should be done to understand this trend.

4 References

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Wortmann, J, O'Neill, MF,Sumpton, W & Campbell, M 2018, *Stock assessment of Australian east coast snapper,* Chrysophrys auratus*: predictions of stock status and reference points for 2016*, <http://era.daf.qld.gov.au/id/eprint/6341>

Appendix A: Factors included in catch rate standardisation

Fisheries Queensland sourced wind direction and strength data from the Australian Government. The wind data were collected from 91 representative coastal weather stations along the Queensland east coast. The recorded measures of wind speed (km hour^{-1}) and direction (degrees for where the wind blew from) were converted to an average daily reading based on recordings between 3 am and 3 pm for each grid square defined in the Queensland commercial fishing logbooks. Missing values were imputed from measurements at the next nearest location. From these data the north–south and east–west wind components were calculated. Squared wind components were also included for each wind direction variable, resulting in a greater proportional weighting for higher wind speeds.

The lunar phase (luminance) was a calculated measure of the moon cycle with values ranging between zero (new moon) and one (full moon) for each day of the year. The luminance measure (lunar) followed a sinusoidal pattern and was copied and advanced 7 days (≈ ¼ lunar cycle) into a new variable to quantify the cosine of the lunar data (O'Neill and Leigh 2006). The two variables were modelled together to estimate the variation of harvest according to the moon phase (i.e. contrasting waxing and waning patterns of the moon phase).

Four trigonometric covariates were used, which together modelled an average monthly pattern of catch for seasonality (Marriott et al. 2013). Both sine and cosine functions were used together to identify the seasonal patterns of catch rates corresponding to autumn, winter, spring and summer periods.

The uptake rates of gears and technology, and fishers perceptions on how advances in fishing technology had improved their catches over time, were combined to calculate four time series of annual increases in fishing power for:

1. no change in fishing power
2. reduced fishing power from the square root of the actual fishing power
3. actual fishing power as estimated from the fisher knowledge data
4. high fishing power from the 75th percentile of the actual fishing power.

The reduced schedule of fishing power was calculated to account for possible overestimation (e.g. in the interviews, fishers may have overestimated the effect of a technology). The high effects scenario was generated to cover the case where other fishing power variables that were not surveyed were important for increasing fishing power (e.g. improved fishing experience through time or other gear and technology).

What was clear from interviews was the general view that technology had dramatically increased the ability of line fishers to catch fish. There were some fishers who had changed their activities little over the years, but this was only a small proportion of the people interviewed. The fact that many fishers attributed such a high level of impact of these technologies on their fishing power has important implications for the standardised catch data that are used in stock assessments. Catch rate trends that do not account for the impact of these technologies will present more optimistic views of stock status.

Appendix B: Standardised catch rates

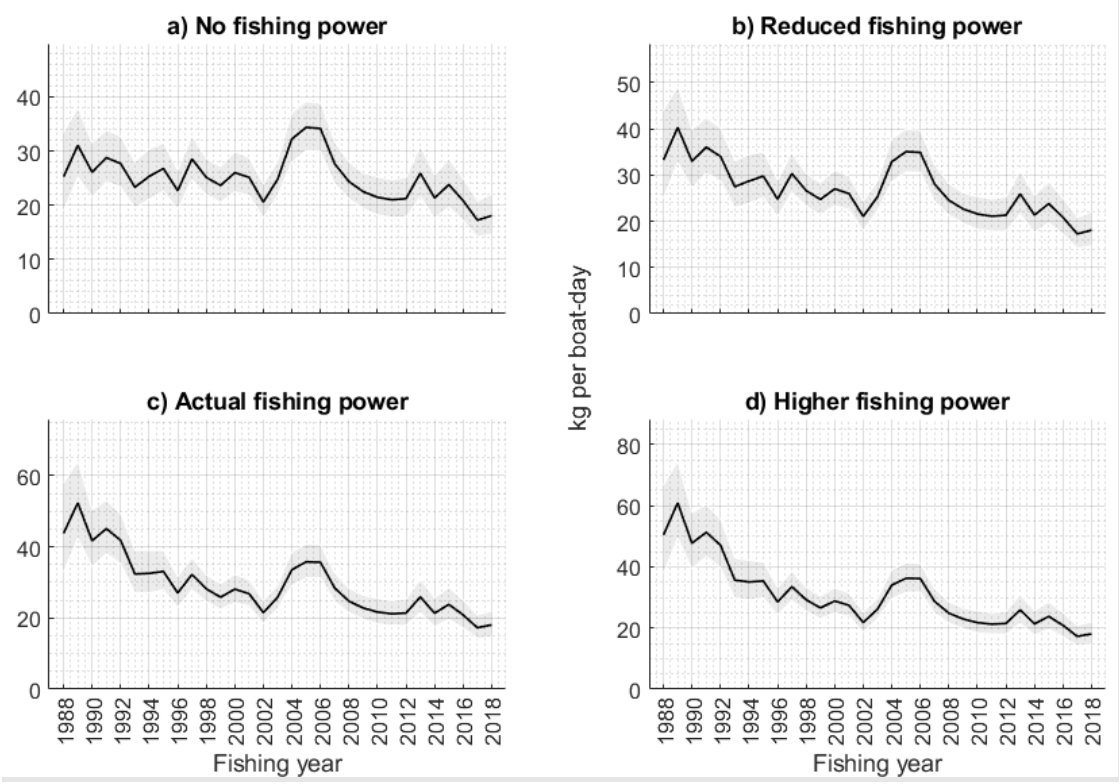

Figure 8: Standardised catch rates for snapper (1988–2018) for the Queensland commercial line fishing sector

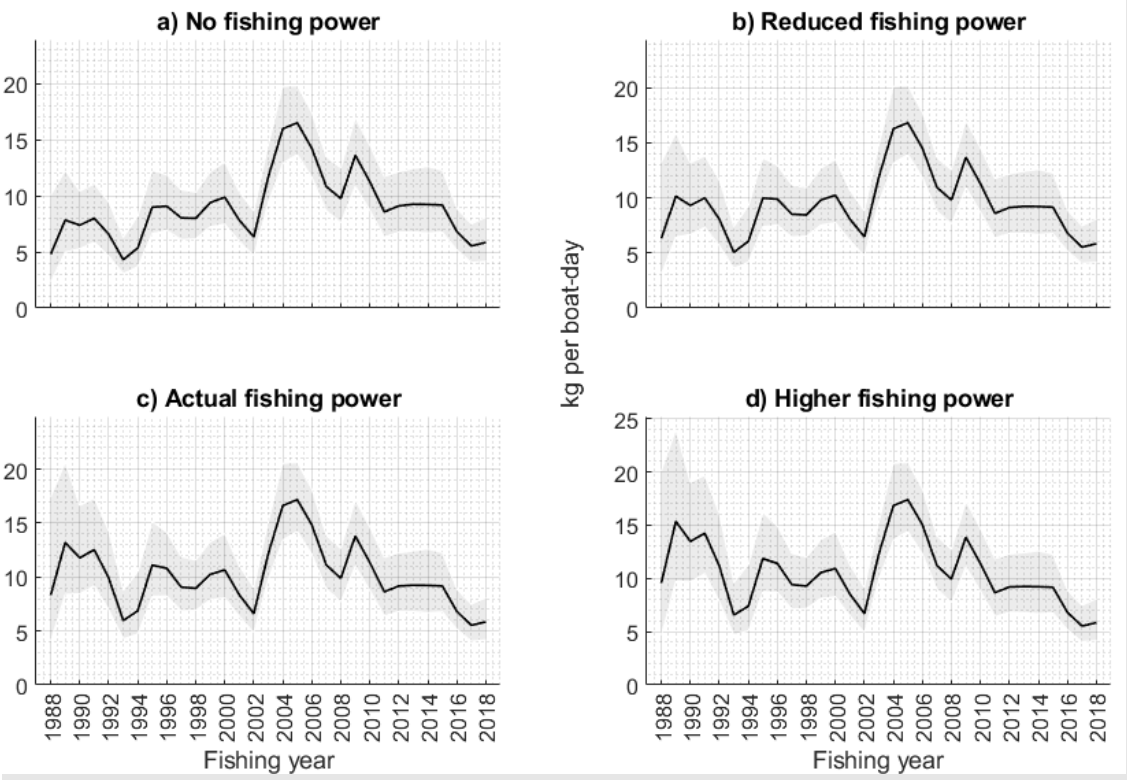

Figure 9: Standardised catch rates for pearl perch (1988–2018) for the Queensland commercial line fishing sector

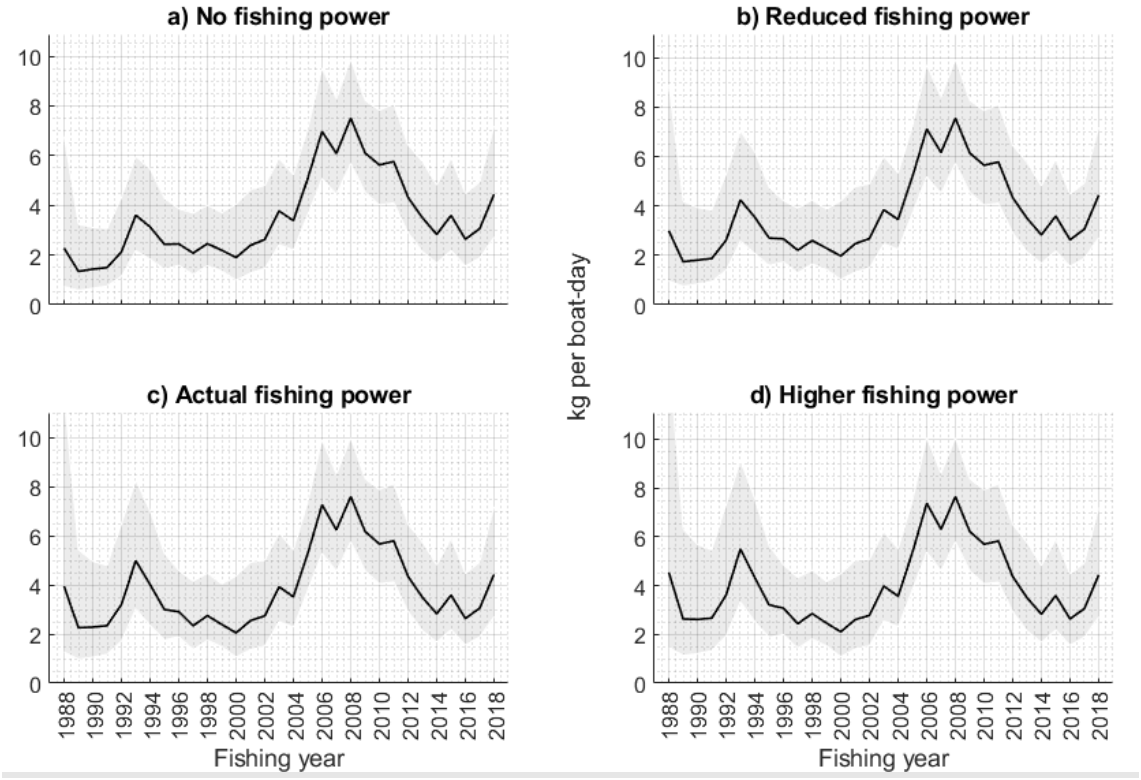

Figure 10: Standardised catch rates for cobia (1988–2018) for the Queensland commercial line fishing sector

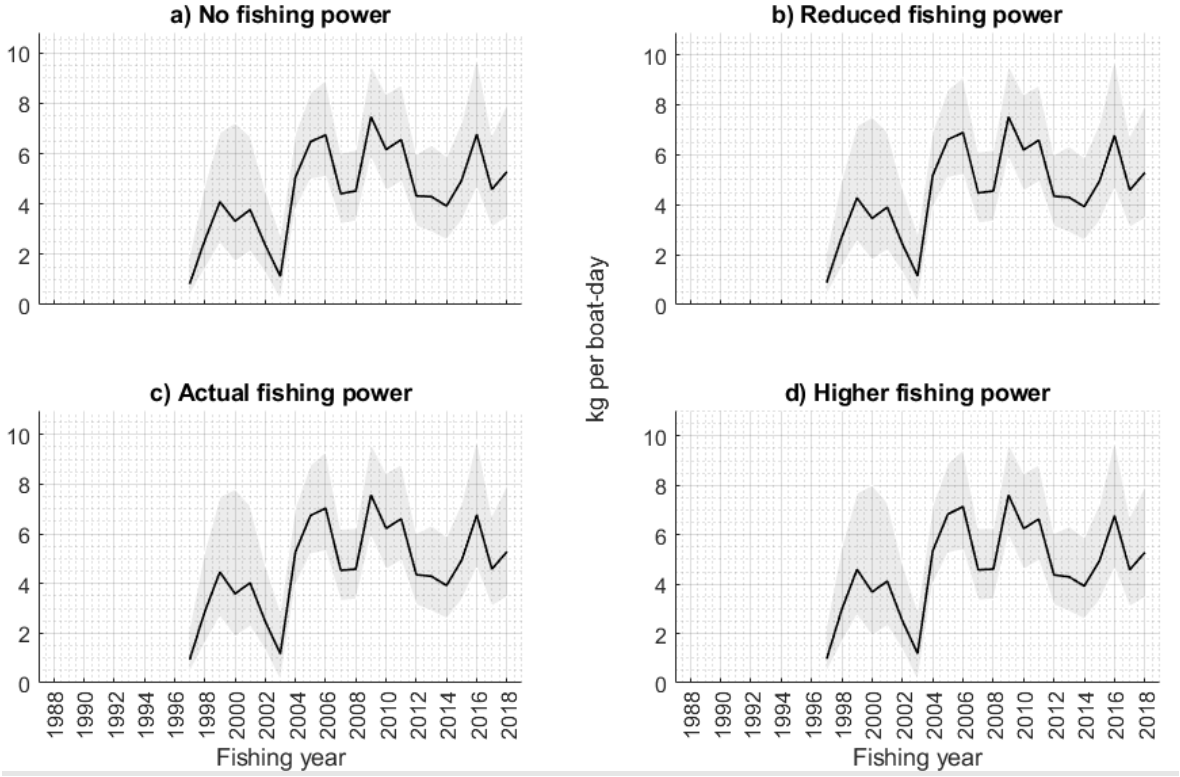

Figure 11:Standardised catch rates for teraglin (1988–2018) for the Queensland commercial line fishing sector

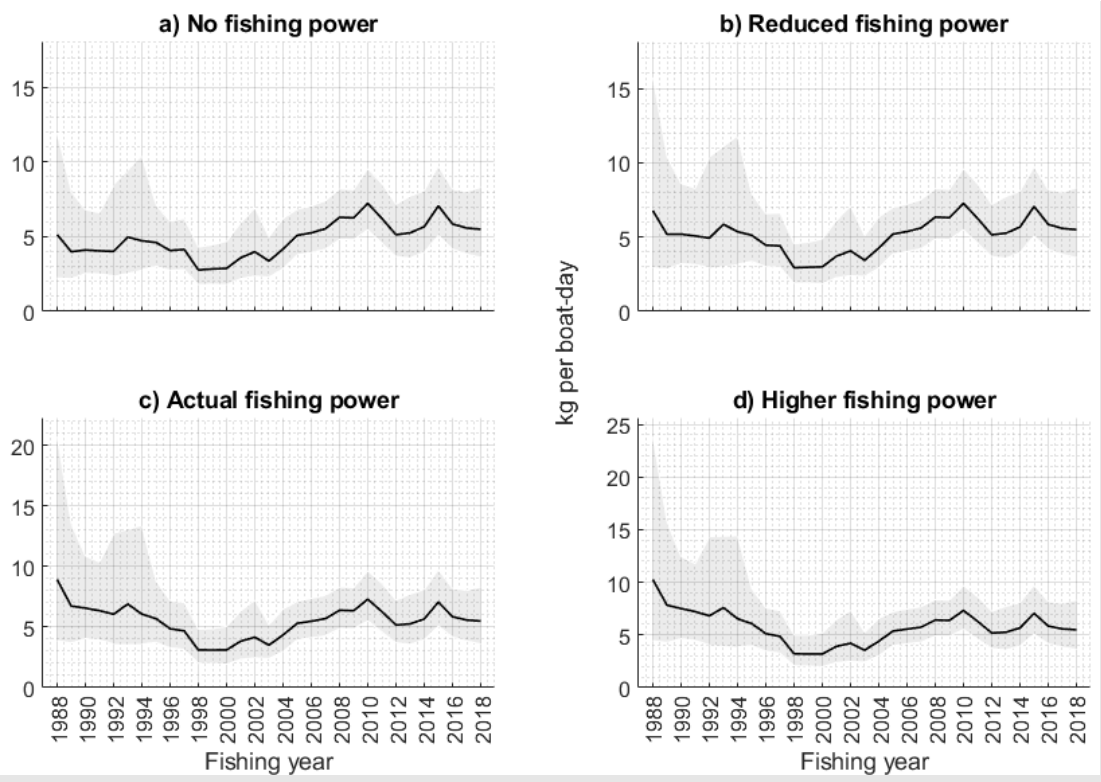

Figure 12: Standardised catch rates for kingfish (1988–2018) for the Queensland commercial line fishing sector

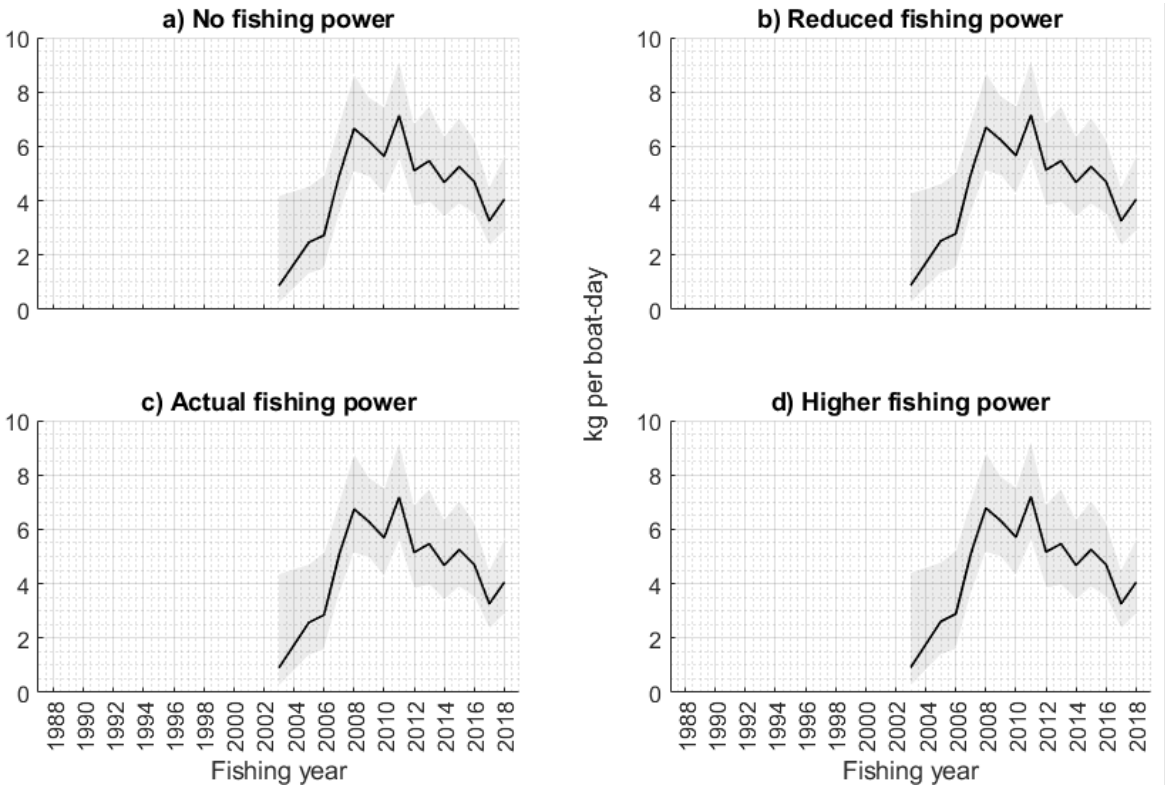

Figure 13: Standardised catch rates for grass emperor (1988–2018) for the Queensland commercial line fishing sector

Appendix C: New South Wales jurisdiction

The most recent snapper and pearl perch catch data from commercial and charter logbooks were provided (Table 5). Most of the commercial snapper catch comes from New South Wales (about 81%), and most of the commercial pearl perch catch comes from Queensland (about 60%) (Figure 14 and Figure 15).

Table 5: List of data sources

Name	Description	Time period	Date supplied/sourced	Data collated
New South Wales commercial logbooks	Monthly catch and effort data	01.07.1984 – 31.12. 2018	25.07.2019	Commercial harvest Commercial catch rate standardisation for trap and line fishing methods
New South Wales charter logbooks	Annual catch	2001–2018	25.07.2019	Charter harvest

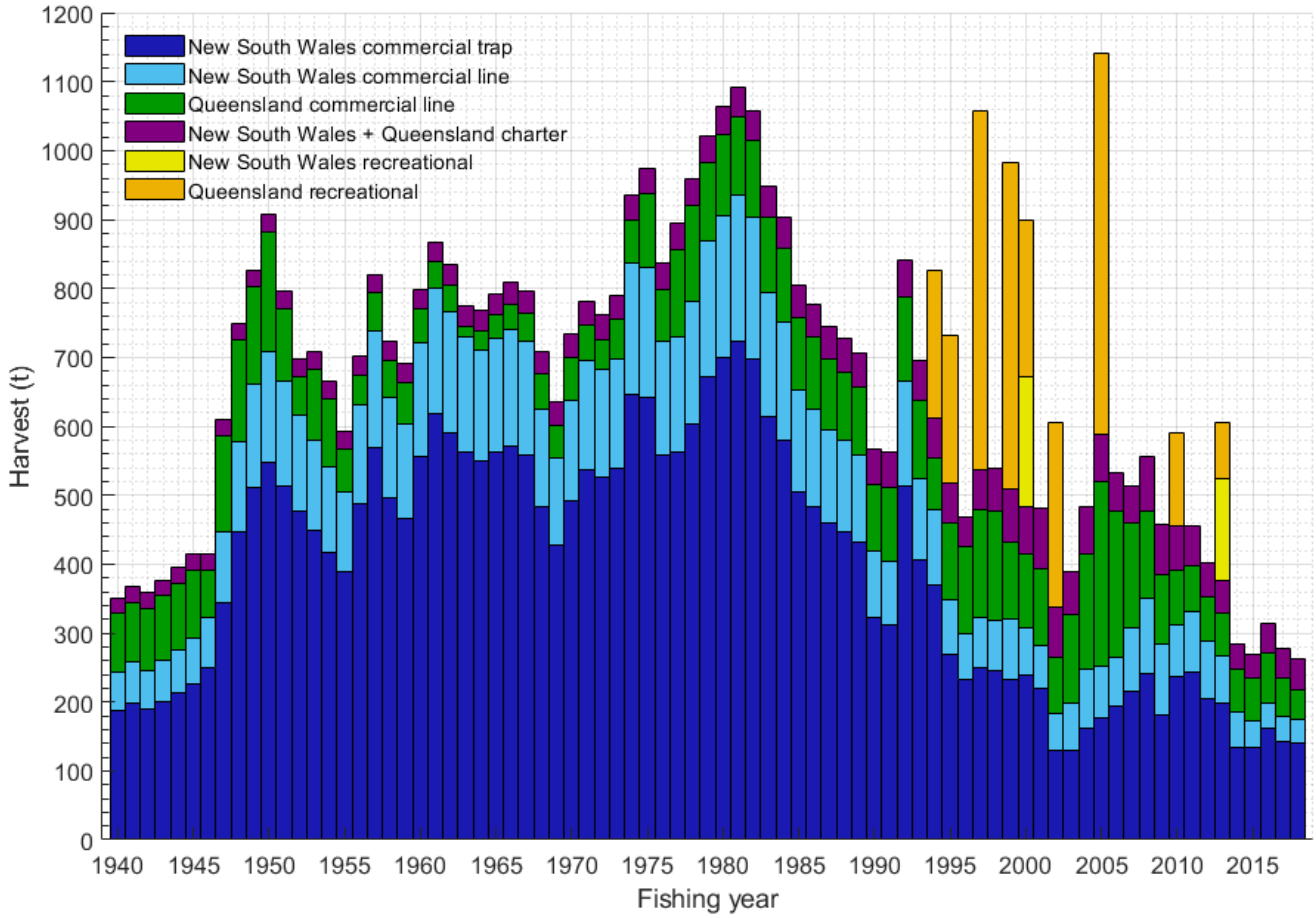

Figure 14: Estimated annual snapper harvest from New South Wales and Queensland (1940–2018)—recreational estimates are from surveys described in Wortmann et al. (2018)

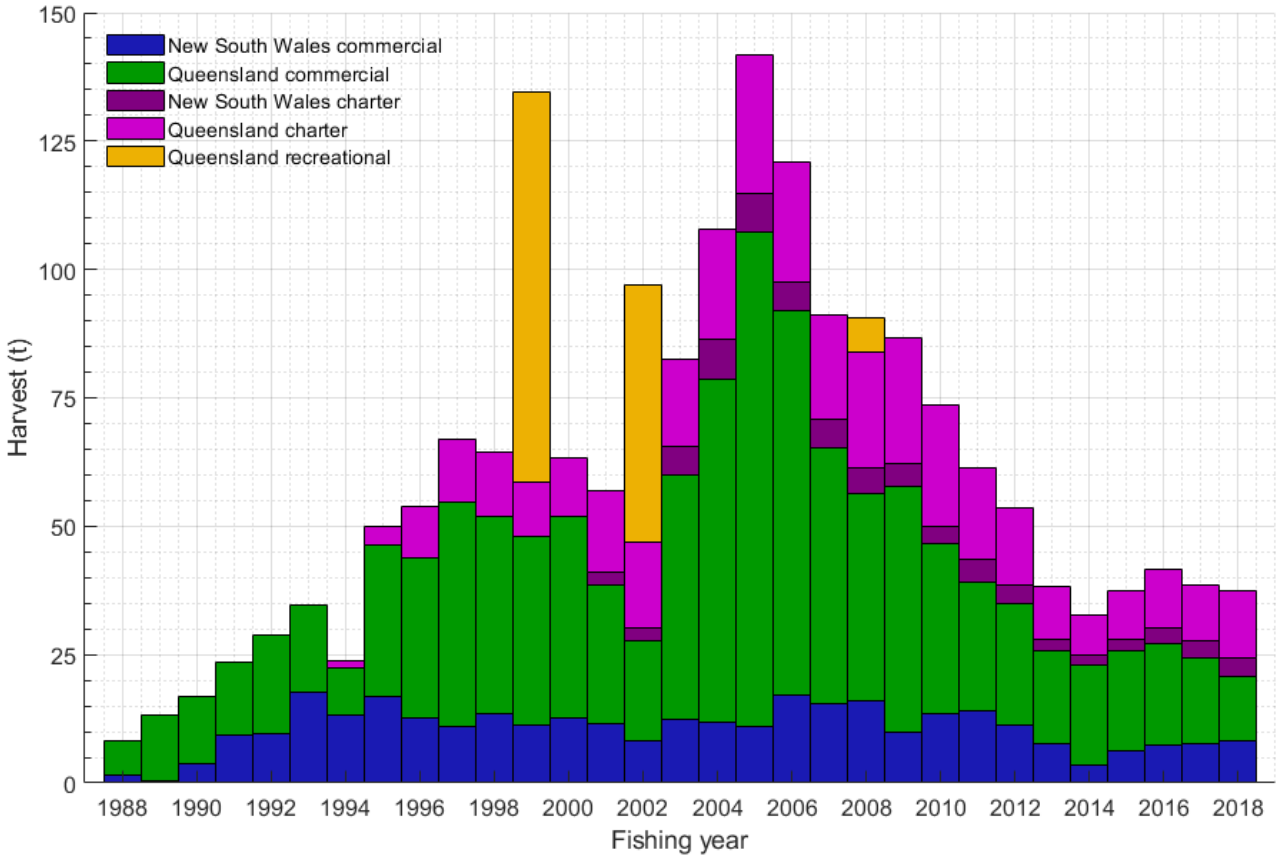

Figure 15: Estimated annual pearl perch harvest from Queensland and New South Wales (1988–2018)—the 2005 recreational survey estimate is not shown in this figure because it was problematic as the estimate was well above other years as per Table 9 in Sumpton et al. (2016); the recreational estimates were taken from the 2014 stock assessment in Sumpton et al. (2016), which did not have the 2013 recreational estimate

The filters applied to the commercial logbook data for catch rate standardisation were that boats that had fished for less than 1 year or more than 1 year but less that 20 days were excluded from the analysis (13% of logbook records for snapper, 12% of logbook records for pearl perch). This was so that there was a long time series of boats in the fishery. Catch rates were standardised for trap (60% of logbook records) and line (40% of logbook records) methods of fishing.

The datasets and methods for the catch rate standardisations were collated and developed from Wortmann et al. (2018). The catch rate standardisations used the statistical application of linear mixed models using restricted maximum likelihood. The analyses used daily logbook information. The catch rate standardisation was programmed in Genstat (VSN International 2017).

The approach used to standardise catch rates assumed that harvest depended on the probability of a catch multiplied by the catchability and the biomass caught and retained (Wortmann et al. 2018). Catch rates were standardised for latitude, lunar phases, seasonality to identify the time of year, and fishing power (changes in gear and technology) (Figure 16, Figure 17 and Figure 18).

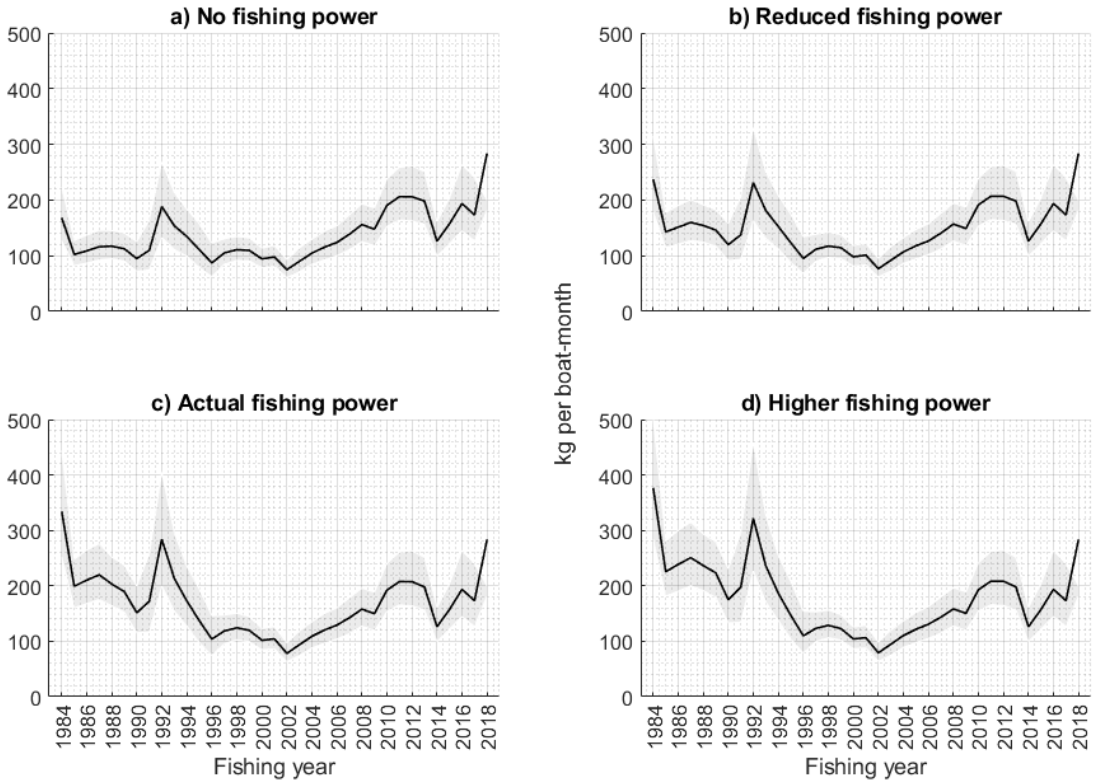

Figure 16: Standardised catch rates for snapper (1984–2018) from New South Wales commercial trap fishing sector

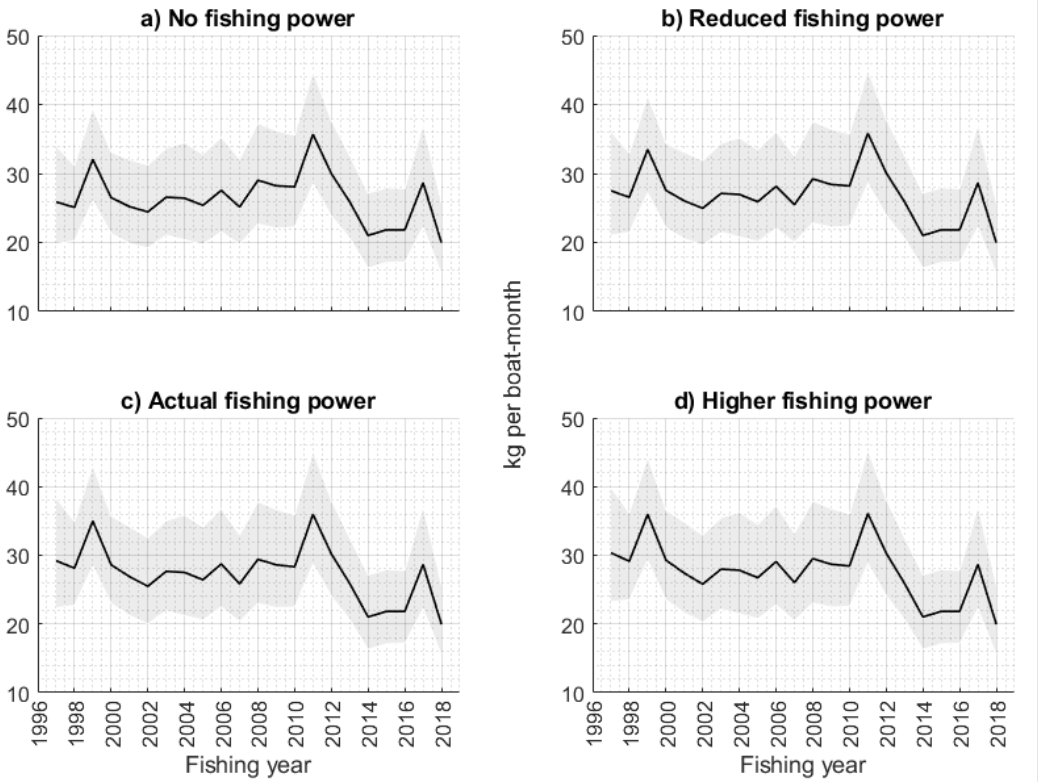

Figure 17: Standardised catch rates for snapper (1984–2018) from New South Wales commercial line fishing sector

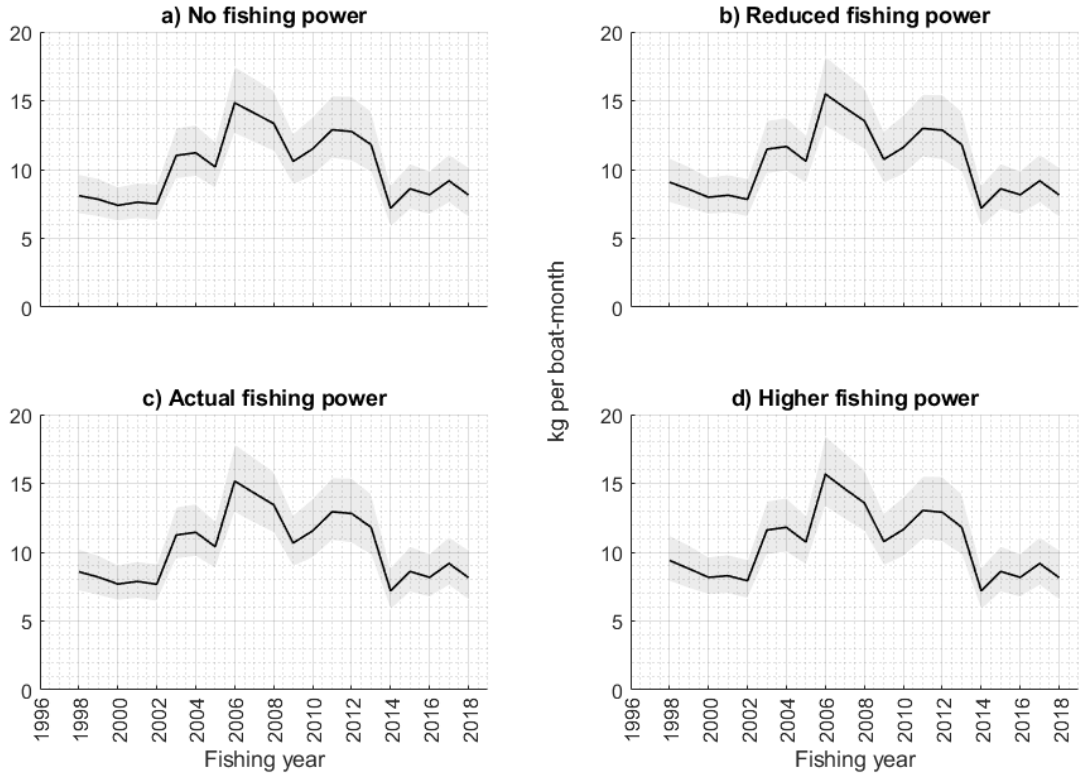

Figure 18: Standardised catch rates for pearl perch (1984–2018) from New South Wales commercial line fishing sector

In order to compare catch rates between states and fishing methods, the catch rates were normalised to the average catch rate from 1997 to 2010. The standardised catch rates for snapper for commercial trap and line fishing methods showed declining trends until 2002, after which trap fishing showed a recovery in catch rates while line fishing generally did not (Figure 19).

There was an overall increasing trend in pearl perch commercial standardised catch rates until 2006, after which both jurisdictions catch rates declined (Figure 20).

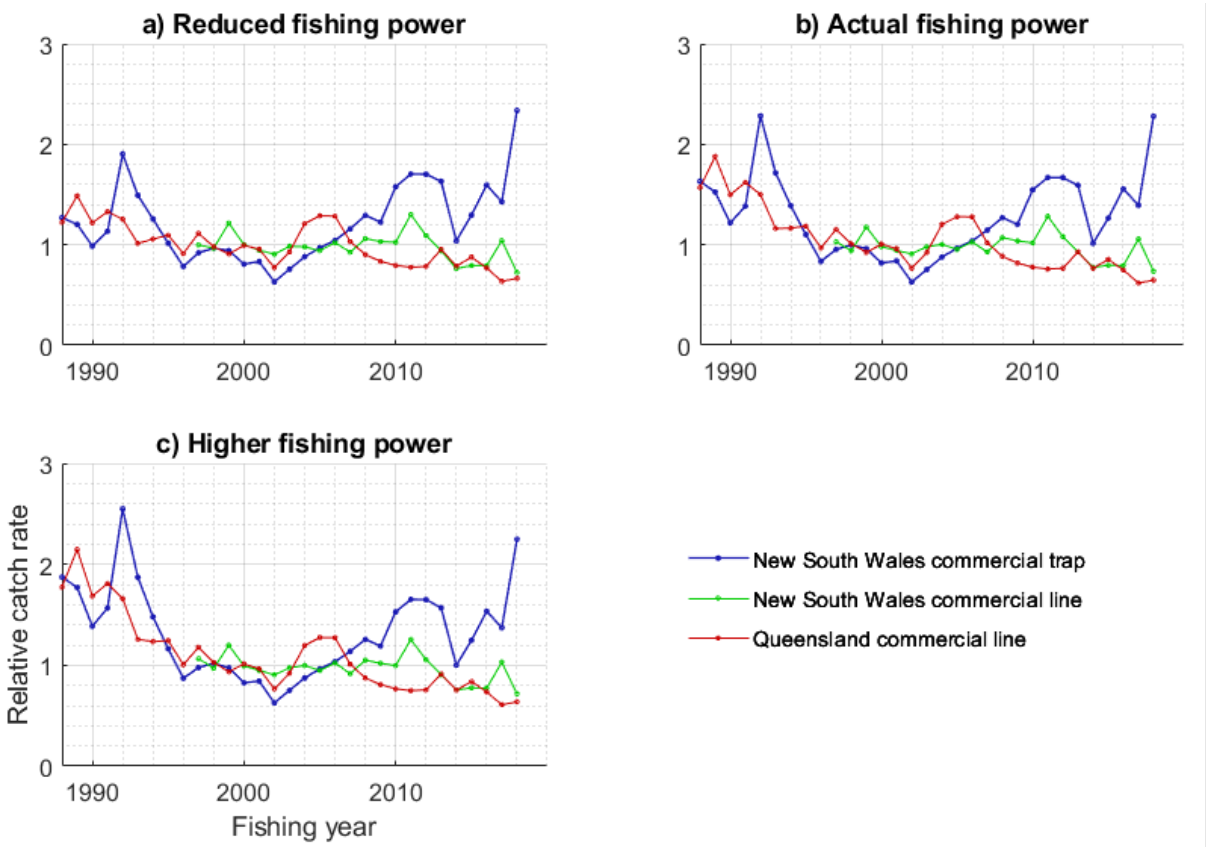

Figure 19: Snapper standardised catch rates relative to the average of the years 1997–2010 for reduced, actual and high fishing power effects (the relative catch rate was defined to be the catch rate relative to the average catch rate of 1997–2010 for each of their own time series)

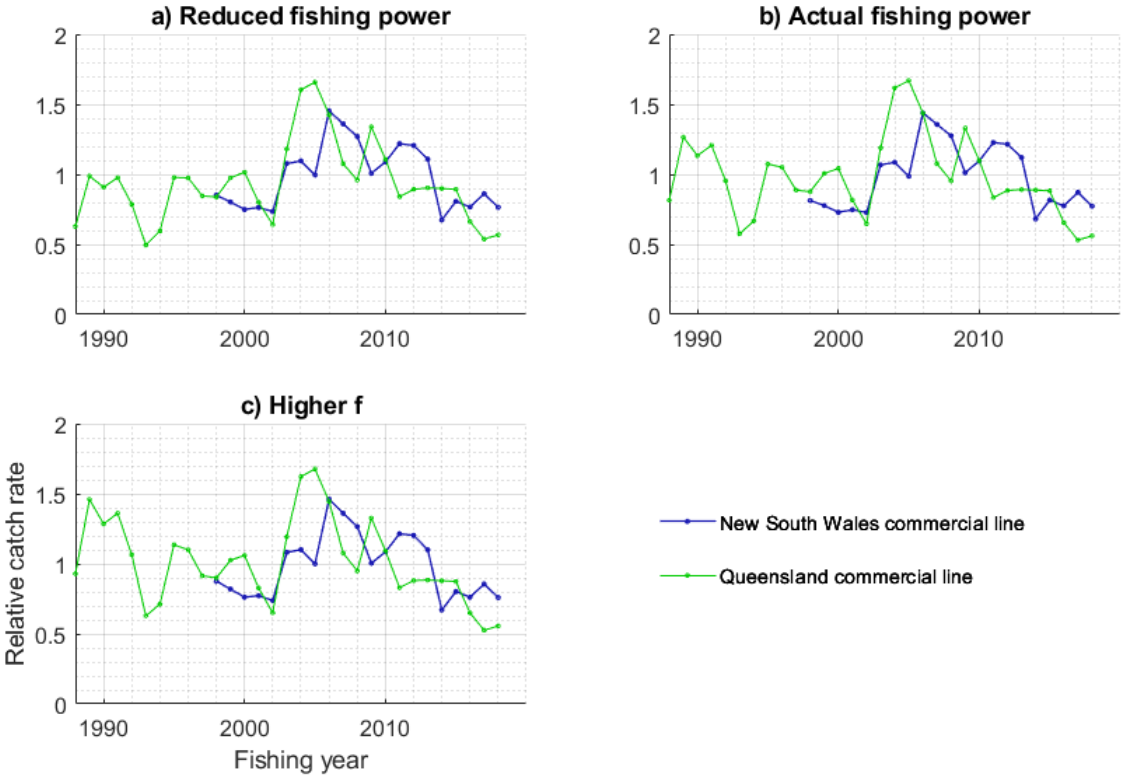

Figure 20: Pearl perch standardised catch rates relative to the average of the years 2000–2018 for reduced, actual and high fishing power effects