Victorian Fisheries AUTHORITY

Review of key Victorian fish stocks — 2021

J. D. Bell, B. A. Ingram, H. K. Gorfine & S. D. Conron
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Victorian Fisheries Authority

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Executive Summary

The Victorian Fisheries Authority (VFA) is the State agency responsible for managing the more than 90 wild fish stocks that are fished by recreational and/or commercial fishers. The VFA does this using a risk-based approach to prioritise the allocation of resources for monitoring, assessing and managing the impacts of fishing.

This report endeavours to:

- Review the status of key Victorian fish stocks to determine their exploitation status;
- Provide fisheries managers and policy makers with the information and advice they need to guide their decisions, work prioritisation and policy development;
- Identify the information requirements to improve future assessments;
- Streamline reporting requirements such as those for obtaining and maintaining export approval under the Federal *Environment Protection and Biodiversity Conservation Act 1999*, the Victorian *Commissioner for Environmental Sustainability Act 2003,* and Victorian fisheries cost recovery policy in accordance with the *Fisheries Act 1995* and the *Fisheries (Fees, Royalties and Levies) Regulations 2008*; and
- Align stock assessments with Victoria's stock reporting and the Commonwealth Status of Key Australian Fish Stocks (SAFS).

This review for fiscal years 1978/79 – 2020/21 inclusive of 13 high priority stocks/species, determined via a risk matrix encompassing biological, economic and social dimensions, updates a previous assessment to 2019/20 of stock status of forty stocks (31 species) considered predominantly in terms of their biological performance and inclusion in the national Status of Australian Fish Stocks (SAFS) report. Importantly, this assessment update does not consider the expected success/failure or otherwise of current or alternative management approaches, or foreseeable changes in management of fishing effort. Consideration of future or previously implemented management responses to stock status issues would be expected to occur as part of follow-up discussions arising from integrated risk assessments. Relative importance of each species/stock based primarily on consideration of relative catch, gross value of production (GVP) and, or, assumed relative catch or social value (i.e. recreational dominated species). Where available the most recent Status of Australian Fish Stocks classifications (https://fish.gov.au/) are also included together with key points about each species performance.

Although high in priority, the prescribed species in abalone (blacklip and greenlip), giant crab and southern rock lobster fisheries, for which assessments have been outsourced and are reported separately, are not covered by this report.

- A more species-expansive review of the status of Victorian fish stocks will be undertaken during the latter part of 2023 to meet the requirements of State and Commonwealth stock status reporting and to inform Victorian and interstate fisheries managers and scientists of the status of key cross-jurisdictional stocks. Implementing regular stock status reviews as opposed to a pre-determined assessment schedule may provide a more adaptive and resource-efficient approach to managing Victoria's fisheries while ensuring sustainability of the stocks.

Introduction

The Victorian Fisheries Authority (VFA) is the agency responsible for managing the State's fisheries resources under the guiding principles of ecological sustainable development consistent with obligations under the *Fisheries Act 1995* and the *Victorian Fisheries Authority Act 2016*.

Recreational, commercial and Indigenous fishing provide a wide range of social and economic benefits to Victorians. Many of Victoria's fisheries are complex, involving multi-sector, multi-species, multiple fishing methods and gears. They are also subject to competing consumptive use as seafood and non-consumptive uses such as tourism and provision of ecosystem services. Furthermore, environmental factors can exert strong influences on production of most inshore and estuarine species. In recent times, access and impacts on finfish stocks have also become increasingly weighted towards the recreational sector. This provides additional challenges for assessment of fish population status and the impacts of fishing, because unlike most commercial fisheries, in general catch and effort for recreationally dominated fisheries are not routinely reported.

Managing complex, wild fisheries to ensure long-term sustainability and satisfactory fishery performance in the face of naturally varying fish populations, climate change, expanding human population, increased urbanisation and competing stakeholder interests (recreation, commerce, conservation, water extraction, land reclamation) is demanding. To ensure

that resources are managed sustainably and maximise the economic, social and cultural benefits, a strong evidence base, informed by knowledge of the stock status, is required.

The VFA prioritises the allocation of resources for the monitoring and assessment activities required to inform management of fisheries based on importance to the community and risk to the resource. High value, commercially dominated fisheries for abalone and rock lobster have well developed and resourced annual stock assessment and data collection programs. They also have management plans with formal harvest strategies and quota systems to which assessments are aligned. Giant crab is less intensively monitored, but like rock lobster and abalone has an established annual assessment and quota setting system. Abalone species, rock lobster and giant crab are not included in this assessment which focusses on species/fisheries that are i) not under quota management, ii) or are recreationally dominated, and/or iii) are emerging without established assessment processes or management plans, and in many cases have limited data. For example, Pipi included in the more expansive reports than this version, only recently came under quota management in 2020, and commercial snapper in PPB are managed by quota now that the buy-out initiated in 2014 is complete (leaving 8 commercial line fishing licences active) with all netting no longer permitted.

It is important to recognise that information available to assess the status of species/stocks or management units is variable among species and locations. For example, Port Phillip Bay and Western Port snapper and King George whiting, and Gippsland Lakes black bream fisheries are subject to comprehensive monitoring programs. Smaller, lower value and lower risk fisheries, such as the recreational fisheries in regional Victorian rivers and estuaries, are assessed using simpler and less resource intensive approaches such as an Angler Diary program. Investment in new and cost-effective electronic data collection methods is a priority of the VFA, e.g. GoFishVic app, and installation of fixed cameras at an expanded range of boat ramps to track effort. The assessments in this report are based on available data considered to be informative about the recent biological status of the specific species/stock/management units. It aims to provide evidence-based advice on the status of species and trends in their stocks or management units, uncertainties in the assessment, and flag emerging issues in performance.

As the amounts and types of information vary among the 15 stocks assessed, expert opinion and knowledge about each fishery and its data are important for interpreting variation and trends. Although data extraction and production of graphic summaries can be automated, this does not extend to processes of data interpretation.

Expert interpretation of available data is refined through internal discussions among VFA scientists, managers and policy specialists about problematic species/stocks/management units. Discussion in each species section of this report provides a synopsis that aligns with terminology in the classification scheme used by SAFS (Stewardson et al. 2018), i.e. depleting, depleted, recovering, with the use of ‘uncertain’ rather than ‘undefined’ as is used in SAFS. Uncertainty encompasses not only stocks lacking in data, but also those for which data are sufficiently variable to preclude identification of trends.

Purpose

The purpose of this report is to:

- Extract, refine, summarise and present key data on the status and performance of selected non-quota or recently developed species/stocks/management units;
- Review the status of selected species/stocks/management units and to indicate levels of any issue or uncertainty over status;
- Provide fisheries managers and policy makers with information to help inform their decisions about work prioritisation, and identification of emerging management issues; and
- Provide a summary of key information that can be used for other related reporting requirements including:
    - Development of external stakeholder communication products;
    - Reporting by other agencies within Victoria’s jurisdiction (Sustainability Victoria, DEECA, Parks Victoria) in alternate years to the more comprehensive national stock status reporting;
    - Cost recovery reporting for commercial fisheries; and
    - Recreational Fishing Licence (RFL) funded monitoring programs (i.e. creel survey and angler diary).

Methods

Most of the reviews in this report are based on multiple lines of evidence covering four key aspects of stock condition and fishery sustainability:

- *Biomass* status using catch per unit effort (CPUE) as a proxy;
- *Fishing pressure* using total catch or effort as proxies;
- *Fishing mortality* trends inferred using length composition data; and,
- *Recruitment* measured using fishery independent sampling of pre-recruits.

Data sources include:

- Fishery dependent commercial catch and effort data and length compositions collected by industry and or VFA staff;
- Fishery dependent creel surveys of recreational catch and effort, and length composition;
- Angler Diary Program that involves structured data collection on catch, effort and length composition by volunteer angler diarists; and
- Annual fishery independent pre-recruit (young-of-year) surveys.

Detailed methods for the creel survey and angler diary programs are described in PoMC (2008), and Conron and Oliveiro (2016).

Fishery dependent CPUE is the most common proxy for biomass trends in fisheries assessments and is mostly available from catch and effort data reported by commercial fisheries. In more limited instances where recreational fishing dominates, and/or commercial data may be insufficient for analysis, recreational angler CPUE was used as an alternative or supplement to assess trends in stock biomass. Victorian commercial fishers have reported catch and effort information since 1978 but corresponding information has only been consistently collected for selected recreational species and locations using creel surveys since 2002, although some earlier creel survey data are available for some areas. Wherever earlier creel survey data are available these have been included. There are no time series for total recreational catches and limited effort data for any Victorian recreational fishery. The only State-wide recreational catch surveys that included several key species assessed in this report were conducted in 2000/01 (Henry and Lyle 2003) and 2006/07 (Ryan *et al.* 2009) so as these reports are outdated, they were not used in this report.

For commercial CPUE trends, only gear types that account for most of the harvests have been considered in this report. Choice of gear types for use in analysing CPUE was made by inspecting plots of harvest by gear type by year for key fishery areas. For most species/stocks catch by area is presented, but if relevant, i.e. major shifts in gear types used to target species, catches by gear types are also included. The CPUE for some fisheries/gear types was standardised using General Linear Mixed Modelling (GLMM) (Appendix 1) to reduce the influence of factors that are known to affect CPUE but are unrelated to real changes in biomass. In this review standardised CPUE is presented along with nominal CPUE wherever possible, however for some CPUE data series, standardisation is problematic due to the involvement of very few fishers (i.e. diary anger data for small estuaries), and poor/unsatisfactory model fits. Generalized Additive Models (GAMS) are used to indicate trends in CPUE time series (Appendix 1).

As a guide to assist with interpretation of CPUE patterns, averages have been used to facilitate discussion of CPUE trends and stock status. Where CPUE is approaching an all-time low the stock will likely be in a depleted state and should be subject to heightened scrutiny by managers and stakeholders. Nevertheless, CPUE decline may reflect change in the way the fishery is operating that has altered the relationship between CPUE and biomass. This, for example, may involve a change in targeting or retention and reporting. The main issue in this situation is it means that recent and future data will no longer be readily relatable to historic series. Average CPUE may be viewed as a benchmark below which the stock and fishery is considered as underperforming, depleting or perhaps at risk of becoming depleted. While periodic drops below the long-term average may not necessarily be indicative of a persistent depleting trend, they nevertheless provide grounds for greater scrutiny and an alternative explanation of the data patterns.

Although standardisation of CPUE data can remove some of the confounding influences when inferring biomass changes, there is always a need to consider any changes that are evident in how a fishery operates, such as modifications to gear, introduction of new technology, targeting preferences, and management changes that can affect efficiency and catchability. Each fishery dependent CPUE time series is carefully examined by VFA scientists within the scope of their knowledge and the operational context of the respective fishery.

Furthermore, some stocks exhibit long-term trends without clear periods of stability, and others show strong cyclical variation or regimes that may be driven by factors other than fishing, such as environmentally induced recruitment variation and prolonged poor recruitment phases. Interpretation of CPUE variation and trends in these instances requires knowledge of the underlying process driving the dynamics independently of fishing. This knowledge is available in some cases, but not others, and where it exists it is brought into the discussions of data trends. However, low understanding of the environmental/ecological drivers of cycles or long-term trends in the indicators can increase the level of uncertainty in stock status, even for higher value species.

The default reference period used for interpreting CPUE trends is **1986–2015 inclusive**. This default period was selected because:

1) It was consistent with previous assessments to the extent that these three decades lie within the 38-year time-period of 1978–2015;
2) It omits the eight years of data from 1978–1985 because the early years of data acquired after commercial catch and effort reporting was introduced are of lower quality/reliability than subsequent years, presumably due to commercial fishers' unfamiliarity or lack of compliance with the reporting scheme that was introduced in 1978 as well as the time it can take for the CPUE for the various fleets to become consistent in terms of the measurement of effort; and
3) Most of Victoria's major fisheries had been operating for decades before the introduction of catch and effort reporting meaning that there is no possibility to benchmark current CPUE against CPUE during the development of the fishery on a 'virgin stock'.

In some cases, declining trends in CPUE are driven by changes in fishing operations, such as differential targeting of species or uptake of technology. If sufficient confirmation is available, then the reference period may be modified to only encompass a period where targeting was occurring, and operational processes were consistent. In this instance, recent CPUE may be well below the lowest point in the reference period, and the reasons for this will need to be discussed when formulating assessment to advise managers. Shorter reference periods may also be used where, for example, the fishery has only been developed recently; management arrangements have changed; the time series of data is limited (e.g. recreational fisheries in Port Phillip Bay, Western Port and the Gippsland Lakes); or where a clear step change has occurred, caused either by increased fishing power (i.e. gear change and uptake of technology) or environmental regime change.

Summary of use of CPUE as fishery performance measures:

- Default reference period 1986–2015
- Reference period average (RPA) = Average of annual nominal or standardised CPUE for reference period
- Reference period low (RPL) = lowest annual CPUE for reference period

Stock Review Summary

This review inclusive of data for 2020/21 fiscal year updates previous assessments of stock status for non-quota managed species in terms of their biological performance. Importantly it does not consider the expected success or failure of current or alternative management approaches, or foreseeable changes in management of fishing effort. Consideration of future or previously implemented management responses to stock status issues would be expected to occur as part of follow-up discussions/integrated risk assessments. Relative importance of each species-stock based primarily on consideration of relative catch, GVP and/or assumed relative catch or social value (i.e. recreationally dominant species), is indicated in Table 1. Where available the most recent Status of Australian Fish Stocks classifications (https://fish.gov.au/) are also included together with key points about each species' performance.

Thirteen species, an aggregate of 15 stocks, were assessed (Table 1). Two years ago, two thirds of the stocks (10) in this report were classed as sustainable in accordance with the 2020 SAFS classification systems, and one was not included in that assessment. Out of those not classed as sustainable, only Gippsland Lakes black bream was classed as depleting, southern sand flathead in Port Phillip Bay and Murray cod were classified as recovering from previous depletion and one stock, southern sand flathead in Corner Inlet-Nooramunga, was classed as undefined i.e. uncertain, due to insufficient or highly variable data.

The analyses of recent performance of stock status indicators suggest no marked changes since the SAFS 2020 status classifications. SAFS assessments do not include rock flathead because this species is only considered an important target species in Victoria,

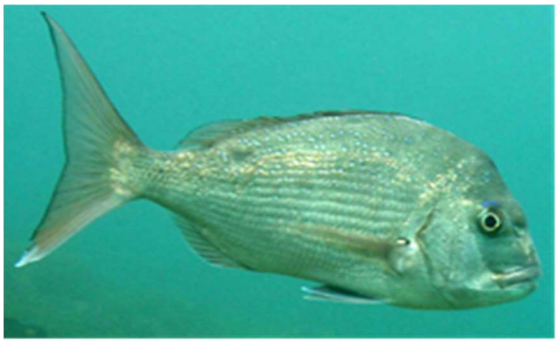
The 13 species and their management units included in the most recent review are:

1. Snapper (*Chrysophrys auratus*): Western Stock
2. King George Whiting (*Sillaginodes punctatus*): State-wide
3. Southern Sand Flathead (*Platycephalus bassensis*): Port Phillip Bay
4. Black Bream (*Acanthopagrus butcheri*): Gippsland Lakes
5. Southern Sea Garfish (*Hyporhamphus melanochir*): Corner Inlet-Nooramunga
6. Rock Flathead (*Platycephalus laevigatus*): Corner Inlet-Nooramunga
7. Southern Calamari (*Sepioteuthis australis*): State-wide
8. Gummy Shark (*Mustelus antarcticus*): State-wide
9. Silver Trevally (*Pseudocaranx georgianus*): State-wide
10. Southern Bluespotted Flathead (*Platycephalus speculator*): Corner Inlet-Nooramunga
11. Eastern Australian Salmon (*Arripis trutta*): State-wide
12. Western Australian Salmon (*Arripis truttaceus*): State-wide
13. Murray Cod (*Maccullochella peelii*): State-wide, naturally self-recruiting inland freshwater stocks

Table 1 Summary of current stock classifications and recent key changes in performance indicators.

Species	Management Unit/Stock	Relative importance	SAFS 2020 classification	VFA assessment of recent performance (2019–2021)
Snapper	Western stock	High	Sustainable	Very strong recent juvenile recruitment suggests major increase in biomass expected over the next five years. Recently stable CPUE, after decreases from 2014.
King George Whiting	State-wide	High	Sustainable	CPUE is recruitment driven. None of the fishery CPUE or pre-recruit time series show persistently declining trends, providing reassurance that the adult stock in coastal waters is continuing to be replenished at rates sufficient to prevent declines in recruitment potential/egg production. Recent modest post-larval recruitment is expected to result in a decline in fishery performance, but the stock is expected to remain within historical bounds so should remain sustainable.
Southern Sand Flathead	Port Phillip Bay	High	Recovering	Continued relatively low recruitment means the stock will remain stable but at a depleted level well below the reference period average for creel survey CPUE. Although cessation of commercial netting should allow the stock to recover from its recruitment impaired state and there has been evidence that this is occurring, without additional data collection future status is likely to become uncertain.
Southern Sand Flathead	Corner Inlet-Nooramunga	High	Undefined	Although stocks outside of PPB have been classed as sustainable due to very low catches (~1.5t pa), lack of information for commercially fished CI-Nooramunga specifically means its current and future status is uncertain.
Black Bream	Gippsland Lakes	High	Depleting	Recent downward trends in commercial and recreational CPUE are apparent, and commercial CPUE is now below the reference period minimum. Stronger juvenile recruitment in recent years and the removal of commercial fishing pressure over is expected to drive stock recovery over the next 5 years.
Rock Flathead	Corner Inlet-Nooramunga	High	Not assessed	Major increase in mesh net effort over last two years accompanied by downward trend in CPUE. No recruitment data available.
Southern Calamari	State-wide	High	Sustainable	CPUE is well above reference period average, short-lived highly dynamic population.
Murray Cod	State-wide	High	Recovering	Although there is limited long-term estimates of population abundances and recreational harvest for Murray cod across the State, CPUE estimates for five of six indicator riverine populations (Broken Creek and River, Campaspe River, Goulburn River, Gunbower Creek, Loddon River and Ovens River) have increased since the early 2010s suggesting that State-wide stocks are improving. Changes in CPUE for some populations may be influenced by stocking of hatchery-bred fish.
Gummy Shark	State-wide	Moderate	Sustainable	Stable.
Eastern Australian Salmon	Eastern Victoria	Moderate	Sustainable	Stable.
Western Australian Salmon	Western Victoria	Moderate	Sustainable	Stable.
Southern Garfish	State-wide	Moderate	Sustainable	Recent increase in CPUE for Corner Inlet, now above the reference period average.
Silver Trevally	State-wide	Low	Sustainable	This 2020 classification is likely inaccurate due to evidence that the broader stock is likely depleted. Landings from Corner Inlet are at historic lows, despite high effort and NSW and Commonwealth assessments indicate depletion so this is also likely for Victoria. Nevertheless, it is unlikely that the Victorian fishery is a major contributor given the low state-wide catch. The status likely to change to depleted or undefined for the 2022 SAFS iteration.
Southern Bluespotted Flathead	Port Phillip Bay	High	Not assessed	Uncertainty in catch history for southern bluespotted flathead makes it difficult to assess the risk associated with the recent historically high harvests, and primarily for this reason, there is uncertainty about stock status of southern bluespotted flathead in Corner Inlet-Nooramunga

Snapper (*Chrysophrys auratus*): Western Stock



Stock Structure and Biology

The Victorian snapper population is comprised of two stocks (**Error! Reference source not found.**).

- *Western Victorian stock*: Wilsons Promontory (VIC) to Investigator Strait (SA)
- *Eastern Victorian stock*: Wilsons Promontory to southern NSW

Snapper can live to at least 39 years and grow to at least 110 cm total length (TL). Length at 50% maturity is 42 cm TL (legal minimum length, LML = 28 cm) which is reached at approximately 5 years of age. Snapper have high fecundity and a slow-moderate growth rate reaching the LML of 28 cm in 3-4 years.

The main spawning period is from November to January, with Port Phillip Bay the main spawning area responsible for most of the western stock replenishment. The spawning aggregations that occur in Corner Inlet-Nooramunga and inshore reefs near Lakes Entrance provide some local recruitment, but snapper from the western stock comprise a relatively large component of fish in eastern Victorian.

Management/Assessment Unit

The western Victorian snapper stock supports recreational and commercial fisheries. The largest fisheries are in Port Phillip Bay (commercial and recreational) and Western Port (recreational), both of which are based on the western Victorian stock. The western stock fisheries account for most of the Victorian snapper harvest and receive most of the assessment and management attention. This report only considers the western stock because there is limited information to inform assessment of the eastern stock, despite its perceived growth as a recreational fishery over the last decade.

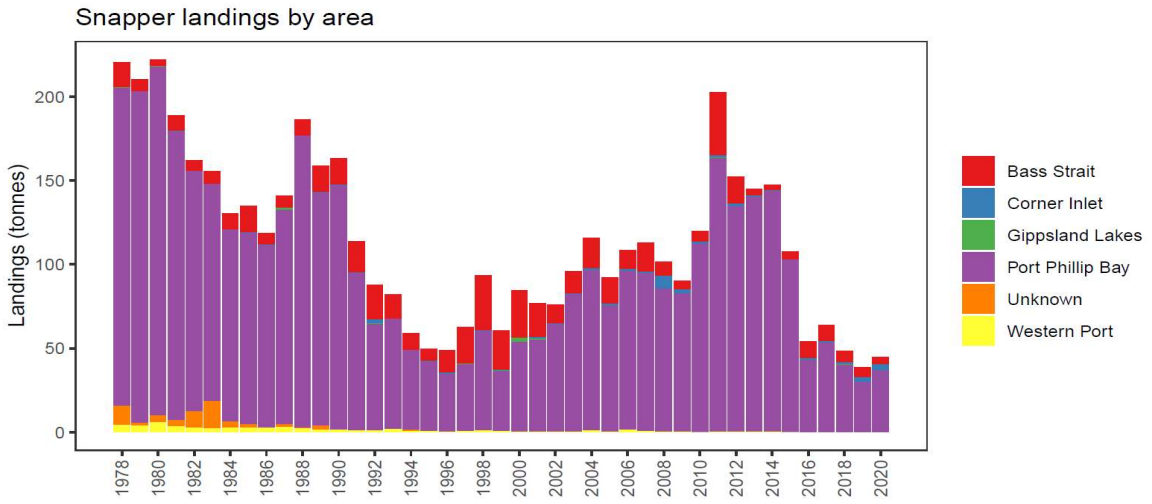


Figure 1 Snapper harvest by Victorian licenced commercial operators by fishing areas during financial years 1978/79–2020/21.

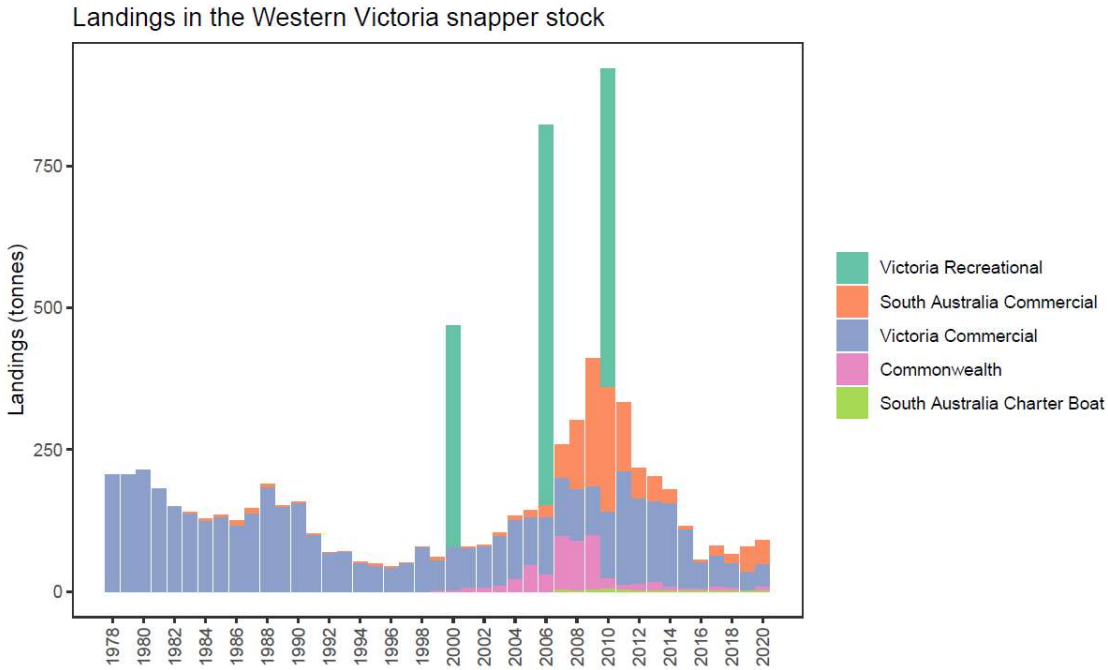


Figure 2 Total national catch of snapper including landings from the Western Victorian stock, financial years 1978–2020.

Assessment Summary

Western Victorian Stock

The status of the Western Victorian snapper stock and associated fisheries were evaluated using:

- Available harvest information for the commercial and recreational sectors
- Nominal and standardised CPUE for commercial long-line in Port Phillip Bay (reference period 2000-2015)
- Nominal and standardised CPUE for the recreational fishery from annual creel surveys in Port Phillip Bay and Western Port for adult (October-December) and juvenile/sub-adult (January-April) snapper (reference period 2002–2015)
- Length composition of long-line fishery catches in Port Phillip Bay
- Length composition of recreational fishery catches in Port Phillip Bay and Western Port from creel survey samples and diary anglers
- Snapper pre-recruit (0+ age) abundance from fishery independent trawl surveys in Port Phillip Bay.

This assessment found:

- *Fishing pressure* – most of the commercial harvests are from Port Phillip Bay and have dropped considerably from ~150 t in 2010–11, to recent harvests of less than 50 t/y being among the lowest recorded since 1978 (Figure 1). Since 2009/10 harvests by non-Victorian licensed operators from the western stock region have also declined to very low levels (Figure 2). Commercial effort using haul seine ceased as of 1 Apr 2022 due to removal of netting from Port Phillip Bay and long-line effort has reduced substantially in recent years due to a reduction of licences (only 8 remain) and the introduction of catch caps (Appendix 2). There is no recent information on recreational harvest or effort.
- *Biomass* – Standardised CPUE of adult snapper taken by the commercial long-line fishery and recreational anglers (October-December surveys) in Port Phillip Bay have decreased since their peaks a decade ago (Figure 3 and Figure 4). Standardised CPUE for recreational anglers in Port Phillip Bay for the October-December period in 2020 was approximately halfway between the reference period average and the reference period low point in 2020 (Figure 4).The decrease in the recreational catch rate in Port Phillip Bay was rapid from 2013 to 2014 but has since stabilised and remained above the lowest point observed during the reference period, however, it is currently below the reference period average for standardised CPUE. The recreational CPUE for January-April is indicative of the biomass of smaller juveniles and sub-adults (pinkies) and is typically highly variable across years due to the passage of weaker and stronger cohorts through the fishery (Figure 5).

Nevertheless, the long-term trend among pinky snapper in Port Phillip Bay is increasing and in 2020 was well above the reference line (Figure 5). Western Port recreational snapper CPUE showed slightly different patterns with the larger adults (Oct-Dec) having declined variably from a peak in the mid-2000s and now showing an upswing from a low point in 2017 to lie just on the reference line in 2020 (Figure 6). Pinkies in contrast, showed a decade of shallow decline which now appears to be levelling out between the standardised minimum and the reference line (Figure 7), bearing in mind the variability in abundance of these juveniles – sub-adults. In this instance, standardised CPUE has increased over the two years to 2020. Forecasts based on the recreational creel in Port Phillip Bay indicate increased abundance is expected for the 5-year period after 2023 (Figure 8., Figure 9, **Error! Reference source not found.** and Figure 11). However, the median length for the October-December period has been lower since 2014 for the Port Phillip Bay recreational fishery). This appears due to lower numbers of larger fish being caught since 2013 by the surveyed anglers but is also influenced by new cohorts entering the fishery thereby reducing the overall average (Figure 9a). The diary angler length compositions showed that the upper range of the length compositions has been consistent at approximately 100 cm since 2013 (Figure 9b).

- *Recruitment* – Recruitment of 0+ age snapper was low from 2015–2017 after moderate recruitments in 2014 and 2015 (Figure 10). In 2018, recruitment of of 0+ age snapper was the highest recorded since trawl surveys began in 1993 (Figure 10). It then fell again for the three years 2019–2021 followed by a sizeble peak in the most recent survey in 2022 (Figure 10). With two very large cohorts to enter the fishery in coming years it is expected that the overall biomass of the stock will increase.

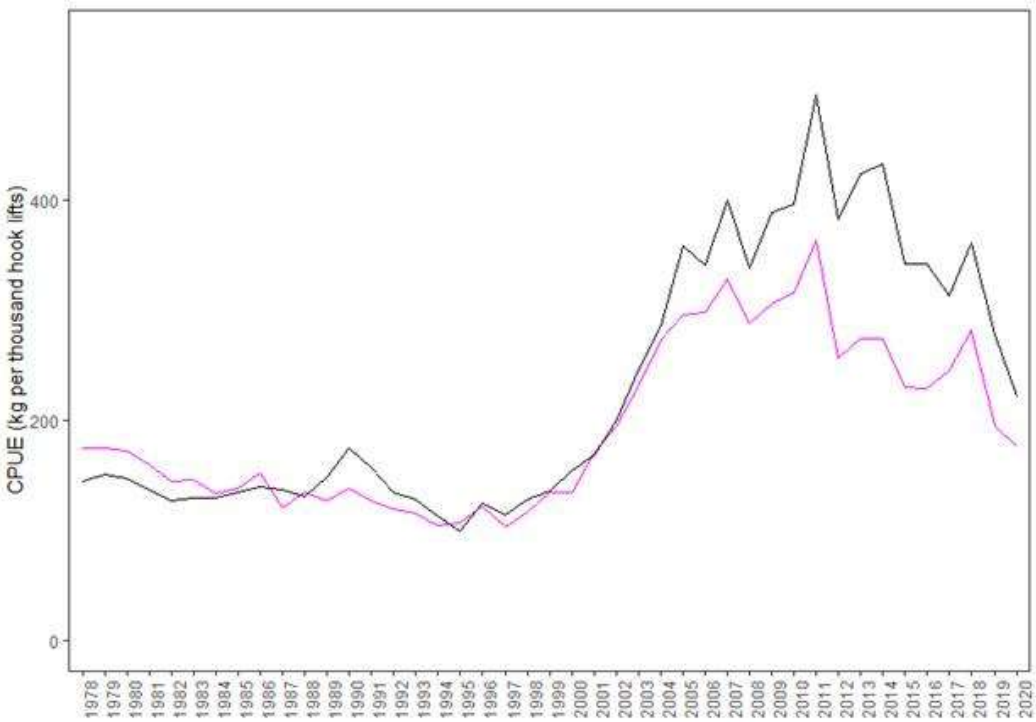


Figure 3 Catch-per-unit effort (CPUE) of snapper by commercial long-line fishers in Port Phillip Bay from 1978–2020 financial years. Black line is nominal CPUE (±SE), and magenta line is standardised CPUE.

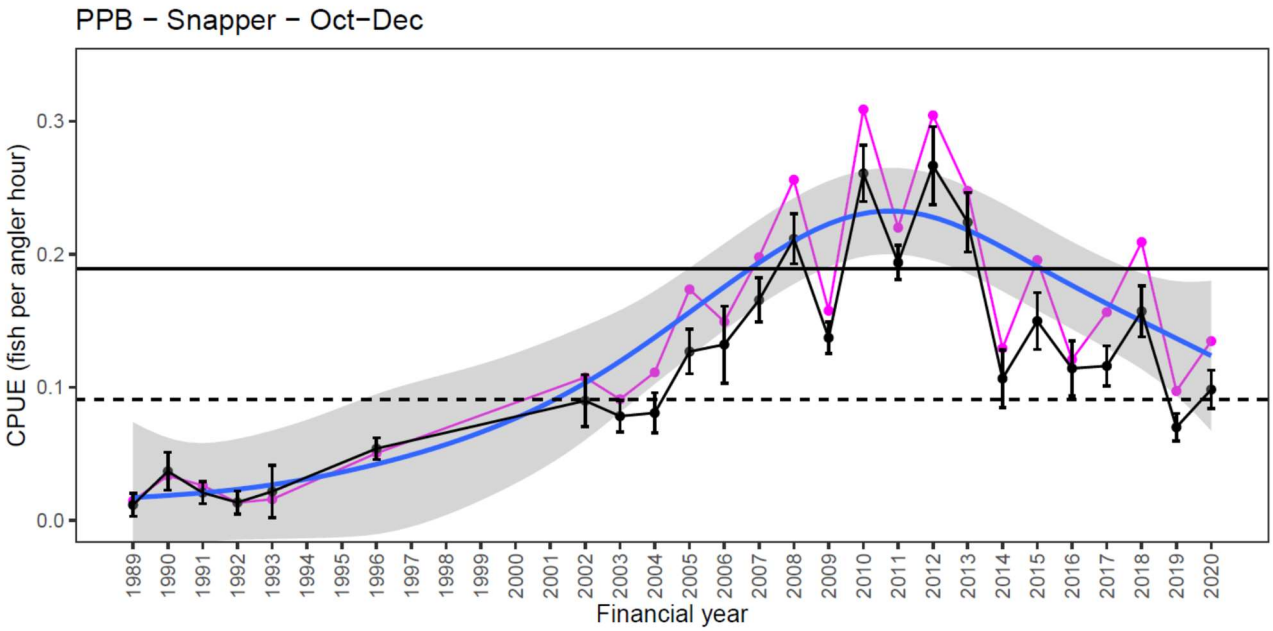


Figure 4 Catch-per-unit effort (CPUE) of snapper by recreational anglers interviewed in creel surveys undertaken in Western Port between October – December during 1997/98–2019/20 financial years. Black line is nominal CPUE (±SE), magenta line is standardised CPUE, blue line is a generalised additive model GAM of the standardised trend with the shaded grey area representing the 95% confidence interval of the GAM. Horizontal black line is the mean standardised CPUE during the reference period (2002–2015) and the dashed black line is the minimum standardised CPUE within the reference period.

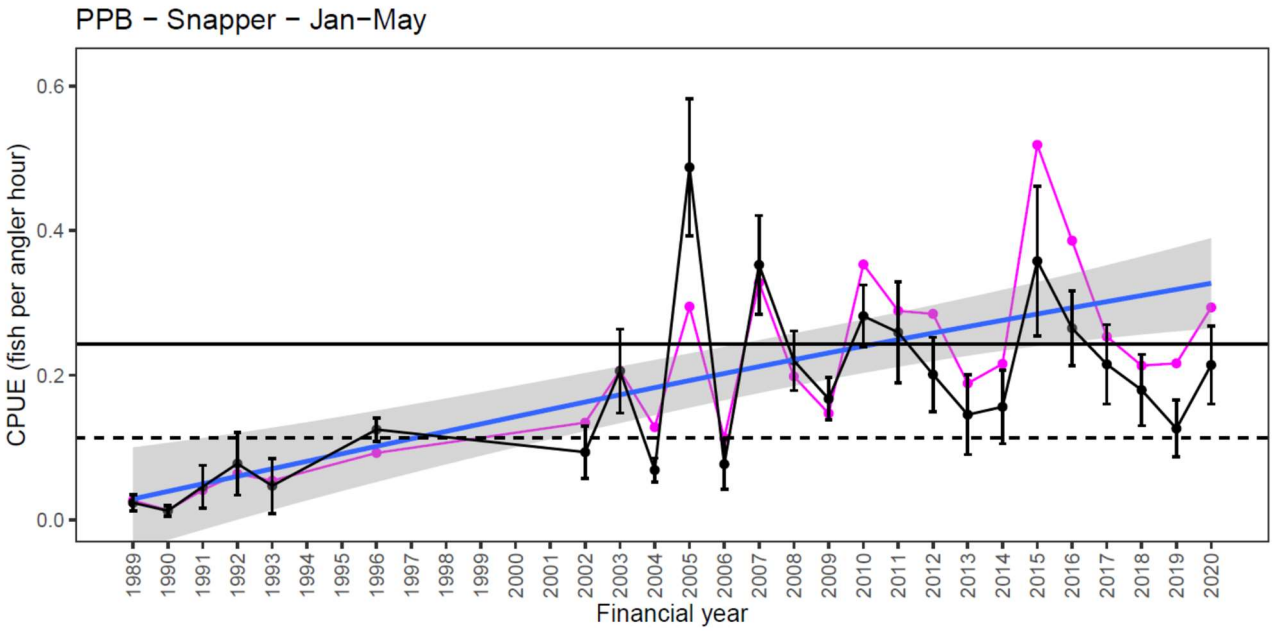


Figure 5 Catch-per-unit effort (CPUE) of snapper by recreational anglers interviewed in creel surveys undertaken in Port Phillip Bay (PPB) between January – April during 1997/98–2019/20 financial years. Black line is nominal CPUE (±SE), magenta line is standardised CPUE, blue line is a GAM of the standardised trend with the shaded grey area representing the 95% confidence interval of the generalised additive model GAM. Horizontal black line is the mean standardised CPUE during the reference period and the dashed black line is the minimum standardised CPUE within the reference period.

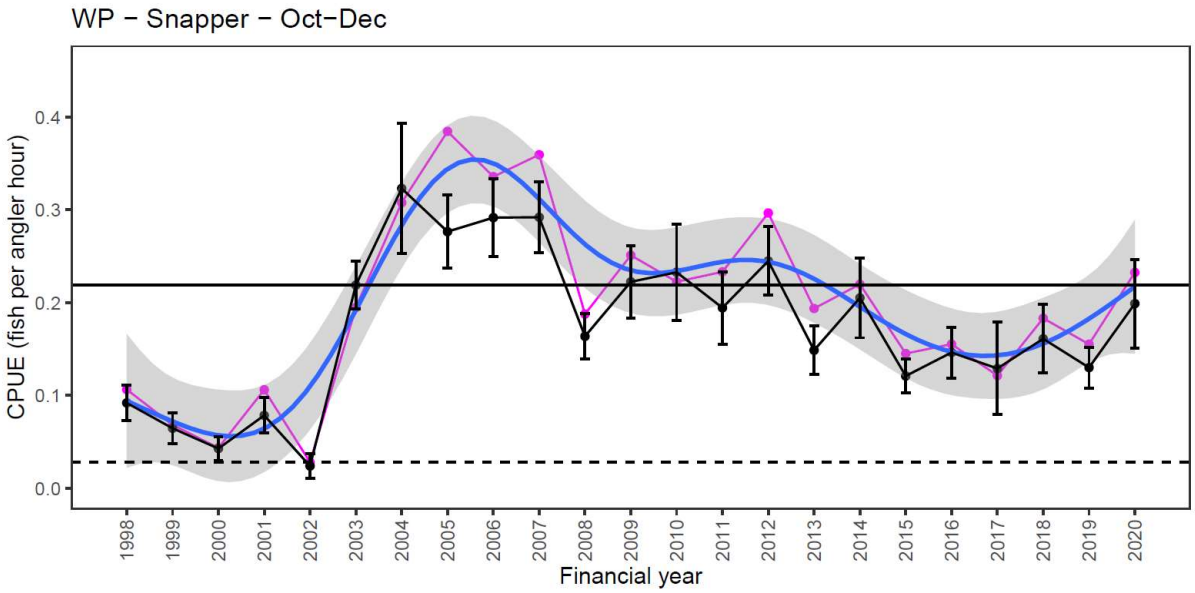


Figure 6 Catch-per-unit effort (CPUE) of snapper by recreational anglers interviewed in creel surveys undertaken in Western Port (WP) October – December during 1997/98–2019/20 financial years. Black line is nominal CPUE (±SE), magenta line is standardised CPUE, blue line is a generalised additive model GAM of the standardised trend with the shaded grey area representing the 95% confidence interval of the GAM. Horizontal black line is the mean standardised CPUE during the reference period and the dashed black line is the minimum standardised CPUE within the reference period.

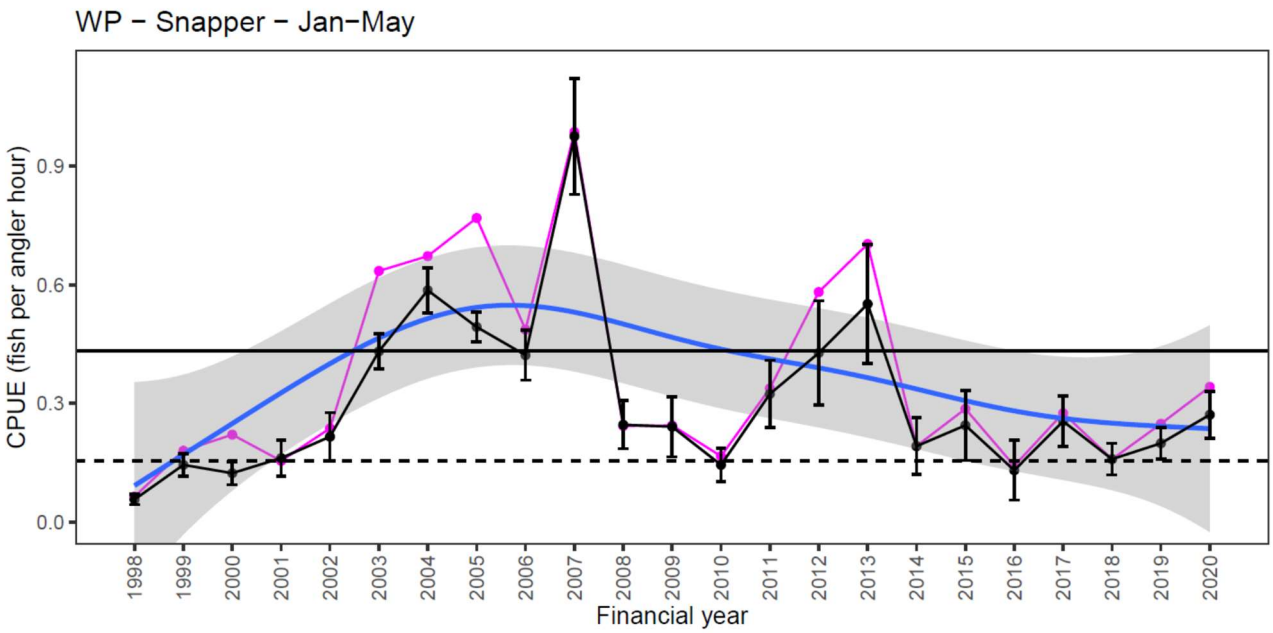


Figure 7 Catch-per-unit effort (CPUE) of snapper by recreational anglers interviewed in creel surveys undertaken in Western Port (WP) January – April during 1997/98–2020/21 financial years. Black line is nominal CPUE (±SE), magenta line is standardised CPUE, blue line is a generalised additive model GAM of the standardised trend with the shaded grey area representing the 95% confidence interval of the GAM. Horizontal black line is the mean standardised CPUE during the reference period and the dashed black line is the minimum standardised CPUE within the reference period.

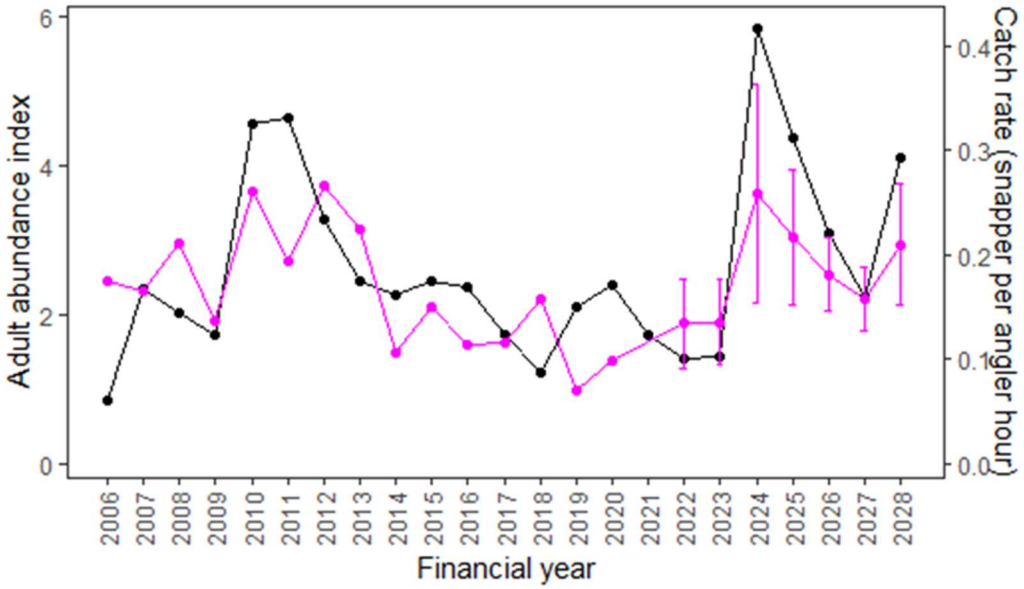


Figure 8 Port Phillip Bay snapper creel observed (2006–2020) and forecast CPUE (pink) and abundance index (black) over the same observed and forecasted (2022–2028) periods.

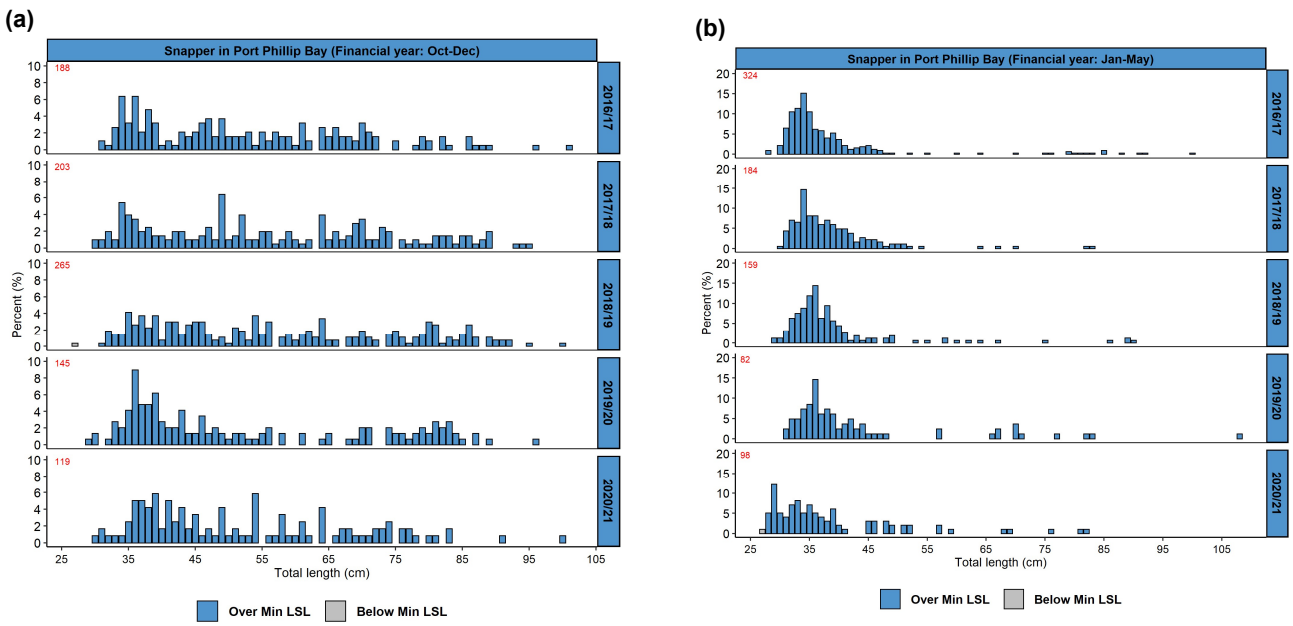


Figure 9 Frequency histograms of Port Phillip Bay recreational fishery snapper creel survey length composition (a) Oct-Dec, (b) Jan-Apr. Red numbers indicate numbers of fish measured. LSL = legal size limit.

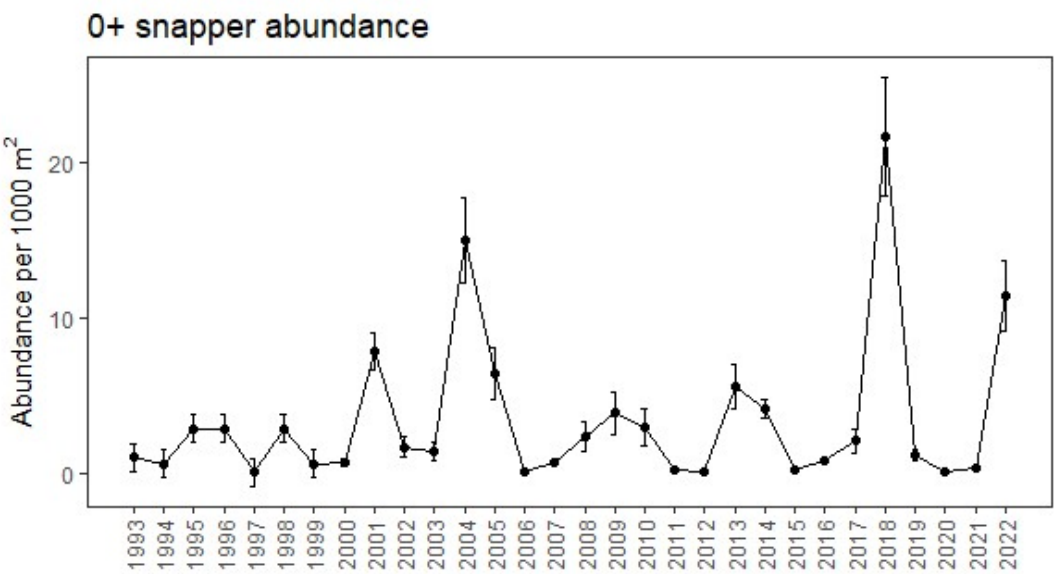


Figure 10 Port Phillip Bay snapper pre-recruit (0+ age) trawl survey catch rates (±SE) 1993–2022. Note: SE can only be calculated from 2000 onwards, data prior is based on extrapolation of beam trawl to earlier otter trawl data using a regression relationship from 11 years when the otter trawl and beam trawl surveys overlapped.

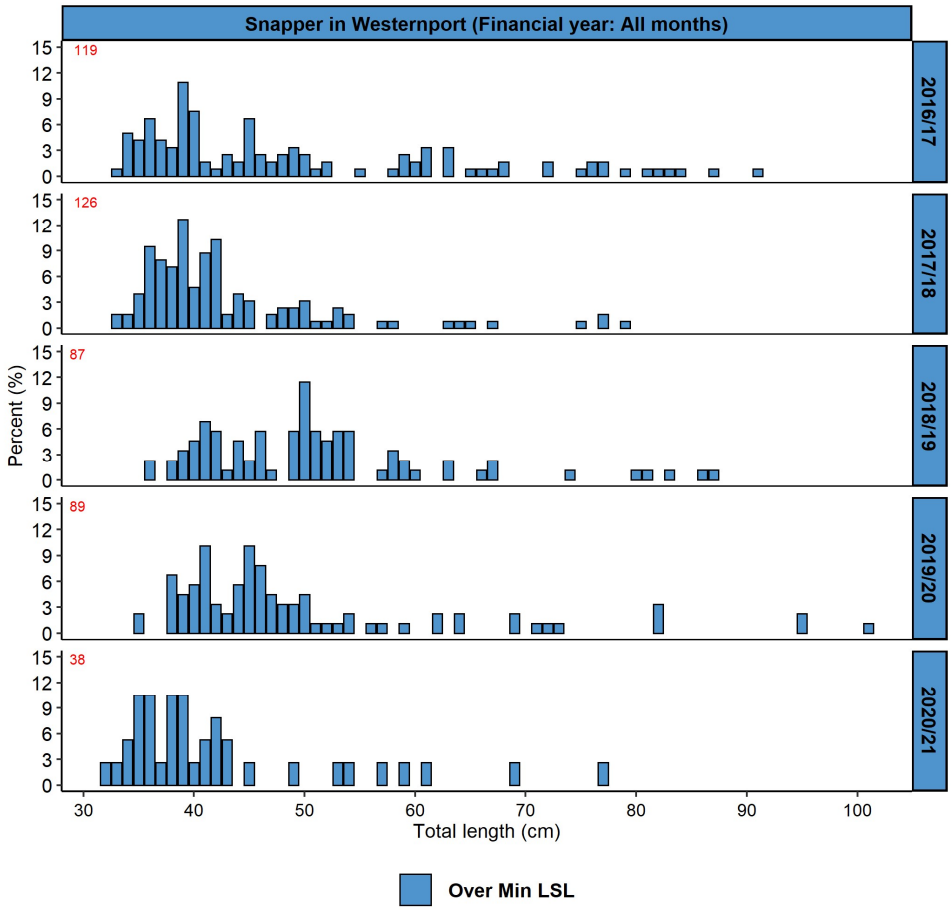
Recreational catch

Recreational harvest in 2000/01 and 2006/07 for the Victorian region of the western stock were estimated at approximately 400 and 670 t respectively (Henry and Lyle 2003; Ryan et al. 2009; VFA unpublished data). For the South Australian region of the western stock, recreational harvests were estimated at between 10–20 t for the three most recent surveys 2000/01, 2007/08, 2013/14 (Fowler et al. 2016).

Stock status summary: Adult biomass for the Western Victorian snapper stock has been depleting since a recent peak in the late 2000s – early 2010s. Nevertheless, fishery performance remains generally good (CPUE is close to the reference period average) for the long-line fishery where nominal CPUE has not declined as much as for the recreational fisheries, likely due to the high skill and effectiveness of the small number of long-line fishers who have been operating since 2010. The recreational fishery for adult snapper in Port Phillip Bay is considered sustainable at its current level, appearing to have stabilised since 2014, but a declining trend in Western Port persists. The decline in Western Port is thought to be related to local dynamics rather than deterioration in overall stock status. Recent strong recruitment with two high peaks observed during the past 5 yers is expected to reverse any declining biomass trends and drive a rebuilding of adult biomass consistent with forecasts from Port Phiilp Bay creel showing an expected improvement in fishery performance over the next 5–10 years. Length compositions are not showing signs of truncation, and commercial fishing pressure has reduced substantially in recent years due to the Port Phillip Bay buy-outs and reduced landings by South Australian and Commonwealth operators. The available evidence indicates that the biomass of this stock is unlikely to be depleted and that recruitment is unlikely to be impaired. Furthermore, the above evidence indicates that the current level of fishing mortality is unlikely to cause the stock to become recruitment impaired. On the basis of the evidence provided above, the Western Victorian biological stock is classified as a sustainable stock.

Low and sporadic catches, and the lack of any notable targeted commercial fishery, means that there is no reliable information on biomass trends from fishery dependent catch and effort data for the Eastern Victorian biological stock. Recreational catch is also unknown and there are no time series of catch rates or length/age composition for the recreational fishery. For these reasons, the status of the Eastern Victoria biological stock remains uncertain.

(a)



(b)

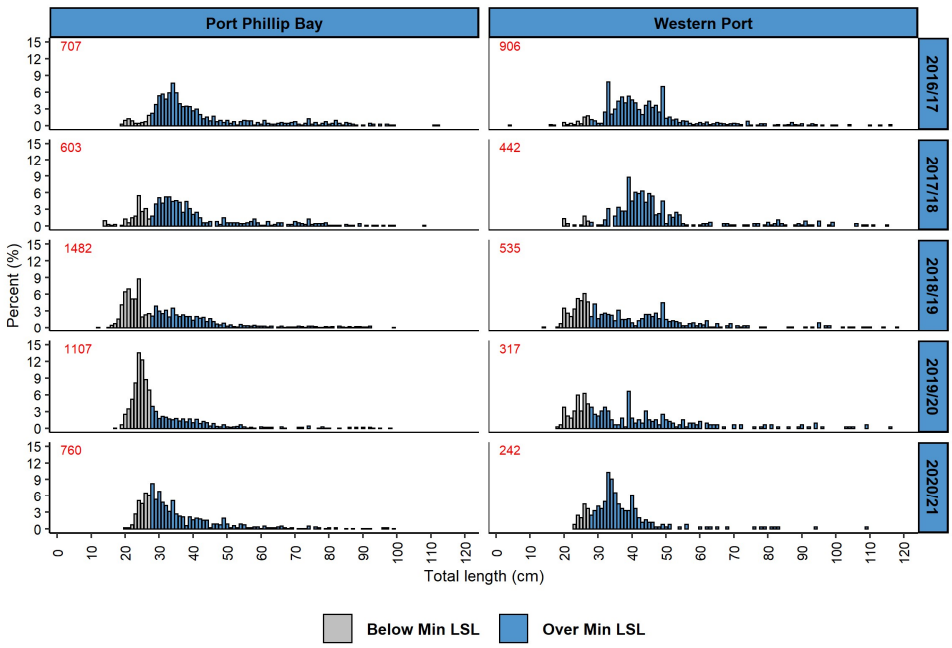


Figure 11 Frequency histograms of Western Port recreational snapper length composition (a) creel surveys all months, (b) diary angler all months (incl. PPB for comp.), fiscal years 2016/17–20120/21. Red numbers are numbers sampled. LSL= legal size limit.

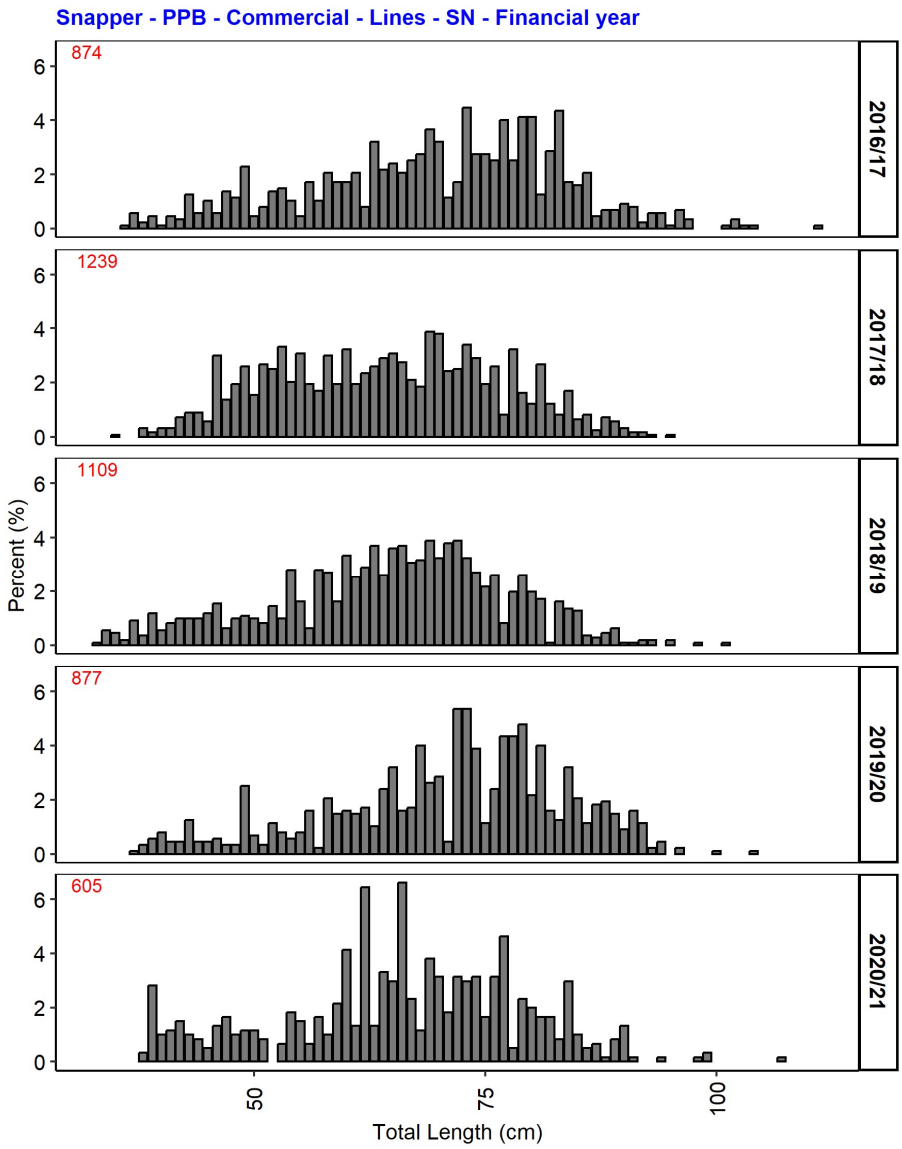
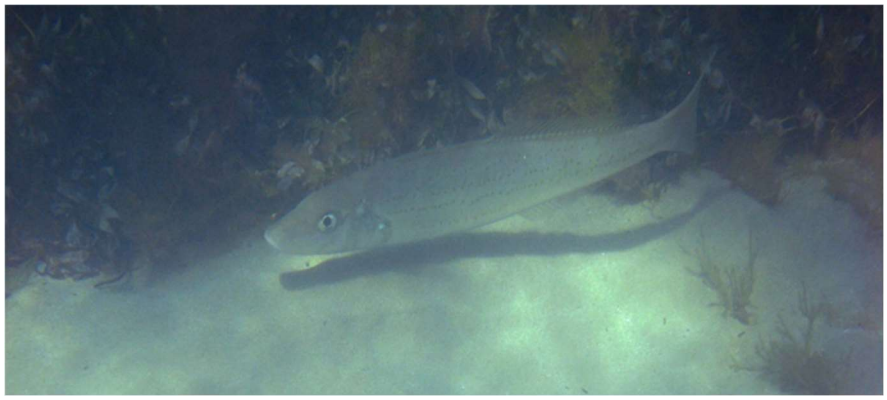


Figure 12 Frequency histograms of Port Phillip Bay line caught commercial snapper length composition (%) for fiscal years 2016/17–20120/21. Red numbers are numbers sampled.

King George Whiting (*Sillaginodes punctatus*): State-wide



Stock Structure and Biology

The Victorian King George whiting population is considered to comprise a State-wide stock that extends into eastern South Australia. The main fisheries are in Port Phillip Bay, Western Port and Corner Inlet, with both commercial and recreational components in Port Phillip Bay and Corner Inlet. In Victorian bays and inlets most King George whiting are harvested as immature fish < 4 yr. of age. Juvenile whiting migrate out of bays and inlets at 3–5 years of age to complete their adult lives in coastal waters where they can live to approximately 20 years old and reach lengths of at least 60 cm. It is thought that the majority of King George whiting that recruit into Victorian bay and inlet fisheries originate from spawning events in coastal waters off far western Victoria and south-east South Australia. King George whiting are highly fecund and have a moderate to high growth rate, reaching the LML of 27 cm in approximately 2 years. Offshore spawning and a long-larval dispersal phase prior to settlement in bay and inlet nursery areas mean that settlement rates of larvae are highly variable from year to year depending on ocean currents. This variability coupled with a short residence time for juveniles within bay and inlet nursery areas (i.e., two-three years when most fish are available for harvest) means that fisheries production and catch rates are naturally highly variable.

Assessment Summary

The status of the Victorian King George whiting stock and associated fisheries were evaluated using:

- Available harvest information for the commercial and recreational sectors
- Nominal CPUE for commercial haul seine in Port Phillip Bay and Corner Inlet-Nooramunga (reference period 1986–2015) (Note: nominal CPUE is used because standardisation has minimal to no influence on seine net CPUE)
- Nominal and standardised CPUE for the recreational fishery from annual creel surveys in Port Phillip Bay and Western Port (reference period 2002–2015)
- Length composition of haul seine fishery catches in Corner Inlet-Nooramunga
- Length composition of recreational fishery catches in Port Phillip Bay and Western Port from creel survey and diary anglers
- Pre-recruit (post-larval) abundance from fishery independent netting surveys in Port Phillip Bay.

This assessment found:

- *Fishing pressure* – commercial harvests have been decreasing over the last two decades, mostly driven by a reduction in netting effort due to commercial licence buy-outs and cessation of netting in PPB (Appendix 2); however, recent high landings in Corner Inlet-Nooramunga have been some of the highest on record (**Figure 13**). There is no recent information on recreational harvest or effort.
- *Biomass* – Nominal CPUE of King George whiting by commercial haul seine in Port Phillip Bay and Corner Inlet-Nooramunga both increased to 2019/20 (Figure 14). These commercial fishery observations were consistent with results from the Port Phillip Bay recreational creel survey that showed CPUE trending strongly upward during 2018–2020 to be well above the reference line (Figure 15). Similarly, there was an overall increasing trend in creel survey CPUE for Western Port (Figure 16). Overall, CPUE indicators suggest stable to improving

stock biomass of King George whiting in Victorian bays and inlets over the last few years after the most recent peak in 2015/16. There are no specific indicators of adult biomass status for King George whiting in coastal waters.

- *Recruitment* – Victoria's whiting fisheries are largely reliant on three year classes (2, 3 and 4+ years of age) so recent recruitment has a major bearing of fishery performance. Recruitment of post-larval King George whiting to Port Phillip Bay has been average or lower in the last few years (Figure 20). The Port Phillip Bay survey data are generally indicatve of post-larval recruitment to other Victorian bays and inlets. Due to modest recent recruiitment, it is anticipated that whiting fishery performance will decline in bay and inlet fisheries over the next few years.
- *Length compositions* – The various length composition data display no long-term trends or signs of increasing truncation, consistent with the transient nature of King George whiting in bays and inlets. A recent increase followed by a decrease (2015–2018) in median lengths observed for all length frequency data (Figure 17,**Error! Reference source not found.** Figure 18, and Figure 19) are consistent with the passage of the strong 2013 cohort (Figure 20) through the bay and inlet fisheries.

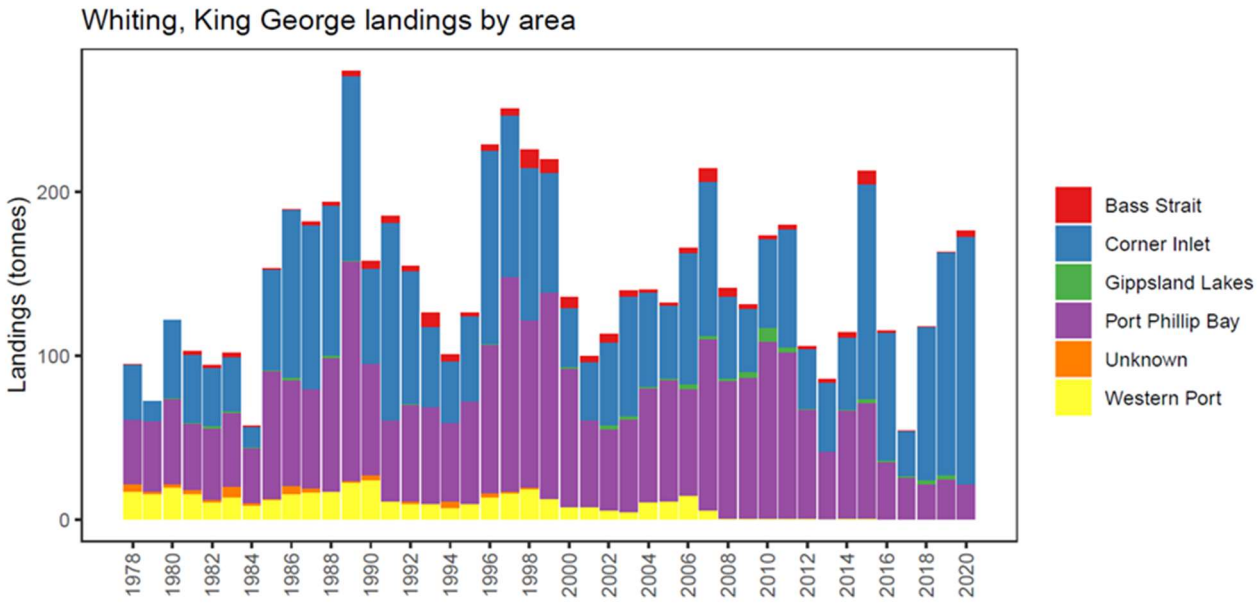


Figure 13 Commercial catch of King George whiting by area in Victorian waters, financial years 1978–2020.

Stock status summary: Indicators of stock status for King George whiting are all directly related to juvenile life stages, and are highly variable being primarily driven by recruitment dynamics. Importantly, none of the fishery CPUE or pre-recruit time series show persistently declining trends, providing reassurance that the poorly known and lightly fished adult stock in coastal waters is continiung to be replenished at rates that are sufficient to prevent declines in recruitment potential/egg production. Recent modest post-larval recruitment is expected to result in a decline in fishery performance, but it is expected to remain within historical bounds so the stock should remain sustainable.

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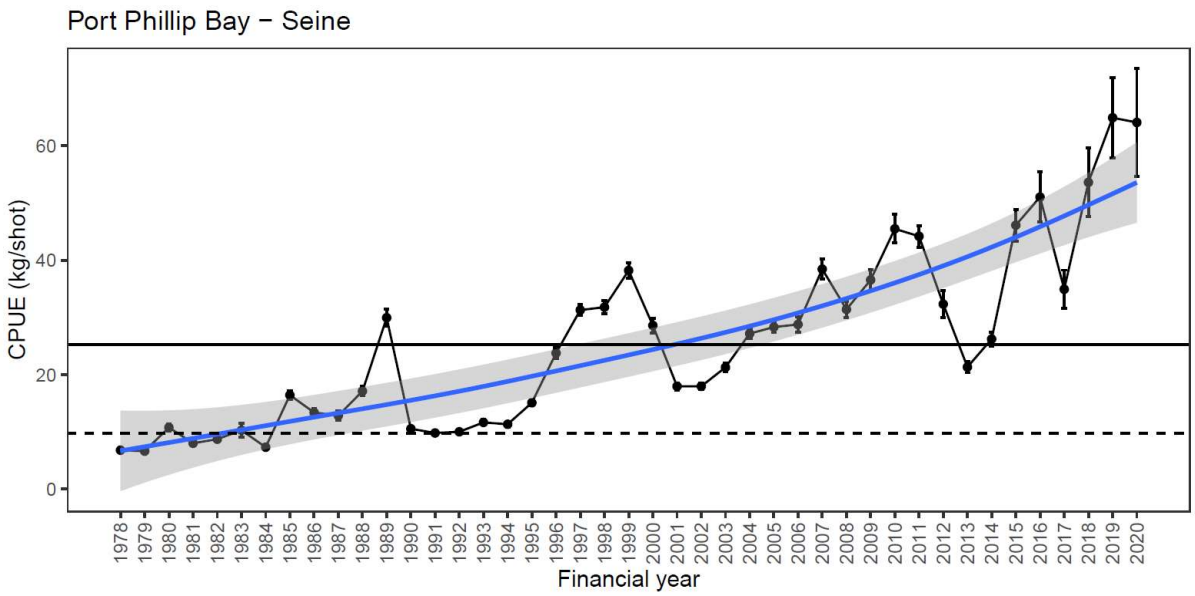
(a)



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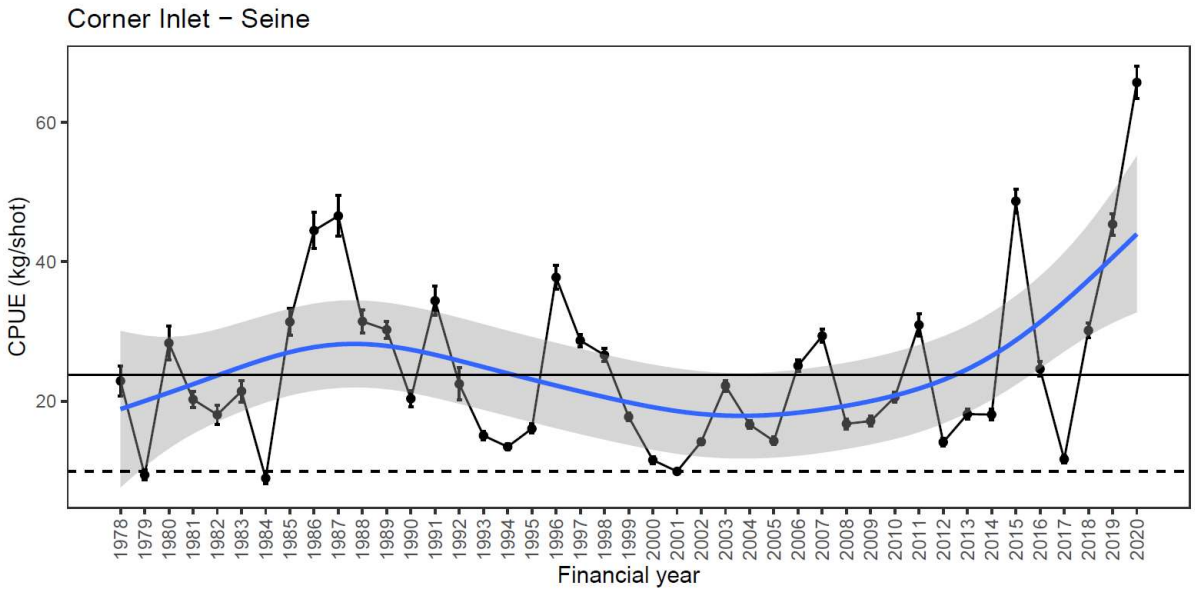


Figure 14 Commercial haul seine catch-per-unit-effort CPUE (nominal) for King George whiting in (a) Port Phillip Bay (PPB) and (b) Corner Inlet (CI), 1977/78–2019/20. Horizontal black line is the mean nominal CPUE during the reference period (1985–2015) and the dashed black line is the minimum CPUE within the reference period. The blue line is a generalised additive model GAM of the standardised CPUE trend with the shaded grey area representing the 95% confidence interval of the GAM.

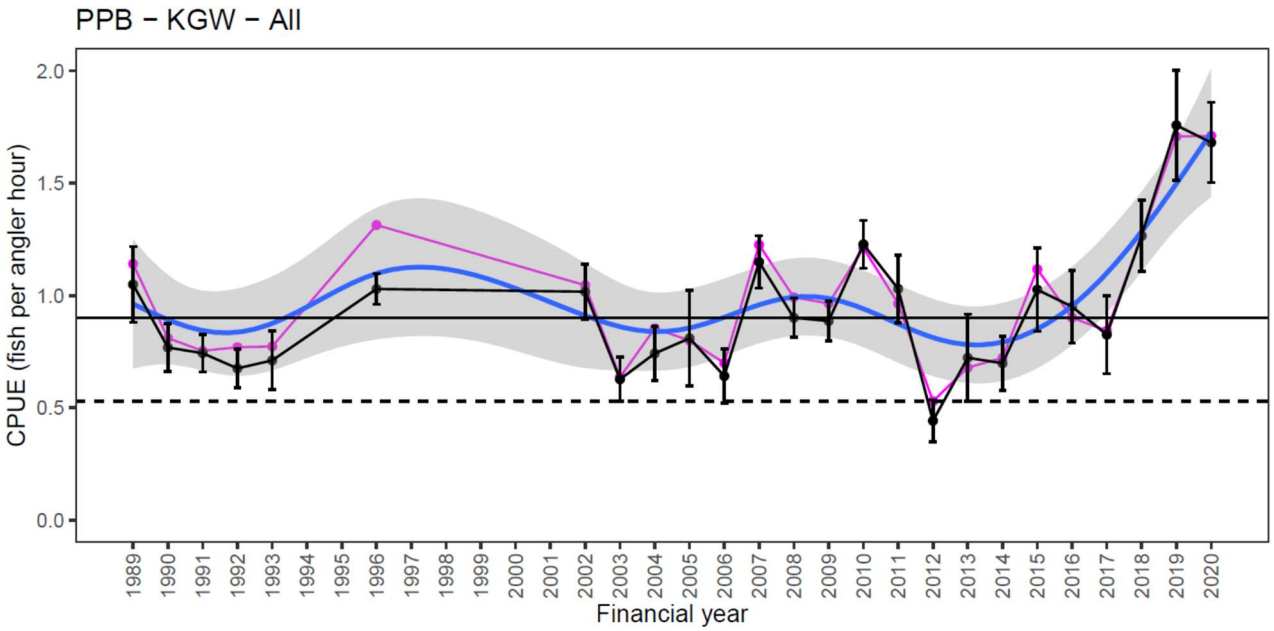


Figure 15 Catch-per-unit-effort (CPUE) of King George whiting (KGW) by recreational anglers interviewed in creel surveys undertaken in Port Phillip Bay (PPB) from 1988/89–2019/20 financial years. Black line is nominal CPUE (±SE), magenta line is standardised CPUE, blue line is a generalised additive model (GAM) of the standardised CPUE trend with the shaded grey area representing the 95% confidence interval of the GAM. Horizontal black line is the mean standardised CPUE during the reference period (i.e. 1989–2015) and the dashed black line is the minimum standardised CPUE within the reference period.

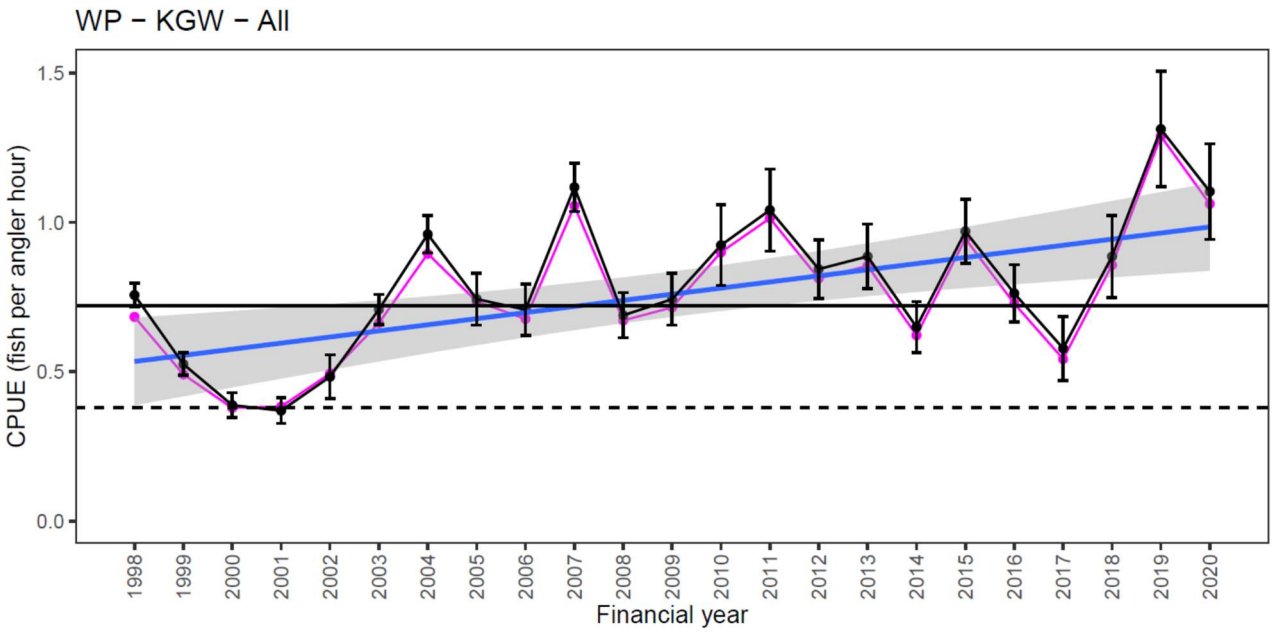


Figure 16 Catch-per-unit-effort (CPUE) of King George whiting (KGW) by recreational anglers interviewed in creel surveys undertaken in Western Port Bay (WP) from 1997/98–2019/20 financial years. Black line is nominal CPUE (±SE), magenta line is standardised CPUE, blue line is a generalised additive model (GAM) of the standardised CPUE trend with the shaded grey area representing the 95% confidence interval of the GAM. Horizontal black line is the mean standardised CPUE during the reference period (1998–2015) and the dashed black line is the minimum standardised CPUE within the reference period.

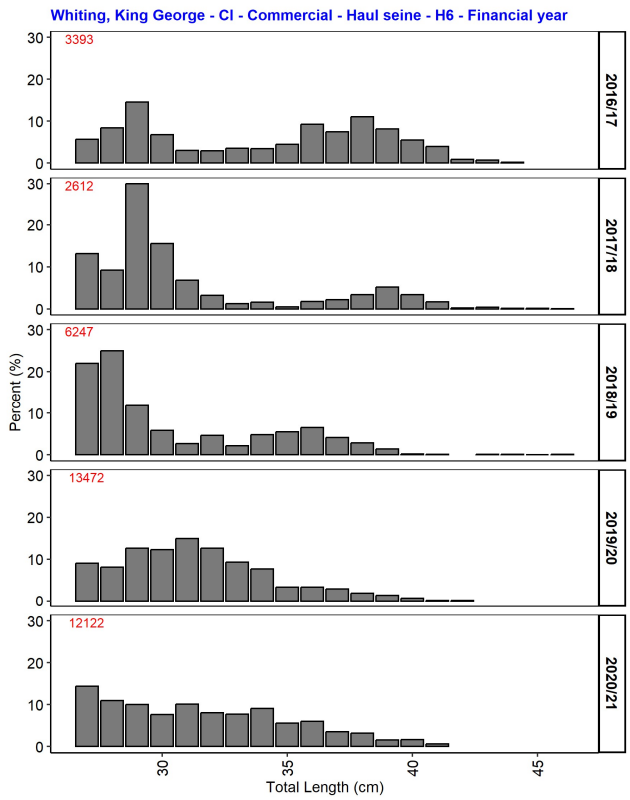


Figure 17 Length frequency histograms for Corner Inlet (CI) King George whiting haul seine (H6) catches from 2016/17–2020/21 fiscal years. Red numbers on x-axis indicate numbers of fish measured scaled to sampled catch weights.

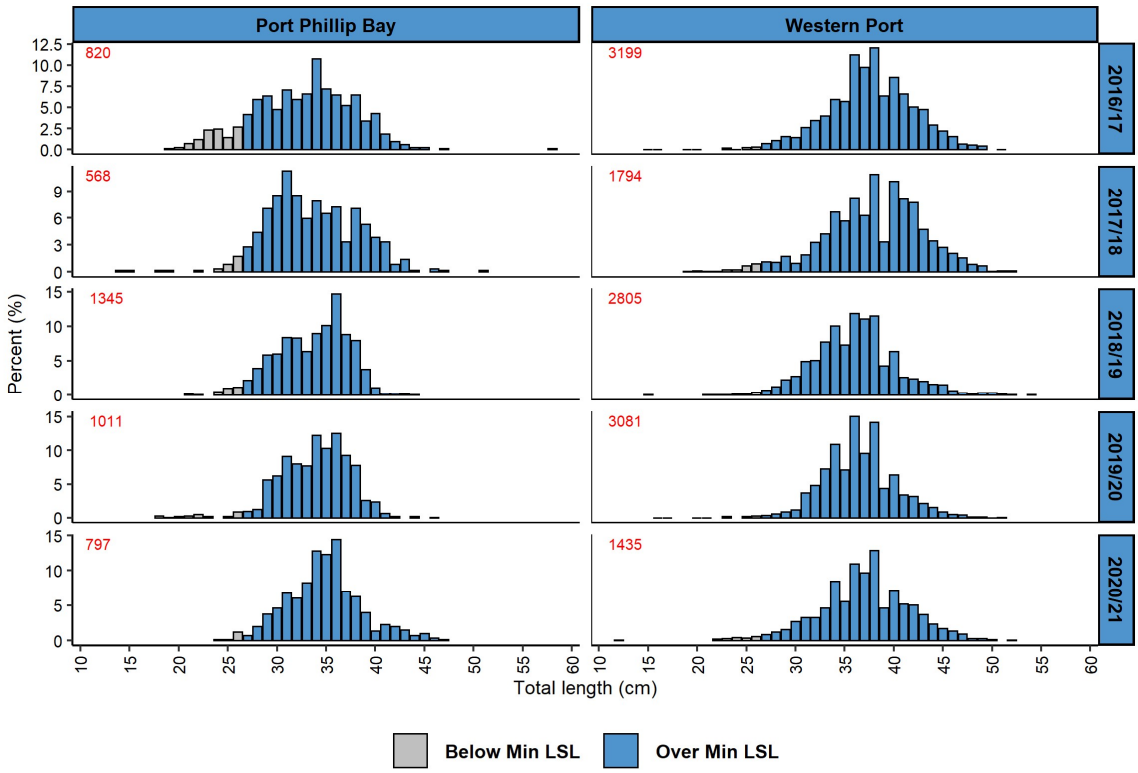
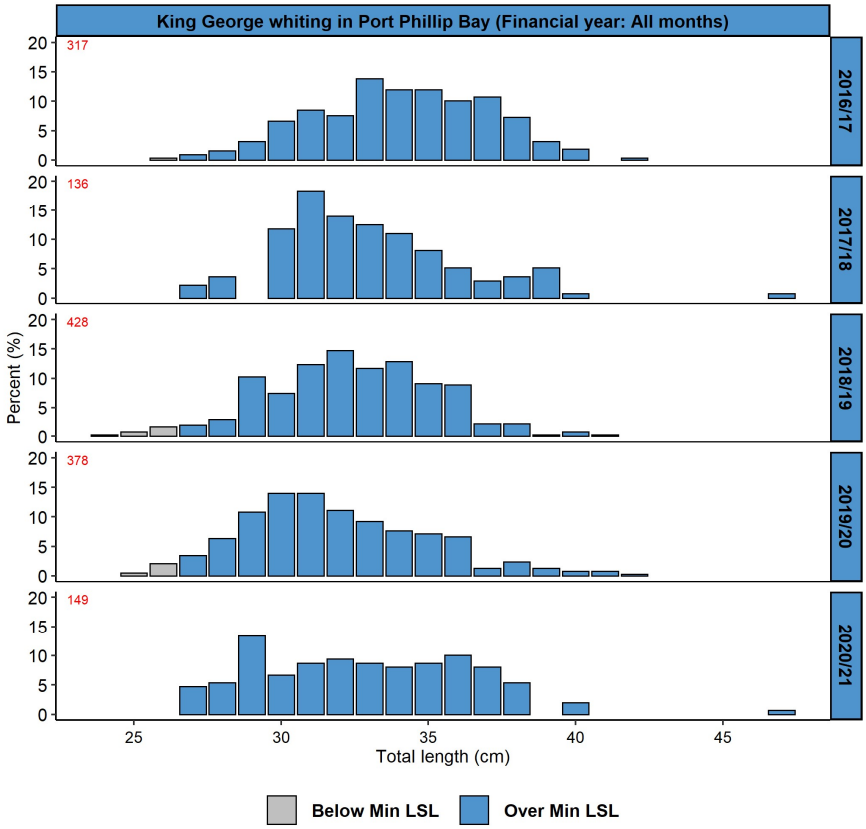


Figure 18 Frequency histograms of recreational King George whiting length composition from Port Phillip Bay and Western Port 2016/17–2020/21. Red numbers indicate numbers of fish measured. Grey bars are those fish equal to or larger that the Legal-Size Limit (LSL) and white bars are sub-legal sized fish less than the LSL.

(a)



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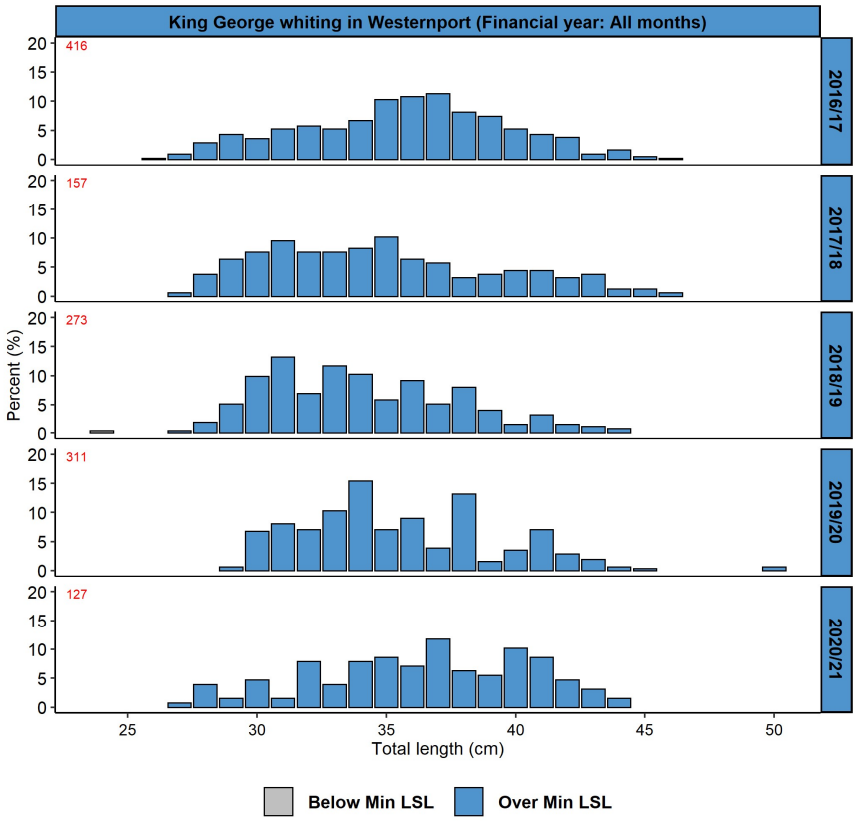


Figure 19 Frequency histograms of recreational King George whiting from creel survey length composition (a) Port Phillip (b) Western Port fiscal years 2016/17–2020/21. Red numbers indicate numbers of fish measured. Grey bars are those fish equal to or larger that the Legal Size Limit (LSL) and white bars are sub-legal sized fish less than the LSL.

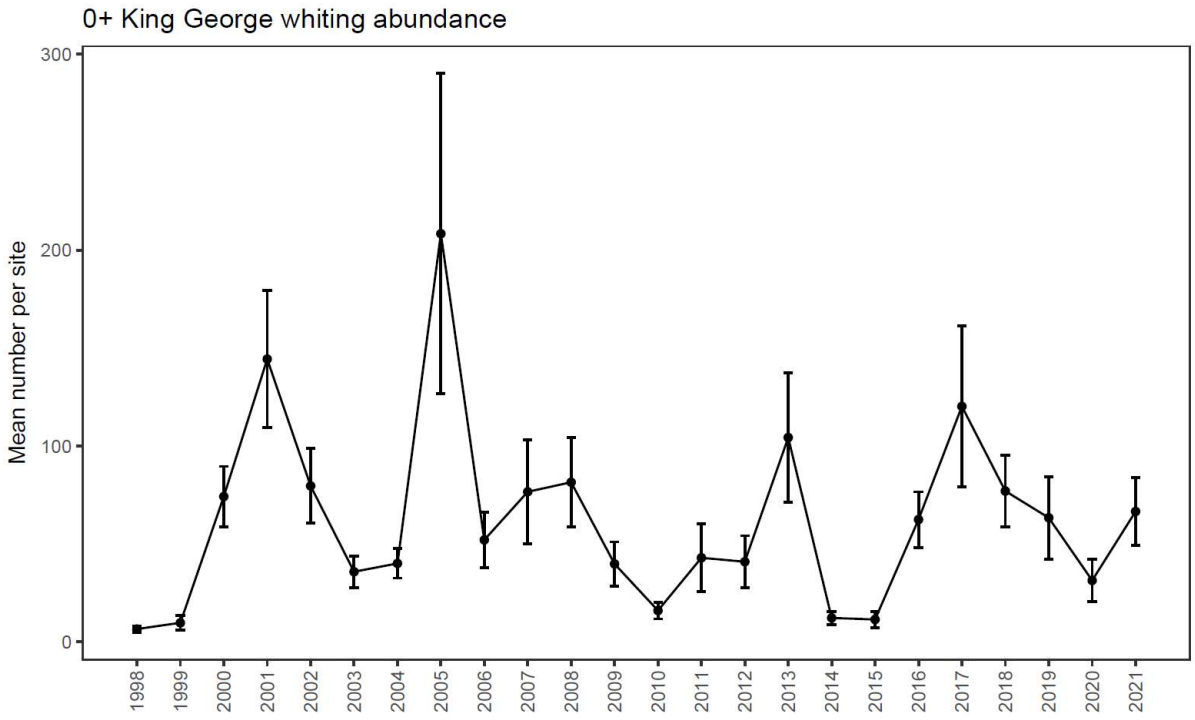


Figure 20 Port Phillip Bay King George whiting pre-recruit (0+ age) trawl survey catch rates (±SE) 1998–2021

Southern Sand Flathead (*Platycephalus bassensis*): Port Phillip Bay

Stock Structure and Biology

Southern Sand flathead are distributed along the entire Victorian coast in coastal waters and in all bays and inlets. The most important fishery for this species is in Port Phillip Bay, with smaller fisheries in Western Port, Corner Inlet, and coastal waters. Most of the Victorian sand flathead catch is taken by recreational anglers with only minor commercial harvesting.

The main Port Phillip Bay component of the sand flathead stock is a predominantly self-replenishing sub-population. The primary spawning period for sand flathead is during October to March.

Sand flathead in Port Phillip Bay can live to at least 23 years and grow to a size of 40 cm TL, although fish over 35 cm are relatively uncommon. Length at 50% maturity is reached at two to five years of age at a TL between 22 and 25 cm. Sand flathead growth rate and maximum sizes are lower for Port Phillip Bay than for coastal populations. Importantly, female sand flathead grow faster, and reach larger sizes, than males, so most sand flathead above the 27 cm LML in Port Phillip Bay are females. This assessment focusses on the main fishery in Port Phillip Bay.

Assessment Summary

The status of sand flathead was evaluated using:

- Available harvest information for the commercial and recreational sectors
- Nominal CPUE for long-line in Port Phillip Bay (reference period 1986-2015)
- Nominal and standardised CPUE for the recreational fishery from annual creel surveys in Port Phillip Bay (reference period 1989-2015)
- Nominal CPUE for diary angler targeted sand flathead trips in Port Phillip Bay
- CPUE of mature sized sand flathead (>25 cm TL) in Port Phillip Bay from fishery independent trawl surveys
- Length composition of recreational fishery catches in Port Phillip Bay from creel surveys and diary anglers
- Pre-recruit (0+ age) abundance from fishery independent trawl surveys in Port Phillip Bay.

This assessment found:

- *Fishing pressure* – There is currently negligible commercial fishing pressure on southern sand flathead in Port Phillip Bay with virtually all of the commercial catch being taken from Bass Strait during the past four years (Figure 21). Changes in, or current status of, recreational fishing pressure are unclear. Length composition data from creel surveys has been stable over the last 15 years (Figure 22).
- *Biomass* – Standardised CPUE from the creel surveys has remained relatively low (compared to historical levels) since the mid-2000s and was approximately midway between the reference period minimum (i.e. 2013/14) and reference period average in 2018/19 (Figure 23). The creel CPUE data indicate that the availability of legal sized sand flathead has stabilised since 2008 and shown signs of an increase from the

lowest point in 2013, particularly in the last year (Figure 23). Consistent with creel CPUE, diary angler targeted CPUE showed a decline from the mid 2000s to the late 2000s, but since 2011 its postive trend is more pronounced than the trend in creel survey CPUE. Unlike creel CPUE, diary angler CPUE represents catch rates of fish both above and below the LML, and the recent increasing trend is influenced by greater abundance of pre-recruit sand flathead below the LML since 2011 (Figure 24) that do not contribute to the creel survey catch rates. Long-line CPUE (Figure 25) is not considered indicative of stock status since 2015 due to likely discarding as a result of TAC changes (multi-species TAC), but is nevertheless included for historical context along with the otter trawl survey data of mature biomass (ceased in 2011). These indicators of mature biomass show a period of higher biomass from the mid-1990s to the early 2000s (Figure 26). The ongoing small beam trawl CPUE for mature fish (> 25 cm TL) indicates a drop in biomass from 2004 to 2006 similar to that in long-line and trawl biomass, and shows an increasing trend since 2012 consistent with the diary angler data (Figure 23). Again this increasing trend is influenced by fish less than the LML being included in the beam trawl survey data. Overall, the various CPUE data indicate sand flathead abundance is slowly increasing from an historic low during the late 2000s, however, the current increase in abundance is largely due to recent recruitment with the population now dominated by small fish below the LML.

- *Recruitment* – Pre-recruit survey data clearly show that the high biomass during the mid-1990s to early 2000s was due to exceptionally strong recruitment during the late 1980s to mid-1990s (Figure 27) (note: sand flathead take about 4–5 years to recruit to the fishery). Recruitment levels since 2000 have been much lower, driving the biomass declines observed from the early 2000s to 2010. It appears that the stock has now stablised at a lower biomass under this lower recruitment regime, and recruitment has been sufficient to balance natural and fishing mortality at this lower level. Recent recruitment events (i.e. 2009, 2013) have been important in preventing ongoing decline, and indeed driving some increase in biomass. Ellevated recrtuiment in 2018 and 2021 is expected to contribute to the stability of the stock and may be sufficient to support continuation of a slowly increasing trend.

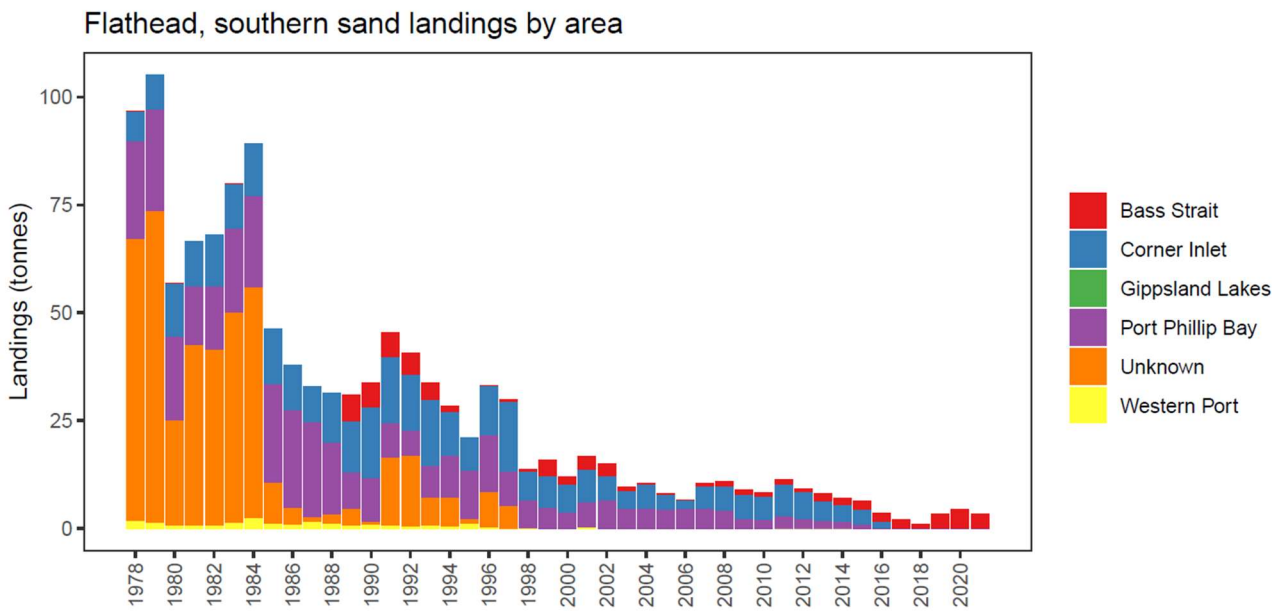
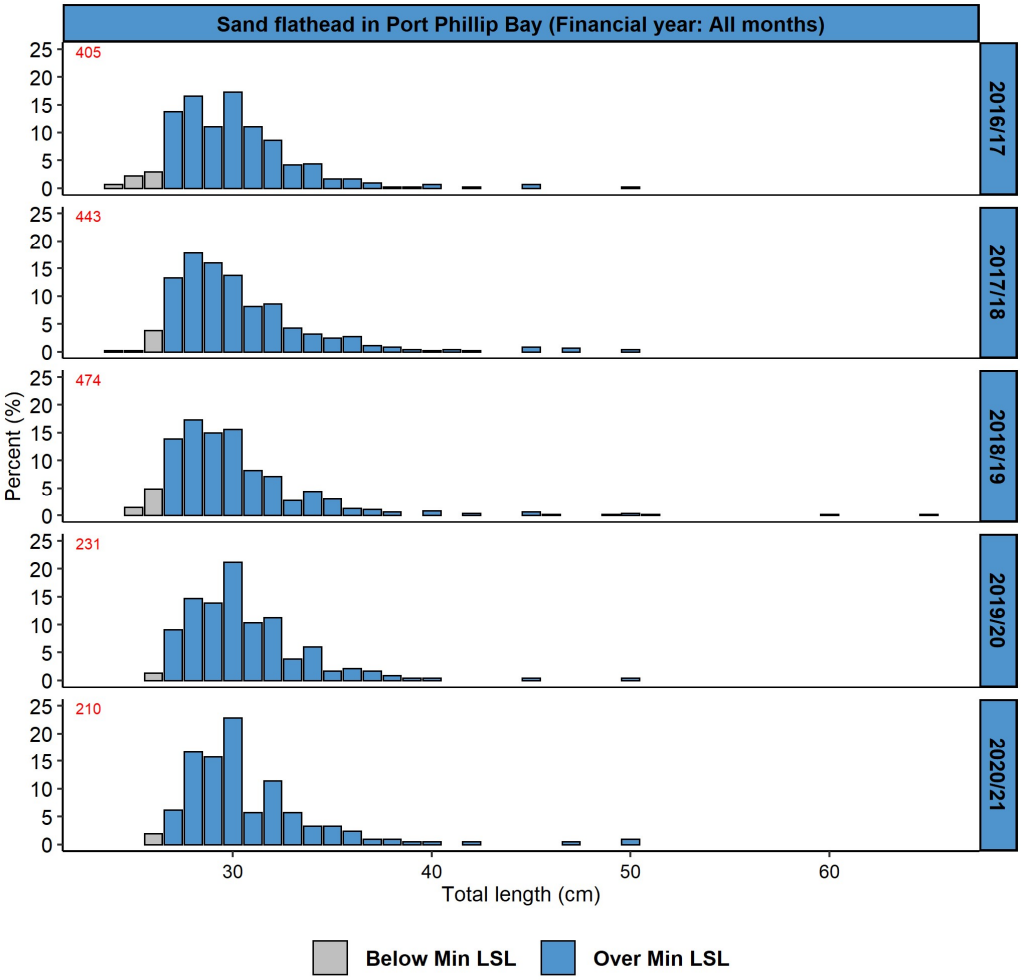


Figure 21 Victorian southern sand flathead commercial catches, financial years 1978–2021. Note: most of the catch classified as “unknown” is from Danish seine or trawl fishing in Bass Strait waters prior to the Danish seine/trawl fishery coming under Commonwealth management in 1998. Recent Commonwealth harvests are not included.

Stock status summary: On balance, the multiple lines of available evidence indicate that the Port Phillip Bay sand flathead population has been stable over the last decade at lower levels of abundance than during the 1990s. This indicates that recent recruitment has been sufficient to balance natural mortality and fishing impacts and that overfishing is unlikely to be occurring. There are recent signs of slow recovery in recreational catch rates, however, due to lack of recent strong recruitment events, any ongoing recovery in stock biomass is expected to remain slow.

(a)


Sand flathead in Port Phillip Bay (Financial year: All months)
405
443
474
231
210
2016/17
2017/18
2018/19
2019/20
2020/21
Percent (%)
Total length (cm)
Below Min LSL
Over Min LSL

(b)

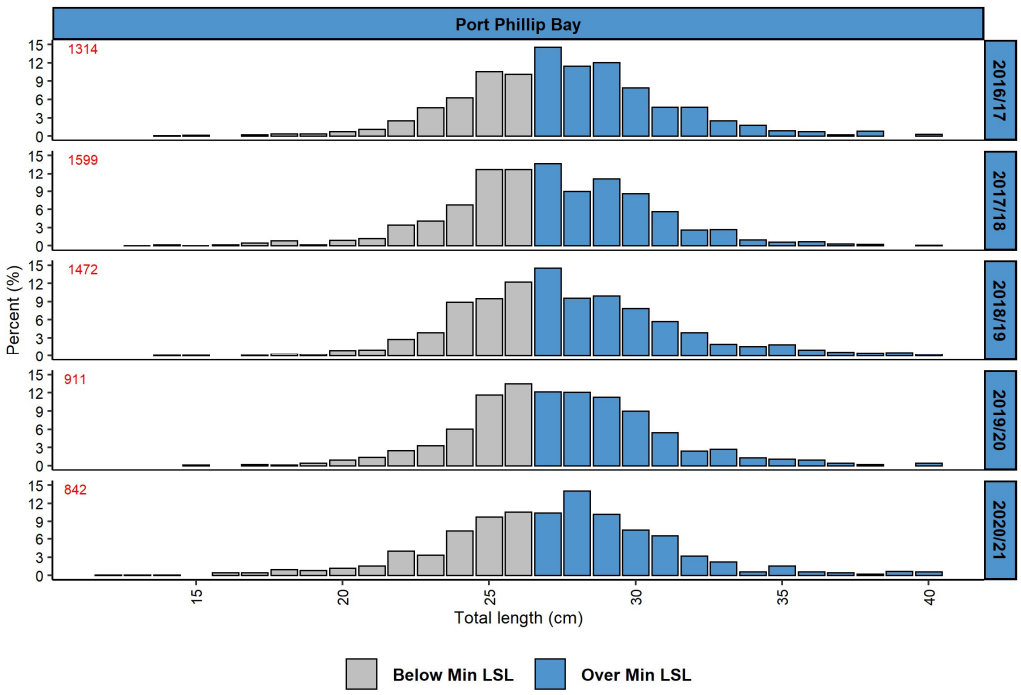

Port Phillip Bay
1314
1599
1472
911
842
2016/17
2017/18
2018/19
2019/20
2020/21
Percent (%)
Total length (cm)
Below Min LSL
Over Min LSL

Figure 22 Frequency histograms of Port Phillip Bay recreational sand flathead length composition (a) creel surveys, (b) angler diary, fiscal years 2016/17–2020/21. Red numbers indicate numbers of fish measured. LSL = legal size limit.

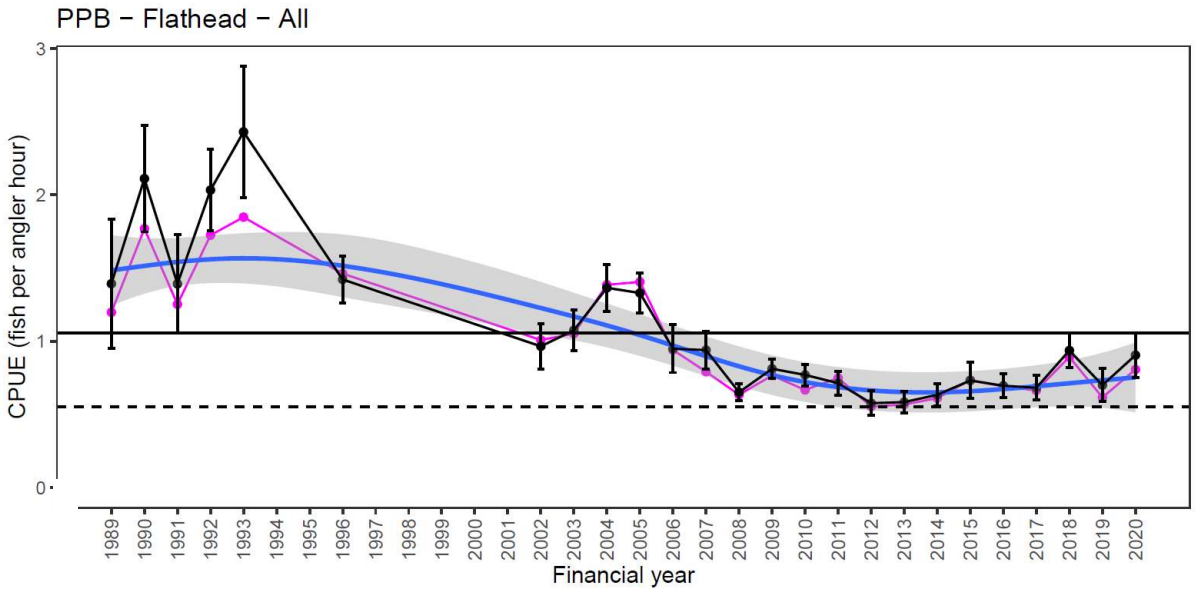


Figure 23 Catch-per-unit-effort (CPUE) of southern sand flathead by recreational anglers interviewed in creel surveys undertaken in Port Phillip Bay (PPB) during 1988/89–2020/21 financial years. Black line is nominal CPUE (±SE), magenta line is standardised CPUE, blue line is a generalised additive model (GAM) of the standardised CPUE trend with the shaded grey area representing the 95% confidence interval of the GAM. Horizontal black line is the mean standardised CPUE during the reference period (i.e., all years up to and including 2015) and the dashed black line is the minimum standardised CPUE within the reference period. Note: Catch rates were standardised prior to 2009 when the size limit was increased from 25 to 27 cm using the proportion of fish >27 cm in the catches of fishers interviewed during creel surveys in earlier years.

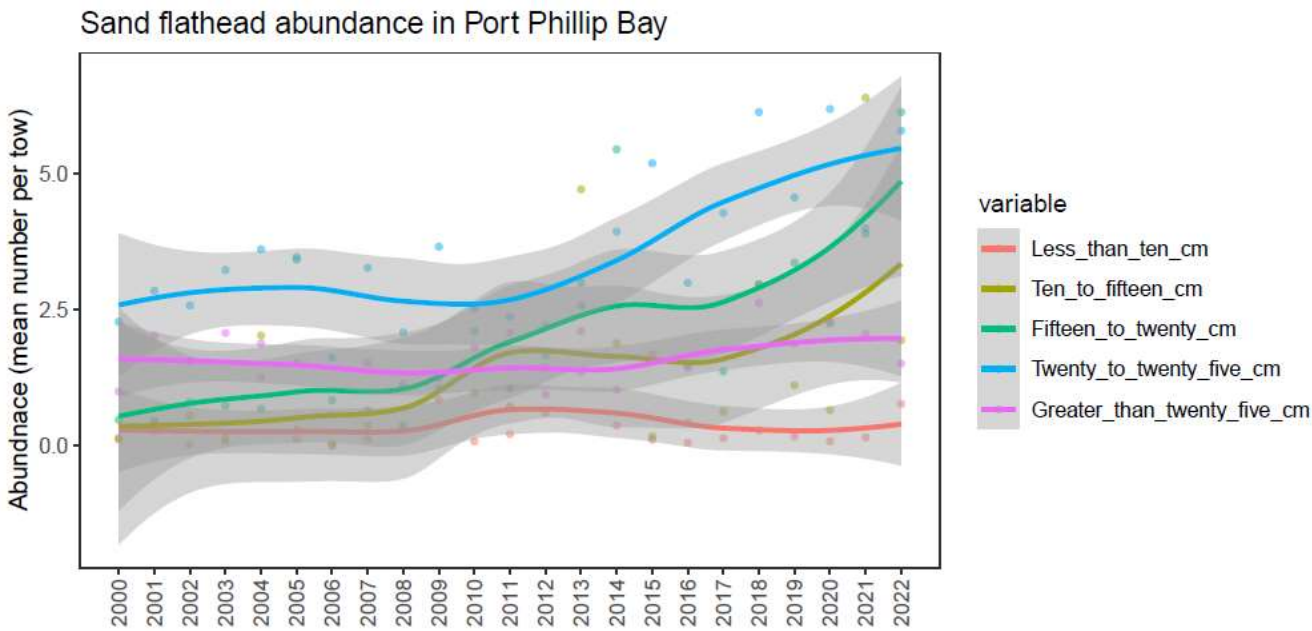


Figure 24 Abundance of sand flathead by size category from research net tows in Port Phillip Bay during 2000–2022.

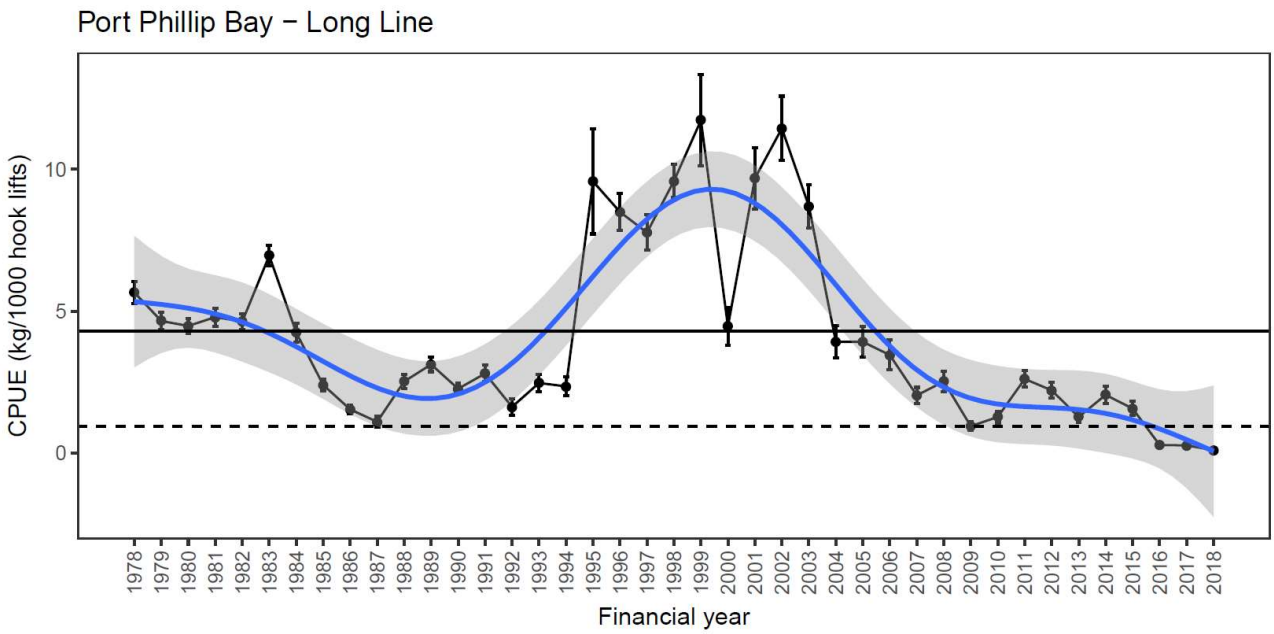


Figure 25 Nominal catch-per-unit-effort (CPUE) (±SE) (black line) for sand flathead by commercial long-line in Port Phillip Bay (PPB) during 1978–2018. Blue line is a generalised additive model (GAM) of the CPUE trend with the shaded grey area representing the 95% confidence interval of the GAM. Horizontal black line is the mean CPUE during the reference period (1985–2015) and the dashed black line is the minimum CPUE within the reference period.

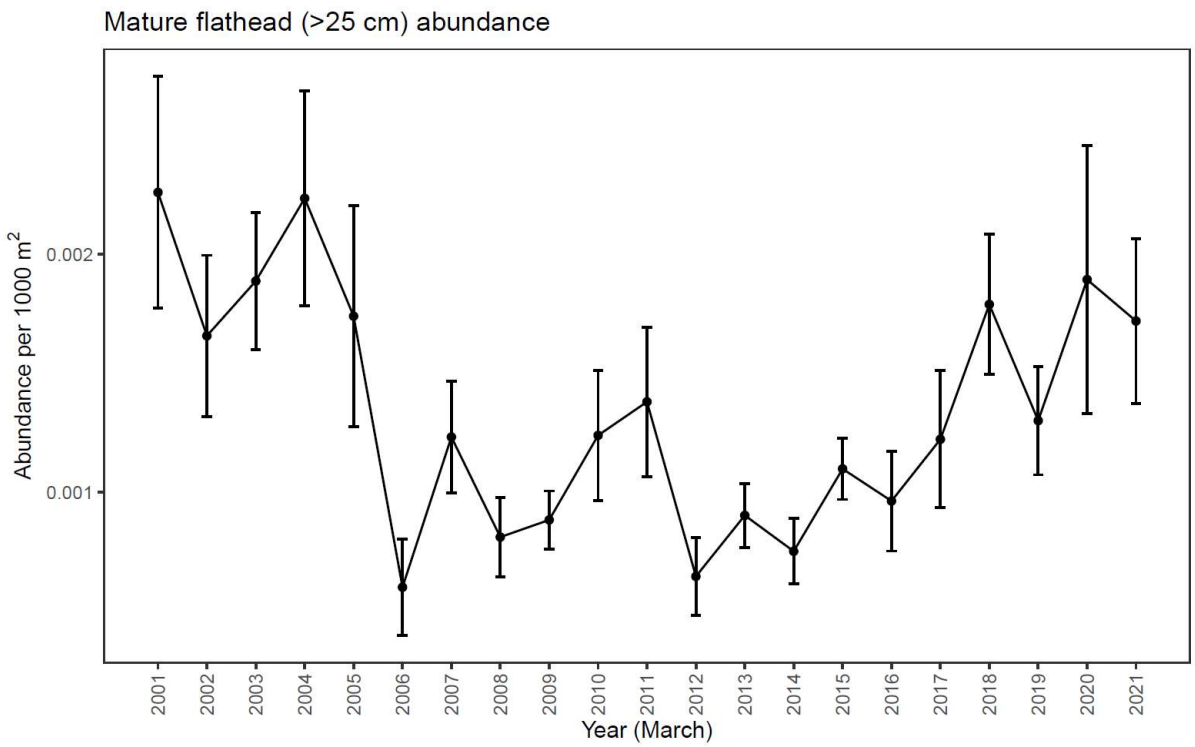


Figure 26 Port Phillip Bay mature (> 25cm) sand flathead abundance (mean ± SE) from 2001 – 2021.

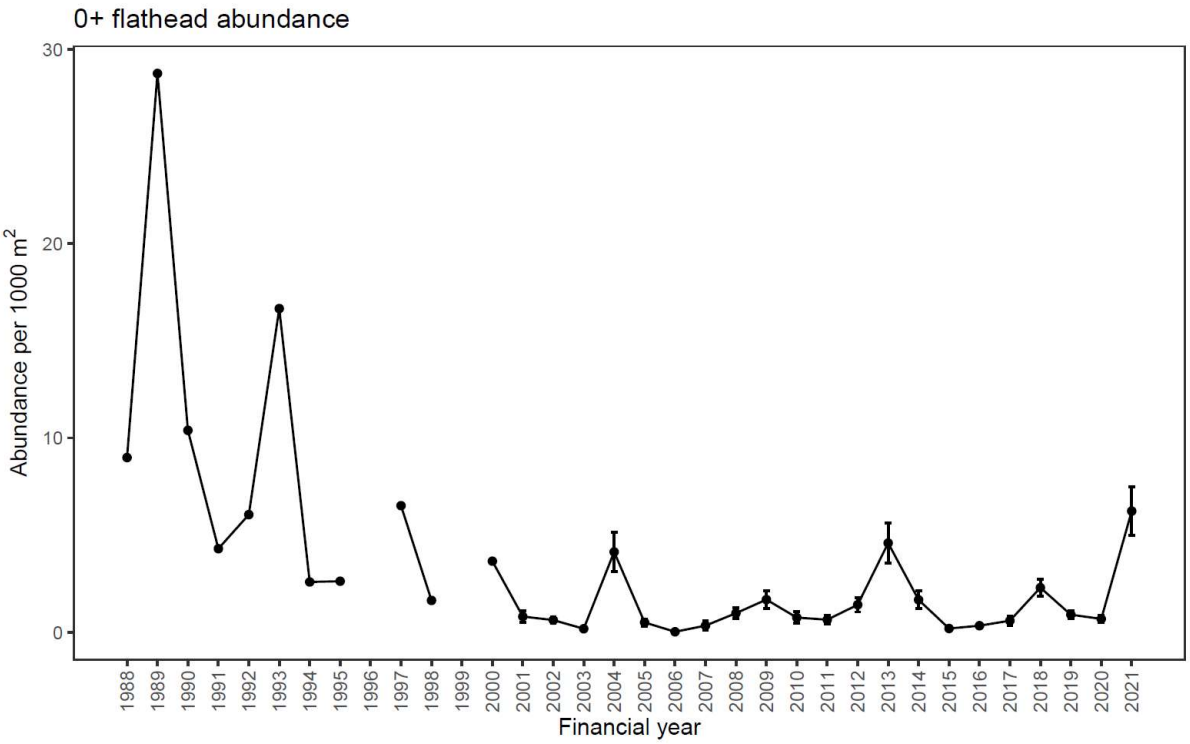


Figure 27 Port Phillip Bay sand flathead pre-recruit (0+ age) beam trawl survey catch rates (±SE) 1988–2021. Note: SE can only be calculated from 2000 onwards, data prior is based on extrapolation of beam trawl to earlier otter trawl data using a regression relationship from 11 years when the otter trawl and beam trawl surveys overlapped.

Black Bream (*Acanthopagrus butcheri*)

Stock Structure and Biology

Black bream populations in the Gippsland Lakes, Lake Tyers, Mallacoota Inlet, the Hopkins and Glenelg Rivers, and other minor inlets and river estuaries are considered to be self-replenishing discrete stocks, with limited mixing among adjacent estuaries.

Black bream can live for at least 29 years and grow to a size of at least 60 cm TL. Size at 50% maturity is reached at two years of age and 20 cm TL (LML = 28 cm). Black bream are characteristically variable in their fecundity and growth rate, taking three to eight years to reach the current LML. The main spawning period is during October to February, and occurs in estuaries, often associated with a salt-wedge.

Assessment Summary

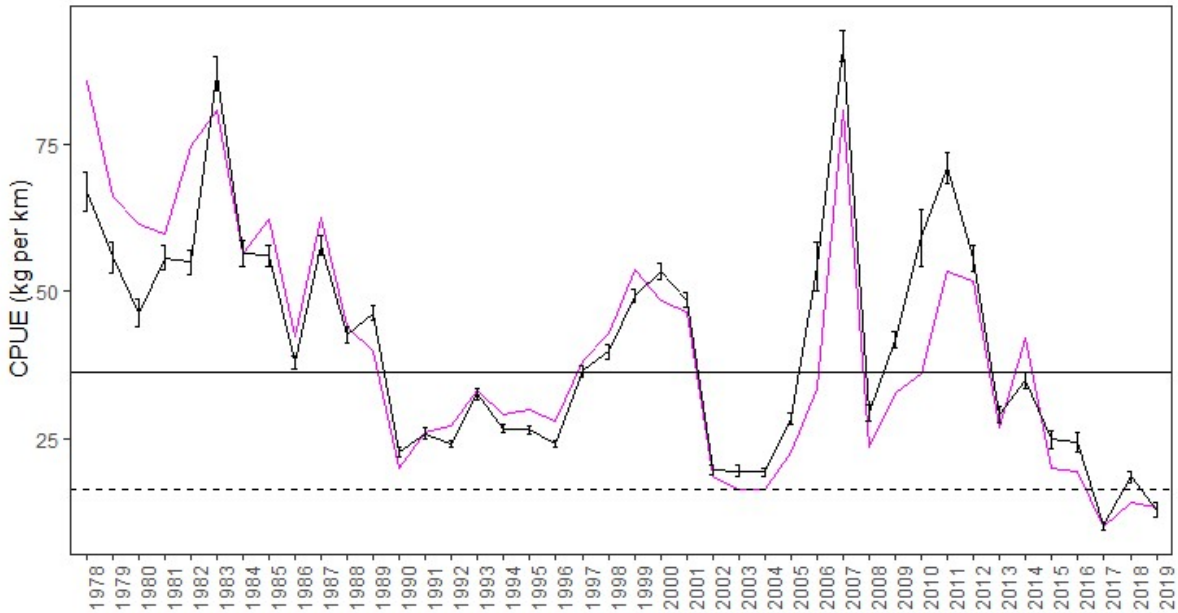
Gippsland Lakes

The status of the black bream in the Gippsland Lakes was evaluated using:

- Available harvest information for the commercial and recreational sectors
- CPUE (standardised and nominal) for commercial mesh net (reference period 1986–2015)
- CPUE (standardised and nominal) for the recreational fishery from annual creel surveys (reference period 1979–-2015)
- Length composition of diary angler catches
- Length composition of recreational fishery creel survey
- Pre-recruit (post-larval) abundance from fishery independent netting surveys (2010–2018).

This assessment found:

- *Fishing pressure* – Commercial harvests have dropped considerably since the 1980s (Figure 28), and more recently have declined substantially in reponse to declining netting effort due to commercial licence reductions since 2010 (Appendix 2). Most of the catch since the early 2000s has been by mesh net. There is no recent information on recreational harvest or effort.
- *Biomass* – Standardised CPUE from mesh nets has declined continuously from 2011 to below the reference period lowest point in 2017/18 through until 2019/20 when fishing ceased in the Gippsland Lakes (



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- Figure 29). Standardised CPUE from the creel surveys has remained low (compared to historical levels) since the early 2000s, and was below the reference period average and only just above the reference period lowest point from 2016-2018 (Figure 30). Since then, recreational CPUE has increased slightly, but reamins well below historic levels
- *Length composition* – Length composition data from creel surveys has been stable over the last 15 years with signs of an increase in the median size of fish harvested from 2009 to 2021 (Figure 32). There has been increased proportions of smaller fish in diary angler catches in 2017–2021, suggesting recent increased recruitment rates as evidenced by the smaller sub-legal fish in recent years (Figure 32).
- *Recruitment* – Recruitment of 0+ age black bream has been relatively stronger from 2017 to 2020, but was lower in 2021 (Figure 31). These cohorts will grow to legal size over the next 4–5 years. However, because of the short length of the recruitment time series it remains unclear how the recruitment index relates to replenishment of adult biomass, or how this relates to historic recruitment rates.

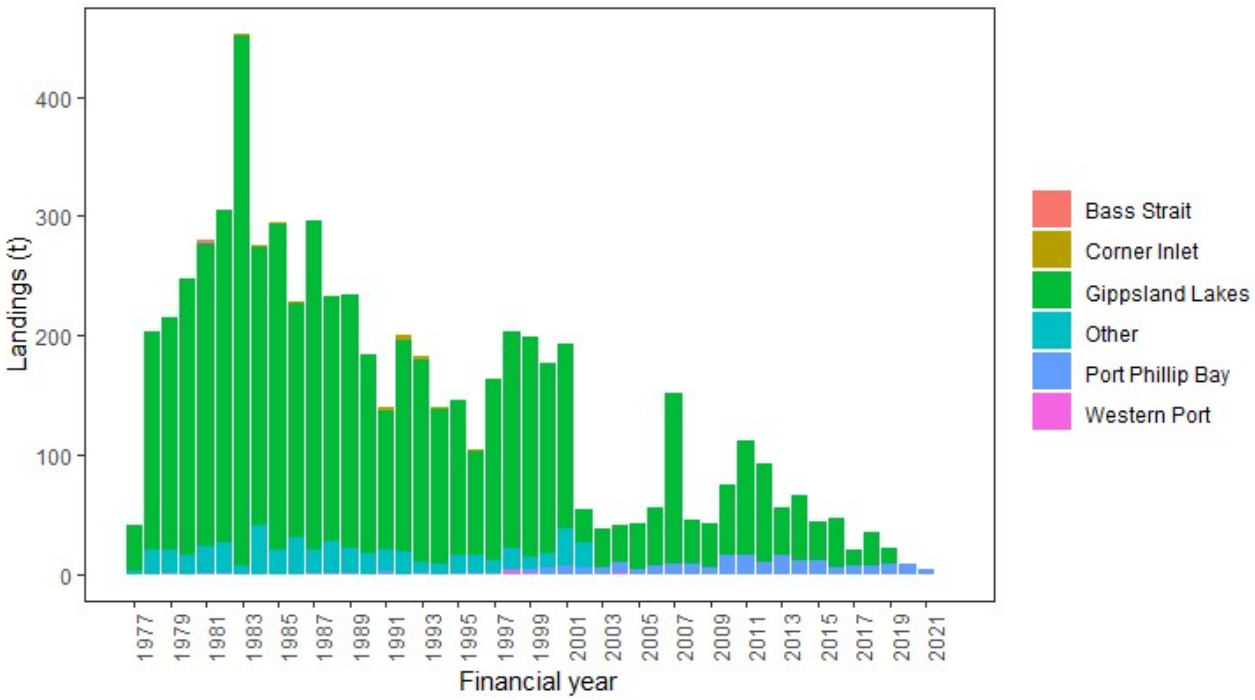


Figure 28 Commercial harvests of black bream from Victorian waters by area during fiscal years 1978–2021.

Stock status summary: Due to the recent mesh net CPUE trending below the reference period minimum; the lower bound of the 95% confidence interval creel survey CPUE being close to the low point; and uncertainty as to the relationship between the pre-recruit index and replenishment of the adult stock, the Gippsland Lakes Black Bream stock has been assessed as depleting.

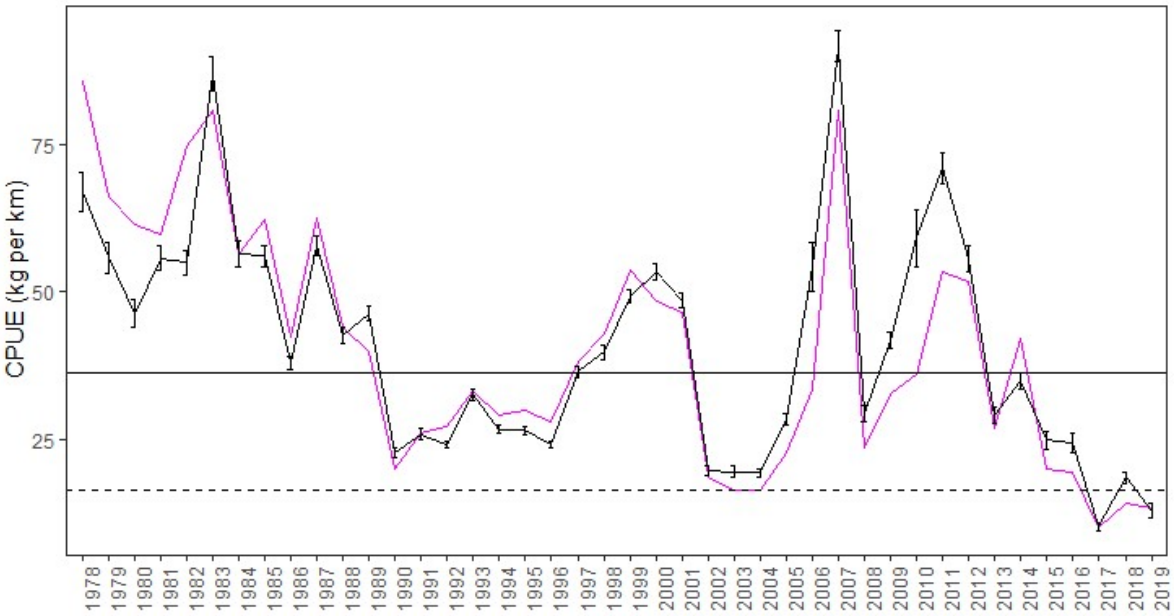


Figure 29 Catch-per-unit-effort (CPUE) of black bream by commercial mesh net fishers in the Gippsland Lakes during 1978 – 2018 financial years. Black line is nominal CPUE (±SE), magenta line is standardised CPUE, blue line is a generalised additive model (GAM) of the standardised CPUE trend with the shaded grey area representing the 95% confidence interval of the GAM. Horizontal black line is the mean standardised CPUE during the reference period (1985–2015) and the dashed black line is the minimum standardised CPUE within the reference period. Note: CPUE is calculated as Kg/km as no soak time data were available prior to 1998 and mesh net fishers in the Gippsland Lakes tend to soak their gear overnight meaning soak time is relatively uniform through time.

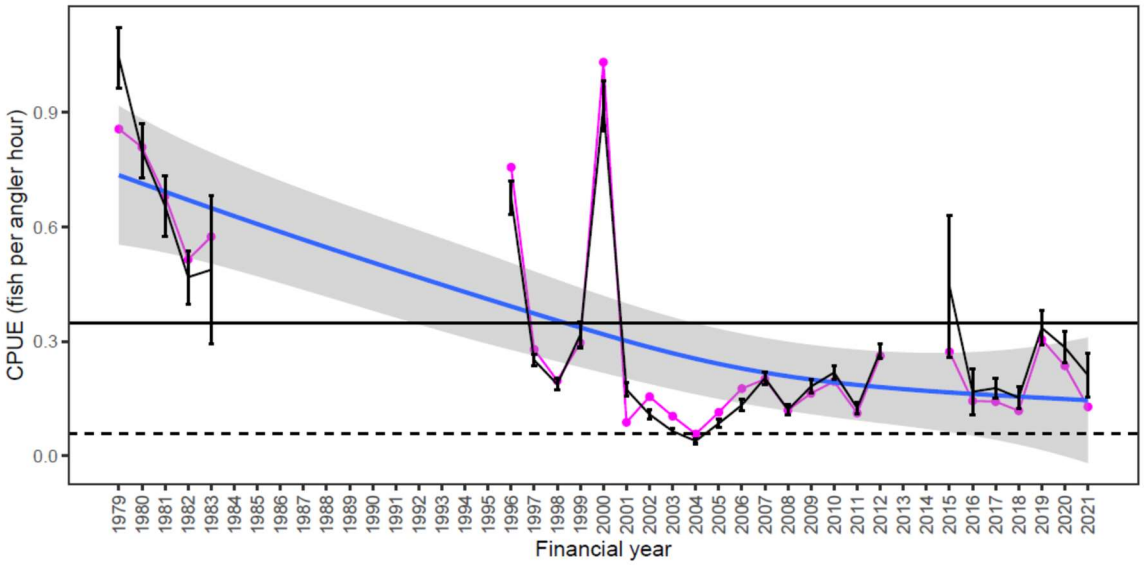


Figure 30 Catch-per-unit-effort (CPUE) of black bream by recreational anglers interviewed in creel surveys undertaken in the Gippsland Lakes during 1979–2021. Black line is nominal CPUE (±SE), magenta line is standardised CPUE, blue line is a generalised additive model (GAM) of the standardised CPUE trend with the shaded grey area representing the 95% confidence interval of the GAM. Horizontal black line is the mean standardised CPUE during the reference period (i.e. all years up and including 2015) and the dashed black line is the minimum standardised CPUE within the reference period.

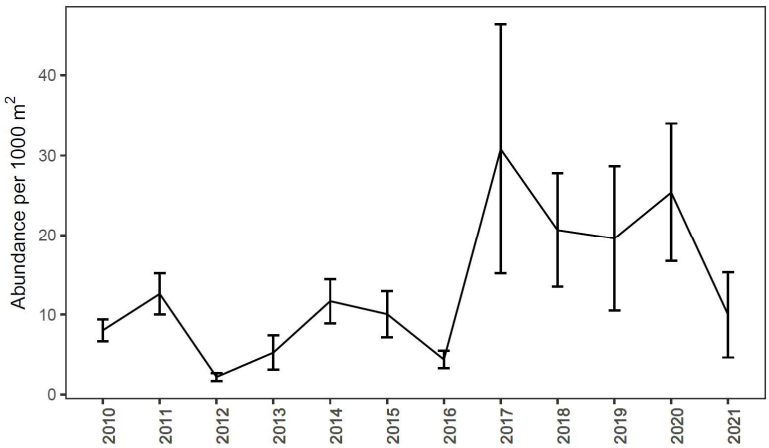
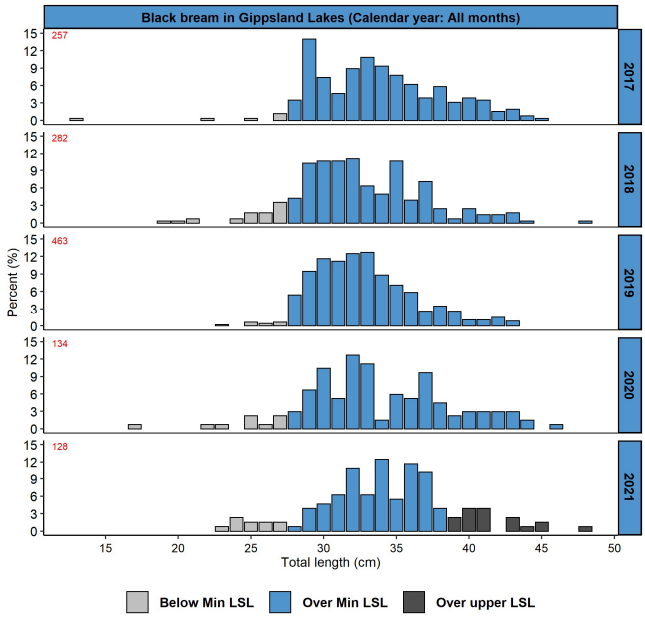


Figure 31 Pre-recruit survey abundance of 0+ black bream in the Gippsland Lakes (mean ±SE) during 2010–2021. Pre-recruit surveys comprise ~50 demersal trawl shots throughout the rivers and lakes of the system.

(a)



(b)

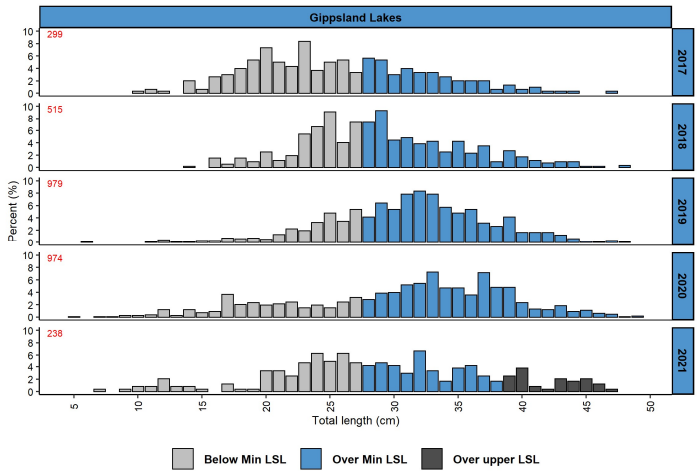


Figure 32 (a) Frequency histograms of Gippsland Lakes black bream length composition for recreational creel survey for calendar years 1997–2021, red numbers on x-axis indicate numbers of fish measured, blue line median length, red line is the legal minimum length (LML). (b) Frequency histograms of Gippsland Lakes black bream length composition from diary anglers for calendar years 2017–2021. Red numbers indicate numbers of fish measured.

Southern Garfish (*Hyporhamphus melanochir*): State-wide

Stock Structure and Biology

The Victorian southern sea garfish population is considered to comprise a single stock that is genetically similar to southern sea garfish in the South Australian gulfs but is distinct from the Tasmanian stock.

Garfish can live to 12 years and grow to 46 cm total length (TL). Size at maturity (50 percent) is reached at approximately 19 months of age and 21 cm TL. There is no LML in Victoria. Garfish have low fecundity and a medium growth rate. Spawning takes place in Bays and Inlets between October and March.

Management/Assessment Unit

Southern sea garfish support recreational and commercial fisheries, with the largest commercial fishery now located in Corner Inlet-Nooramunga after the phasing out of net fishing from Port Philip Bay from 2016. Southern Sea Garfish are an important recreational species in Port Phillip Bay, particularly for land-based anglers fishing from piers. Smaller fisheries are located in Western Port (recreational) and the Gippsland Lakes (recreational and previously commercial) (Figure 33). This report considers Victorian southern sea garfish as a single stock.

Assessment Summary

State-wide stock

For this assessment the status of the southern garfish stock was evaluated using:

- Nominal CPUE for commercial haul seine harvests in Corner Inlet-Nooramunga. The performance of the CPUE biomass proxies were assessed in relation to the specified reference level and limit points using a default reference period (1979–2015)
- Commerial catch and effort data.

There are insufficient recreational fishery data for meaningful assessment.

This assessment found:

- *Fishing pressure* – Southern garfish are predominantly caught by seine in Corner Inlet-Nooramunga with landings in Port Phillip Bay declining to zero due to netting buy-outs (Appendix 2). As a result, southern garfish landings have delined through time (Figure 33). Catches have, however, increased over the last few years in Corner Inlet-Nooramunga, due to increased seining effort (Figure 33 and Figure 34).
- *Biomass* – Due to the issues with retention rates in Port Phillip Bay outlined above, Corner Inlet is used as the primary performance measure for the Victorian southern garfish fishery. CPUE appears to follow a cyclical

pattern in which a single year of high catch rate is followed by 2–7 years of lower catch rate rate. This is somewhat surprising given the species has relatively low fecundity and is therefore less likely to show a boom-and-bust population strategy as do short-lived highly fecund species. In this instance, the GAM is useful in elliminating some of the variation around this cycling and it indicates there was a general decline in CPUE from 1978–1996 before a stabilisation around the reference period average that has persisted through until 2020/21 (Figure 34).

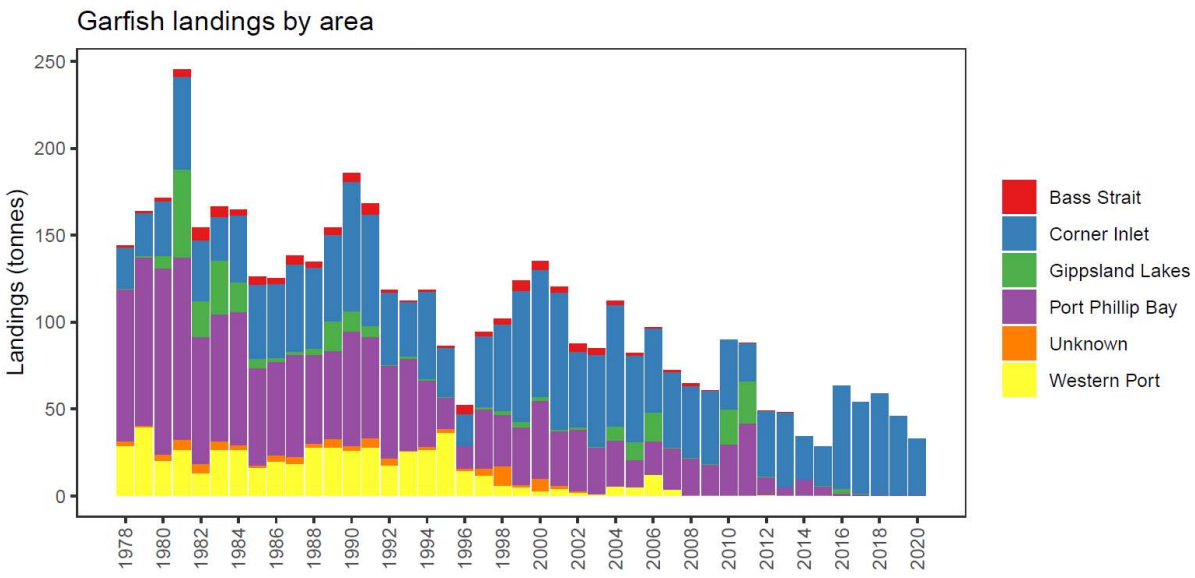
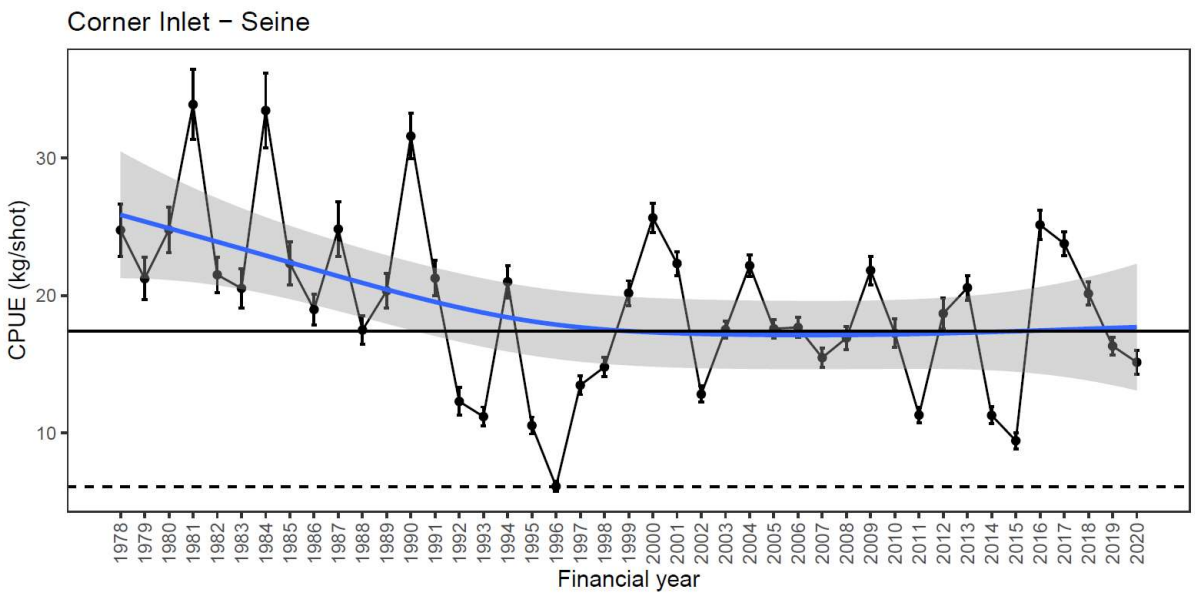


Figure 33 Total commercial harvests of southern sea garfish from Victorian waters, financial years 1978–2020.

Stock status summary: There has been decreasing fishing effort with gears for which southern garfish are susceptible to capture that is unrelated to southern garfish abundance and a relatively stable temporal CPUE trend suggesting that the southern garfish stock is performing adequately, and stocks are unlikely to be recruitment impaired. CPUE trend is stable and although the last two years of CPUE in the main fishery of Corner Inlet-Nooramunga are below the reference period average, it remains within the bounds of historical cycling. Based on the above summary southern sea garfish in Victoria is assessed as sustainable.

(a)



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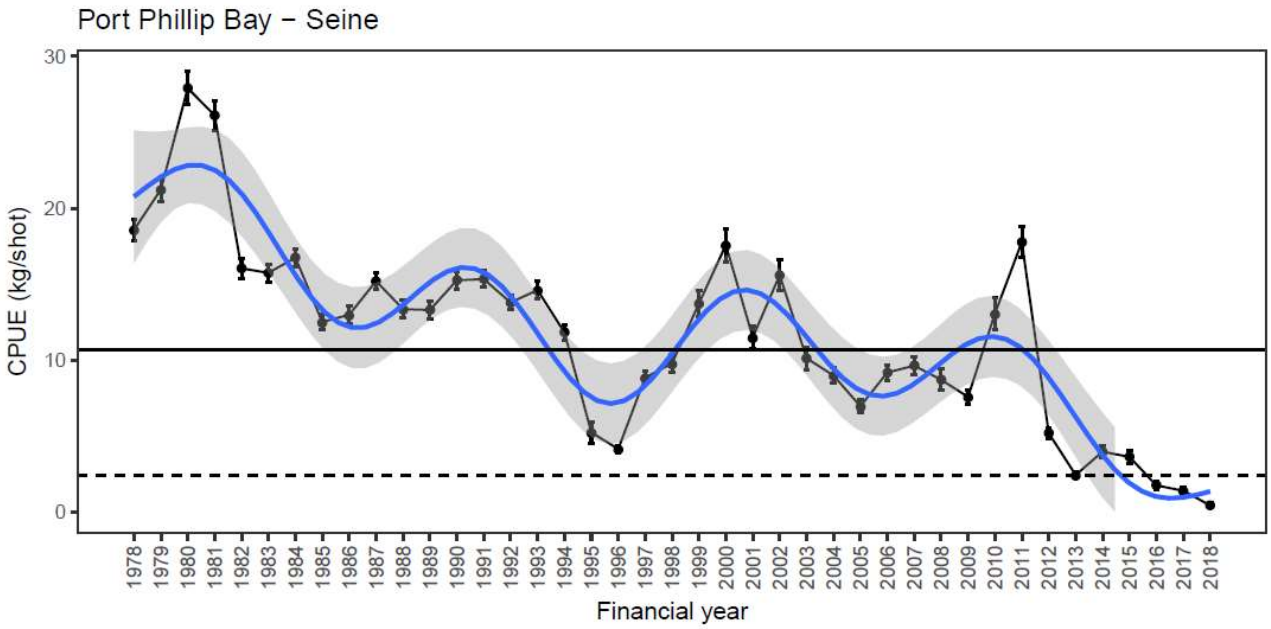
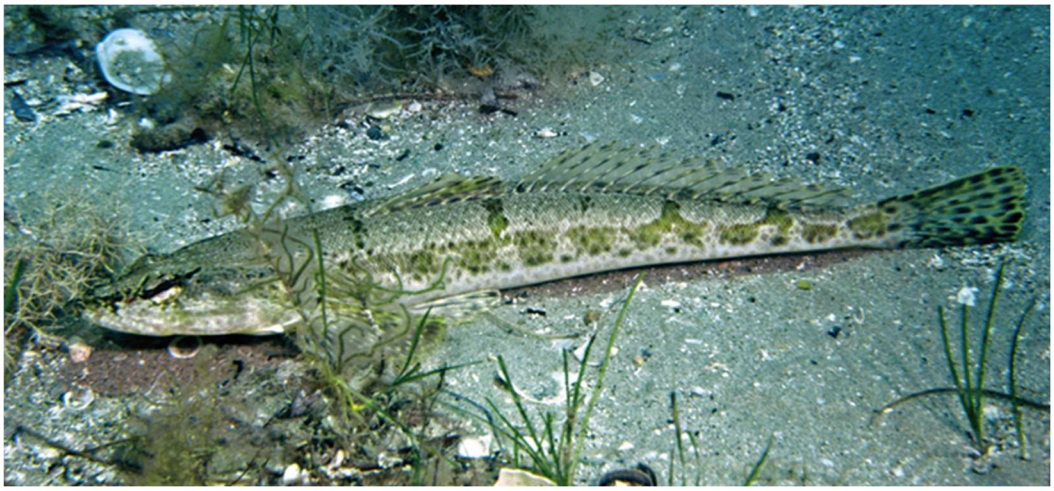


Figure 34 Southern sea garfish nominal catch-per-unit-effort (CPUE) (±SE) for the (a) Corner Inlet haul seine fishery (1978–2018 financial years), and (b) Port Phillip Bay haul seine fishery (1978–2018 financial years). Horizontal black line is the mean CPUE during the reference period (1985-2015) and the dashed black line is the minimum CPUE within the reference period. Blue line is a generalised additive model (GAM) of the nominal CPUE trend with the shaded grey area representing the 95% confidence interval of the GAM.

Rock Flathead (*Platycephalus laevigatus*): Corner Inlet-Nooramunga



Stock Structure and Biology

The stock structure of rock flathead in Victorian waters is unknown. Female rock flathead can live for 21 years and grow to at least 50 cm TL. Male rock flathead only live for 16 years but likewise grow to 50 cm TL. Maturity (50 percent) is reached at 2 years and 23 cm TL (LML = 27 cm TL). Rock flathead are highly fecund and grow rapidly. The main spawning period is spring/summer in inshore coastal regions.

Management/Assessment Unit

Rock flathead primarily supports the commercial mesh-net and haul seine fishery in Corner Inlet. Up until 2016, when the removal of netting was implemented, the species was also important to the Port Phillip Bay commercial fishery. There are very small recreational catches in Port Phillip Bay, Western Port and Corner Inlet. This report only considers the population of rock flathead in Corner Inlet-Nooramunga, as a single management unit.

Assessment Summary

Corner Inlet

For this assessment, the status of the Corner Inlet rock flathead population was evaluated using:

- Nominal and standardised CPUE for commercial mesh-net, and nominal CPUE for haul seine,
- Length composition data from haul seine catches,
- Catch and effort data for the Corner Inlet commercial fishery.

This assessment found:

- *Fishing pressure* – At the state-wide scale, harvest of rock flathead has decreased since the peak harvest recorded in 2010 (Figure 35). Over 70% of the peak harvest in 2010 was from Corner Inlet-Nooramunga, and most of the decline in catch, at least until 2016, is due to declines in catch from Corner Inlet-Nooramunga (Figure 35a). While seine net effort has been relatively stable over the last 10 years, after declining to about half the peak level observed in the early 2000s, mesh net effort has increased considerably since the lowest levels in the early 2000s (Appendix 2). Mesh net effort in 2020/21 was close to historic high levels (Appendix 2). Length composition of seine net catches, which are less affected by selectivity bias than mesh nets, have been relatively stable, with fish up to 55 cm still being captured, and the dominant length categories being in the 28-31 cm length range (Figure 36, Figure 37 and Figure 38).

Biomass – CPUE by mesh net is highly variable, with regular peaks at approximate 5-year intervals, and an underlying increasing trend from the early 1980s to the mid-2000s, though this could be influenced by non-species specific ‘flathead’ reporting earlier in the time series (Figure 39 a). Since the mid-late 2000s the underlying trend has been decreasing,

though there are two peaks in CPUE, one in 2015/16 and one in the most recent year, 2020/21 (Figure 39 b). Seine net CPUE had a major peak from 2009 to 2011 (also observed in mesh net CPUE), but similar to mesh nets, has since declined, but showed a similar increase in 2020/21 to mesh nets (Figure 39 b).

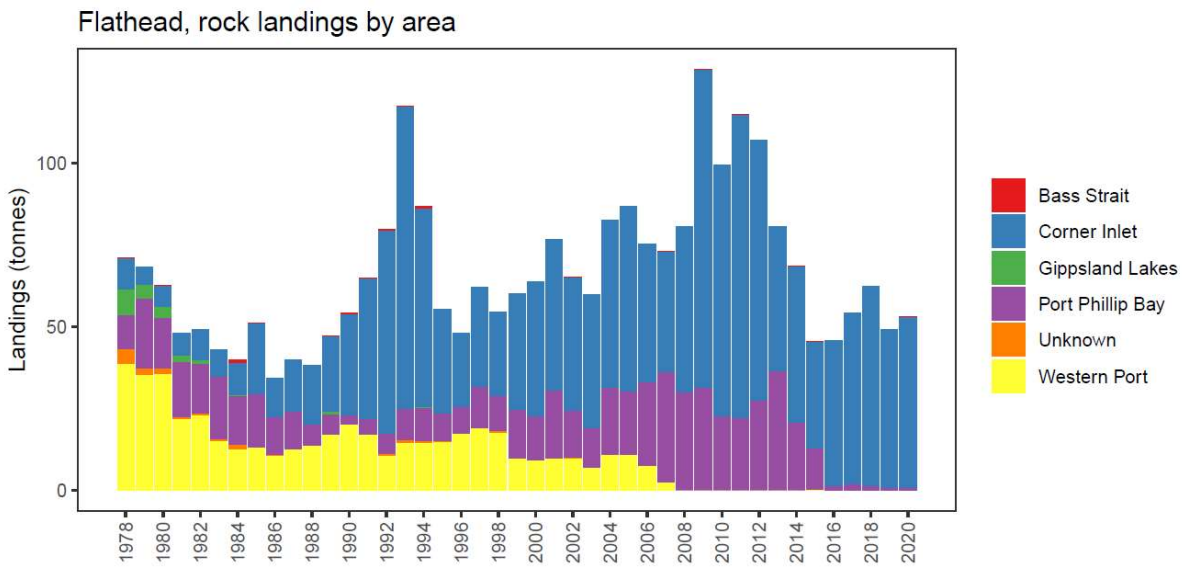


Figure 35 Total Victorian commercial catches of rock flathead by (a) area and (b) gear types, financial years 1978–2020.

Stock status summary: Overall, while regular peaks in CPUE likely relate to recruitment variation, the underlying trend of a declining mesh net CPUE is noteworthy, particyularly because of recent increases in mesh net effort and catch. While the length composition has been stable with a consistent presence of large fish in the catches, the combination of decreasing CPUE, increasing effort and increasing catch of rock flathead in Corner Inlet-Nooramunga may result in further stock decline.

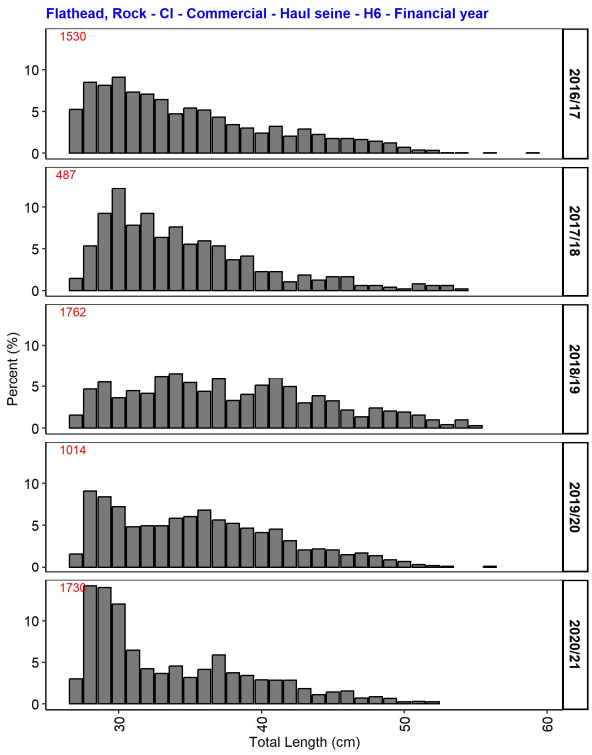


Figure 36 Frequency histograms of Corner Inlet length composition from haul seine catches financial years 2016/17–2020/21. Red numbers indicate numbers of fish measured scaled to catch sample weight.

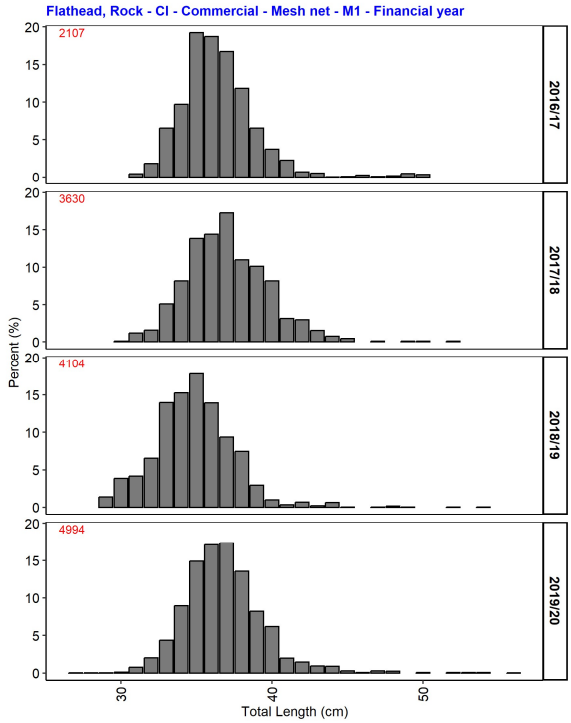


Figure 37 Frequency histograms of Corner Inlet length composition from mesh net (M1) catches financial years 2016/17–2019/20. Red numbers indicate numbers of fish measured scaled to catch sample weight.

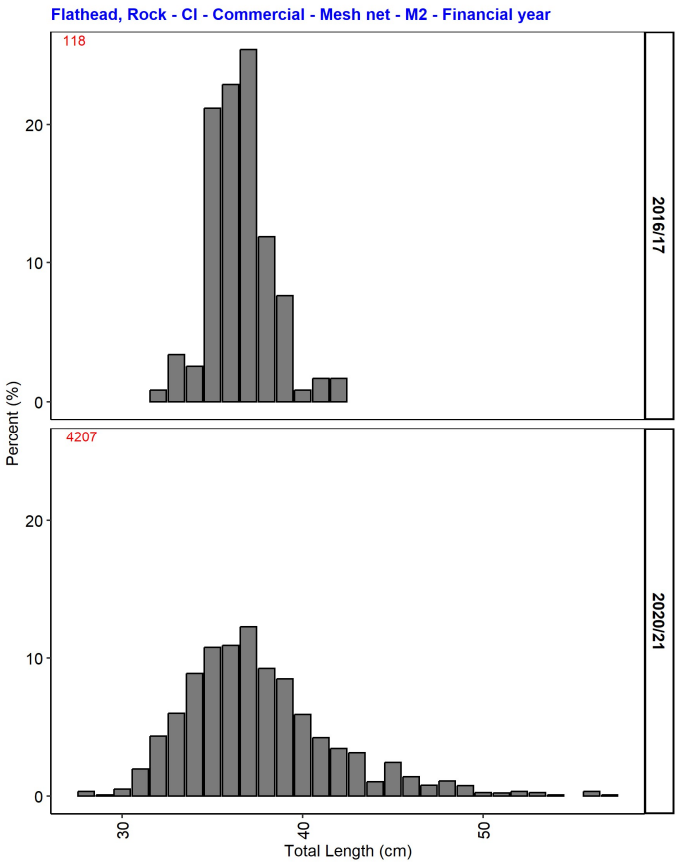


Figure 38 Frequency histograms of Corner Inlet length composition from mesh net (M2) catches financial years 2016/17 & 2020/21. Red numbers indicate numbers of fish measured scaled to catch sample weight.

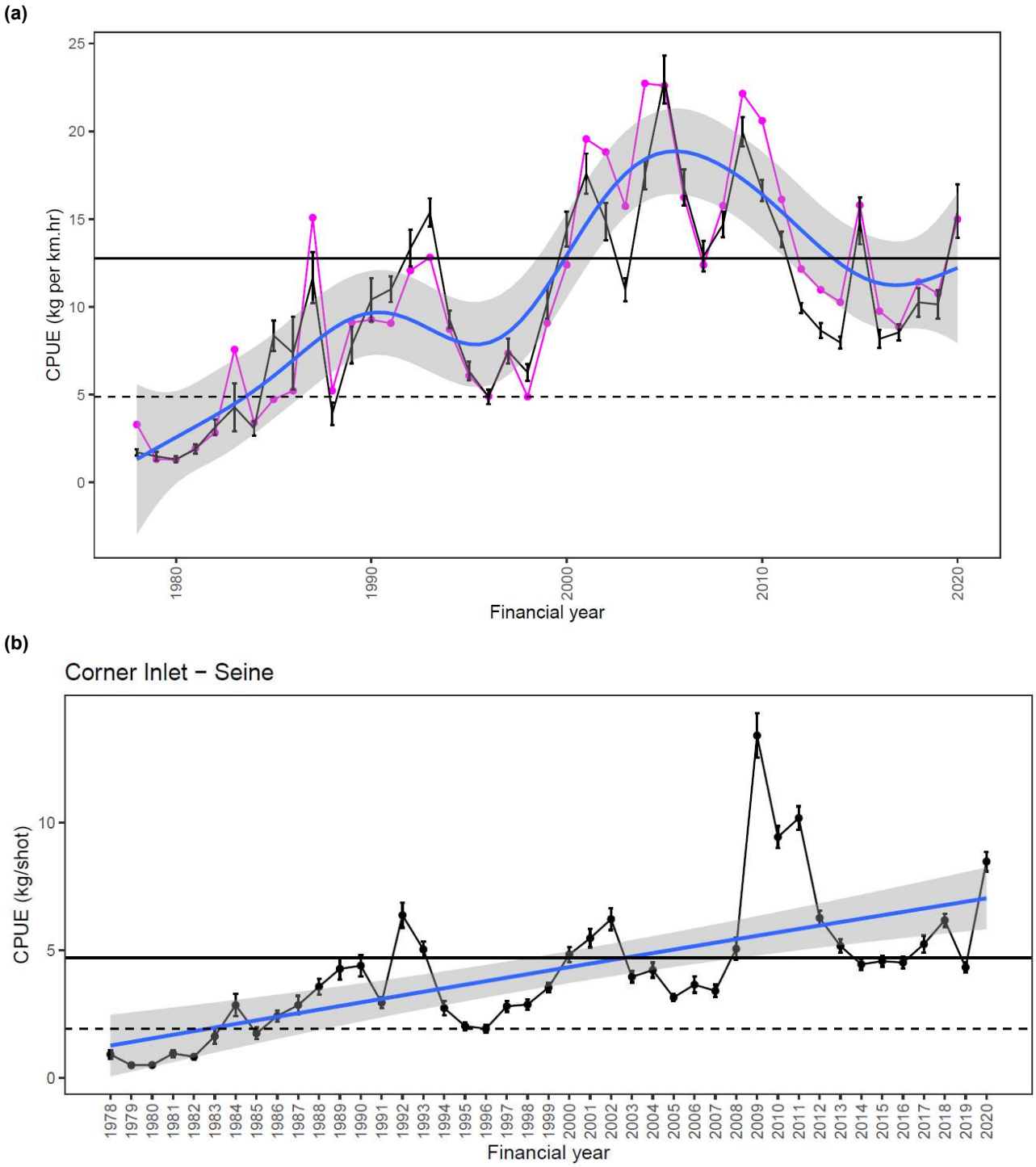


Figure 39 Catch-per-unit-effort (CPUE) of rock flathead by (a) commercial mesh net, and (b) seine net in the Corner Inlet during 1978–2018 financial years. Black line is nominal CPUE (±SE), magenta line is standardised CPUE, blue line is a generalised additive model (GAM) of the standardised CPUE trend with the shaded grey area representing the 95% confidence interval of the GAM. Horizontal black line is the mean standardised CPUE during the reference period (1986–2015) and the dashed black line is the minimum standardised CPUE within the reference period.

Southern Calamari (*Sepioteuthis australis*): State-wide

Stock Structure and Biology

Southern calamari are genetically similar in Victorian waters and thus considered a single stock with phenotypic variation. Southern calamari live for less than 1 year and grow to 55 cm mantle length (ML). Maturity (50 percent) is reached at 3 to 6 months at 15-20 cm ML (LML = 27cm TL). Calamari grow quickly and are moderately fecund. The main spawning period is spring/summer in inshore coastal regions with eggs laid in seagrass and reef algal habitats.

Management/Assessment Unit

The Victorian southern calamari population supports commercial fisheries in Corner Inlet and Port Phillip Bay, though landings from the latter have declined in recent years due to commercial fishing buyouts. There are also recreational fisheries in Port Phillip Bay, Corner Inlet, Western Port and coastal waters. This report considers the Victorian population calamari a state-wide stock.

Summary of the Assessment

Corner Inlet

For this assessment, the status of the Corner Inlet southern calamari population was evaluated using:

- Nominal CPUE for commercial fishery haul seine in Corner Inlet. Catch rates from Port Phillip Bay in recent years are potentially biased due to discarding of calamari in favour of more valuable species due to a combined TAC and are therefore no longer assessed. The performance of the haul seine CPUE biomass proxy was assessed in relation the specified reference level and limit point using the reference period 1979–2015 for the haul seine fishery.
- Nominal CPUE for recreational fishers targeting calamari in Port Phillip Bay. The performance of the recreational CPUE biomass proxies was assessed in relation to the average and minimum values of standardised CPUE during reference period.
- Commercial catch, and effort data.
- Calamari size composition from surveyed samples of recreational fishery catches.

This assessment found:

- *Fishing pressure* – Commercial catches of calamari are almost entirely taken by seine net. Prior to the 1990s squid jig was also used, but effort with this gear has virtually ceased in all bays and Bass Strait (see Appendix 2). There has been a decline in seine effort in all bays and inlets with Corner Inlet-Nooramunga the only fishery continuing to use this gear for much of the fishing effort, and now accounting for most of the commercial catch (Figure 40). State-wide the commercial catches have declined by over 60% from a peak period during the early 2000s, largely as a result of the decline in seine netting in Port Phillip Bay.
- *Biomass* – CPUE of commercial seines has remained above the reference period average for the last 8 years in both Corner Inlet-Nooramunga, being the highest, or close to on record, for the last five years (Figure 41). Recreational CPUE from creel surveys has generally been between the reference period average and minimum since 2006, though has fallen below the reference period average during the last two years (Figure 42).

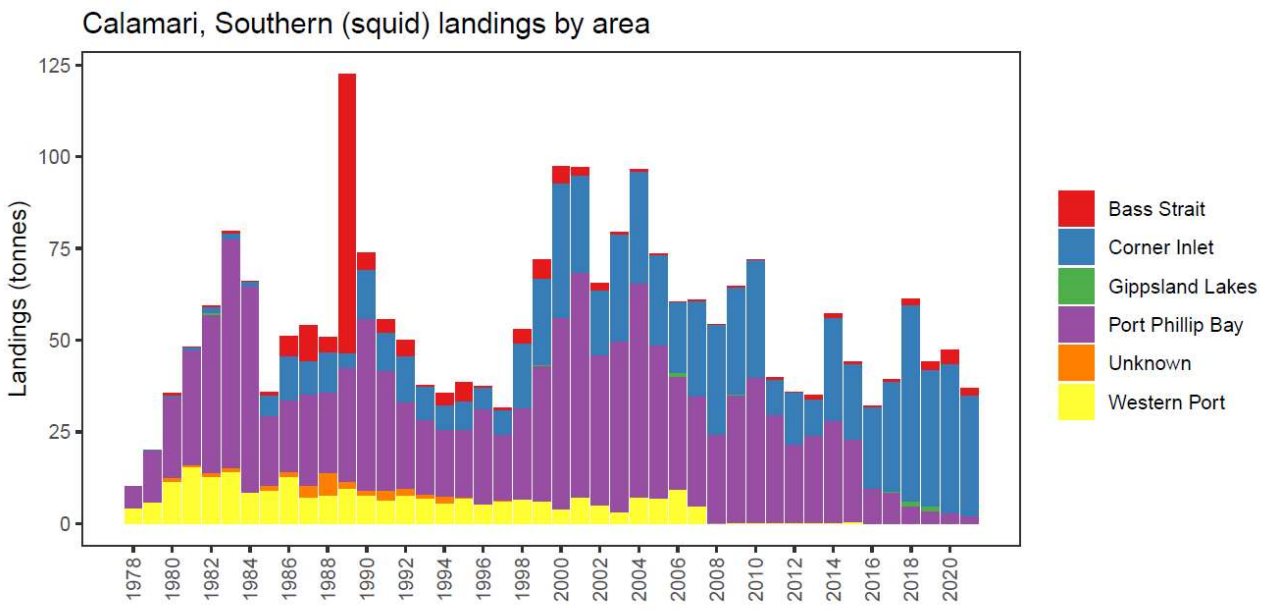


Figure 40 Total commercial catches of southern calamari by area in Victorian waters, 1978–2021/22 financial years.

Stock status summary: There has been decreasing commercial seine effort in most fisheries, which is associated with buy outs in Port Phillip Bay and Western Port and a transfer of effort in Corner Inlet from seining to mesh netting (see Appendix 2). This decreasing seine effort is not associated with declining southern calamari catch rates. Given southern calamari only live for a maximum of one year, the available stock within any given year is largely reflective of annual spawning success and interannual changes in catch rate likely reflect this aspect of their population biology. There is no evidence to suggest recruitment impairment and in the context of their biology, and the relatively low level of fishing pressure, the stock is expected to remain sustainable into the future.

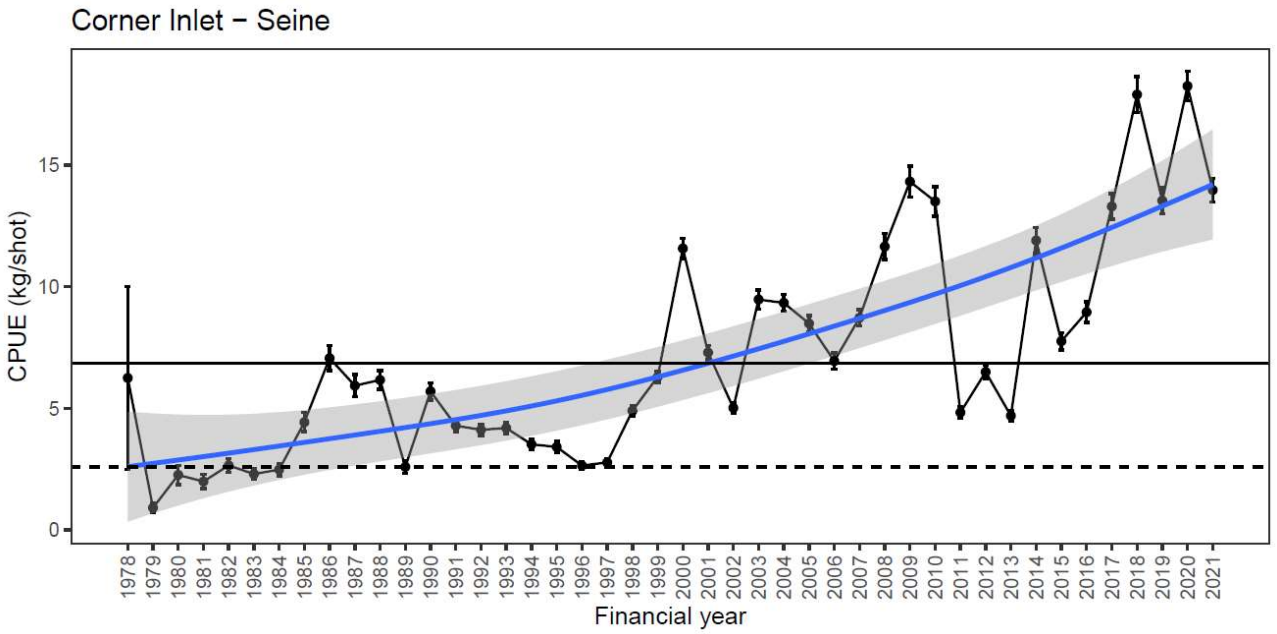


Figure 41 Southern calamari nominal catch-per-unit-effort (CPUE) (±SE) for (a) Port Phillip Bay haul seine, and (b) Corner Inlet haul seine (1978–2021 financial years). Horizontal black line is the mean CPUE during the reference period (1985–2015) and the dashed black line is the minimum CPUE within the reference period. Blue line is a generalised additive model (GAM) of the nominal CPUE trend with the shaded grey area representing the 95% confidence interval of the GAM.

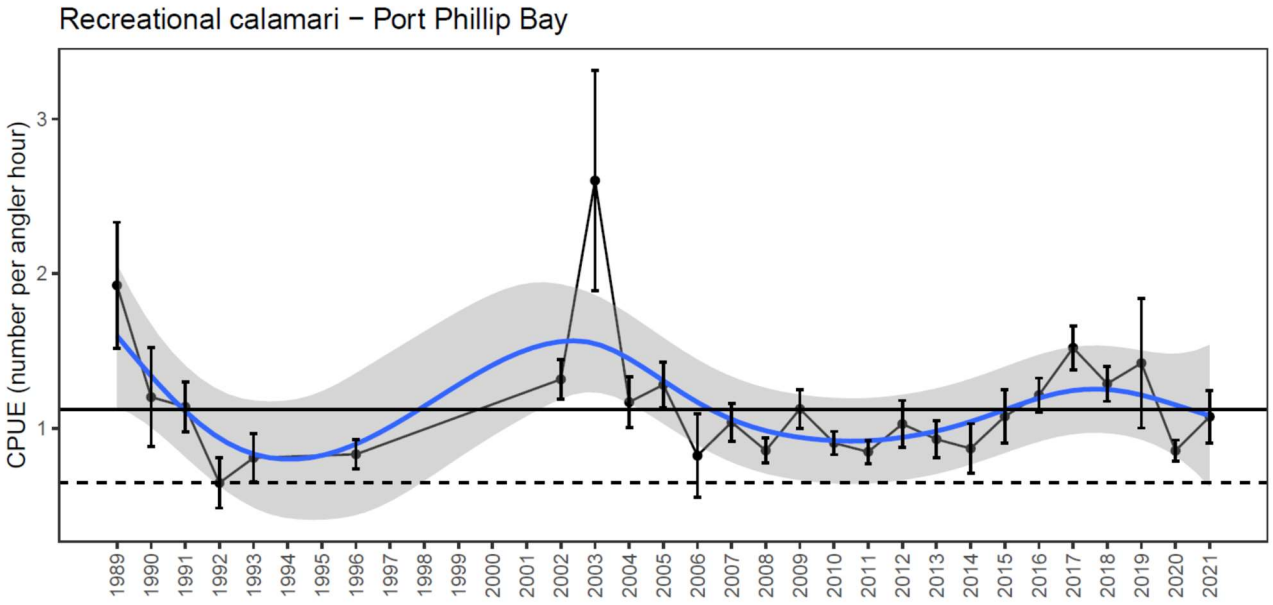


Figure 42 Southern calamari nominal catch-per-unit-effort (CPUE) (±SE) for the Port Phillip Bay recreational fishery from boat ramp creel surveys (financial years 2004–2016). Horizontal black line is the mean CPUE during the reference period (1989–2021) and the dashed black line is the minimum CPUE within the reference period. Blue line is a generalised additive model (GAM) of the nominal CPUE trend with the shaded grey area representing the 95% confidence interval of the GAM.

Gummy Shark (*Mustelus antarcticus*): State-wide

Stock Structure and Biology

Gummy shark populations in Victorian waters are a component of a single biological stock for south-eastern Australia. Gummy shark can live to 16 years and grow to over 180 cm total length (TL) (25 kg total body mass). Maturity (50 percent) for females is at 110–125 cm TL and for males is at 95–115 cm TL. Gummy shark have low fecundity (an average of 14 pups per two year breeding cycle) and an 11 to 12 month gestation period. The growth rate of male gummy shark is higher than for females. The peak parturition period is November to December with shallow coastal waters, including sheltered bays, the preferred pupping habitat.

Management/Assessment Unit

The gummy shark populations in Victorian waters support commercial gillnet and hook fisheries as well as recreational fisheries in Port Phillip Bay, Western Port, Corner Inlet and other inshore coastal waters. The Commonwealth Southern and Eastern Scalefish and Shark Fishery harvests by far the largest component of the gummy shark catch and is managed by the Commonwealth of Australia using a harvest strategy that includes age structured population dynamic model to inform quota setting decisions. This report considers the Victorian gummy shark population in Victorian waters as a state-wide stock.

Assessment Summary

For this assessment, the status of the state-wide Gummy Shark population was evaluated using:

- Total commercial gummy shark catch and modelled gummy shark catch output for the Southern and Eastern Scalefish and Shark Fishery,
- Nominal CPUE trends for the Victorian commercial Gummy Shark fishery from Corner Inlet-Nooramunga using mesh nets (reference period 1985–2015) and Port Phillip Bay using longline (reference period 1985–2015),
- Nominal recreational CPUE from creel survey in the Western Port recreational fishery (reference period 1998–2015).
- Time series of commercial catch and recreational fishery size composition data.

This assessment found:

- *Fishing pressure* – Gummy shark landings were high (700–800 t) in Victoria from 1978–1997, after which trip limits were introduced for most state fisheries and the Commonwealth formally created the Southern Shark Fishery (now a component of the South East Scalefish and Shark Fishery; SESSF) (Figure 43). This is reflected by the large decline in Bass Strait mesh net effort post-1998 (see Appendix 2). In recent years, fishing effort using the gears that capture the majority of gummy shark in Victorian state fisheries have both increased (Corner Inlet) and decreased (Port Phillip Bay), with the latter a result of license buy-outs. After this, gummy shark CPUE increased in Victoria's bays and inlets (Figure 44 and Figure 45) potentially because targeted fishing occurred following the closure of offshore gummy shark Victorian fisheries.

- *Biomass* – Gummy shark long line CPUE in Port Phillip Bay has been among historic highs in recent years in Port Phillip Bay and is well above the reference period average, potentially as a result of targeting this species due to the decreasing abundance of snapper (see snapper section). Conversely, CPUE has been declining in Corner Inlet since about 2006, dropping below the reference period average in 2018/19 where it has remained, but has not fallen below the reference period minimum (Figure 45). Recreational catch rates in Western Port have been variable, showing no long term trend, throughout the time period analysed (Figure 46) and there has been a relatively consistent size composition of the catch (Figure 47) indicating that recruitment has been ongoing and fishing mortality is not high enough to decrease the proportion of larger fish in the population.

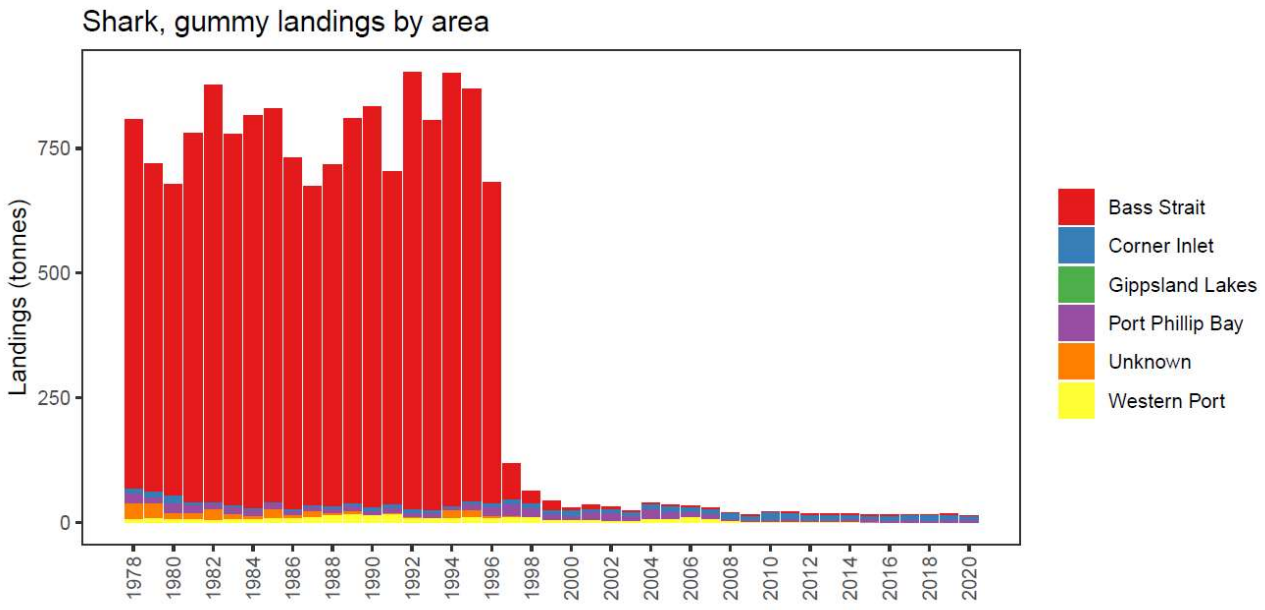


Figure 43 Total catch from the Victorian commercial Gummy Shark fishery by area by fiscal year during 1978–2020. Note from 1997 gummy shark in coastal waters transferred to Commonwealth management. Since 1997 most Gummy Shark harvested adjacent to Victoria were taken under Commonwealth issued licences and are not represented in this figure.

Stock status summary: The Gummy Shark fishery component of the SESSF comprises multiple populations with varying reproductive characteristics (Walker, 2007), however, the Victorian fishery comprises of catches from a single biological stock (i.e. Bass Strait), and this stock is modelled independently in formal quantitative stock assessments (Tuck, 2018). Tuck (2018) found that the Bass Strait stock was above the 48% of unfished pup production limit and therefore sustainable at current catches. This study also projected future sustainable catches and the landings from the Commonwealth and state fisheries have remained below these projections. The information available in this current assessment reinforces that the gummy shark population is performing adequately with recreational CPUE in Western Port and commercial longline CPUE in Port Phillip Bay increasing through time in line with the Commonwealth stock assessment. Although trends in commercial mesh net CPUE in Corner Inlet were contrary to the positive trends elsewhere, gummy shark represent a relatively minor component of this fishery, and the landings are minimal within the context of the stock wide landings, and although it could represent localised depletion, it is not considered likely to represent the abundance of the broader stock. Based on the multiple lines of evidence available it can be concluded that the Victorian gummy shark population is sustainable.

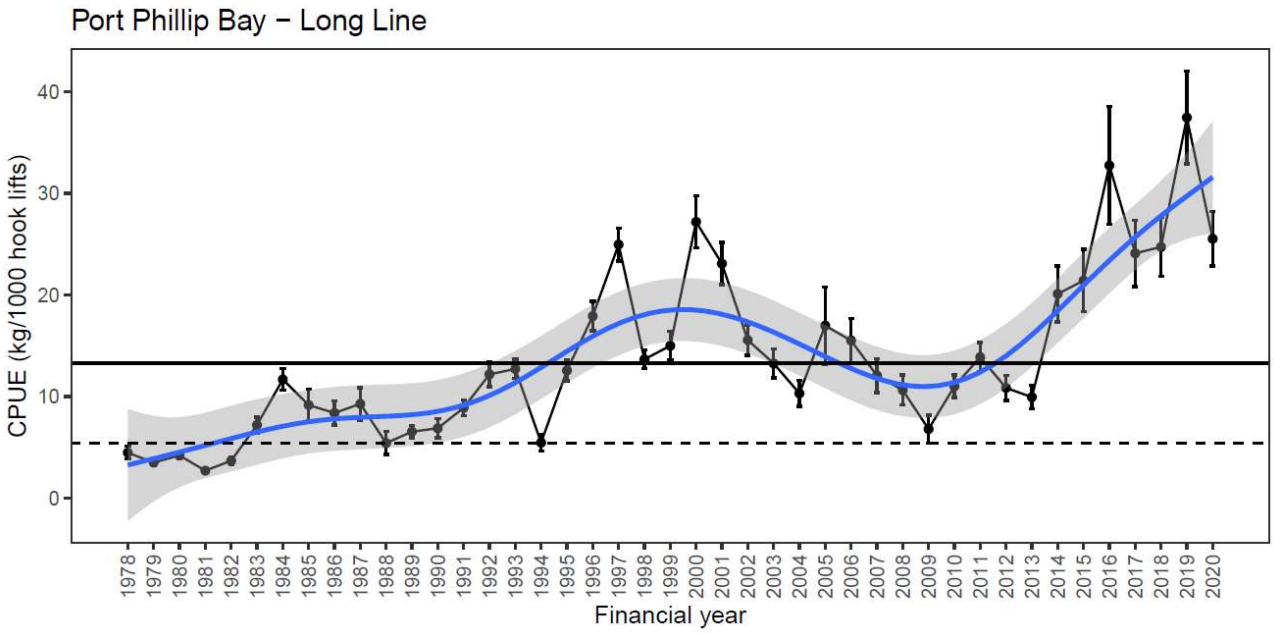


Figure 44 Nominal catch-per-unit-effort (CPUE) (±SE) of gummy shark by commercial longline fishers in Port Phillip Bay (1998–2020). Horizontal black line is the mean nominal CPUE during the reference period (1985–2015) and the dashed black line is the minimum standardised CPUE within the reference period. Blue line is a generalised additive model (GAM) of the CPUE trend with the shaded grey area representing the 95% confidence interval of the GAM.

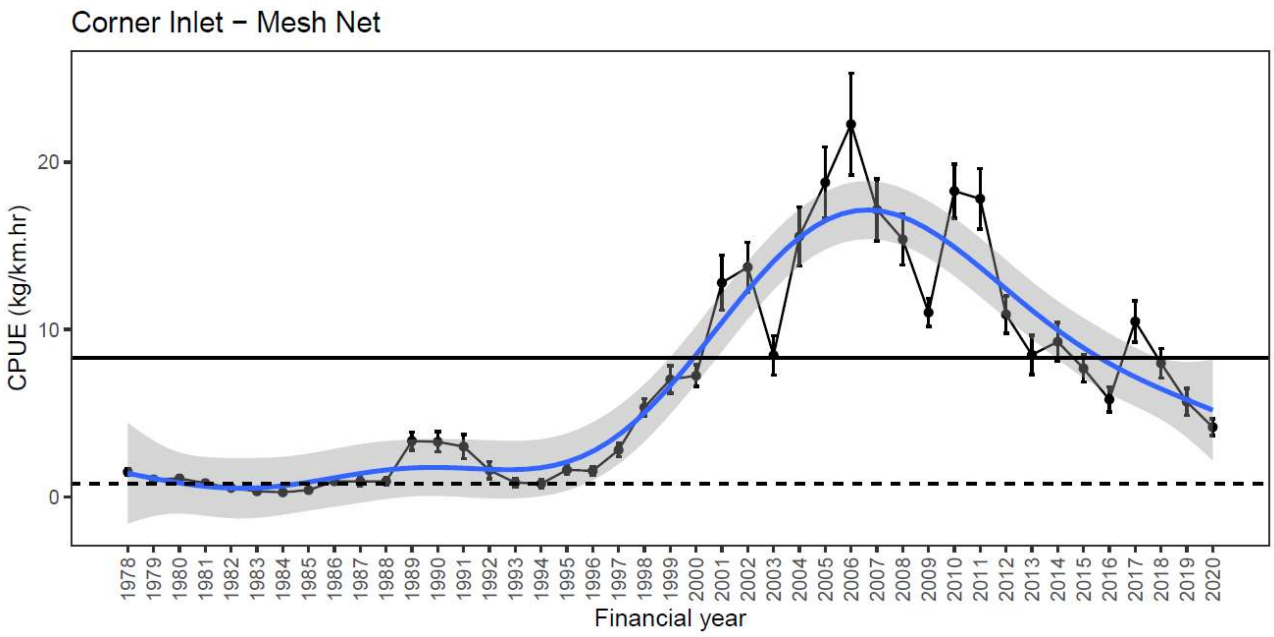


Figure 45 Nominal catch-per-unit-effort (CPUE) (±SE) of gummy shark by commercial mesh net for Corner Inlet (1998–2020). Horizontal black line is the mean nominal CPUE during the reference period (1985–2015) and the dashed black line is the minimum standardised CPUE within the reference period. Blue line is a generalised additive model (GAM) of the CPUE trend with the shaded grey area representing the 95% confidence interval of the GAM. Note: data prior to 1998 are not presented as catch rates were extremely low suggesting a lack of targeting gummy shark in this region of the fishery.

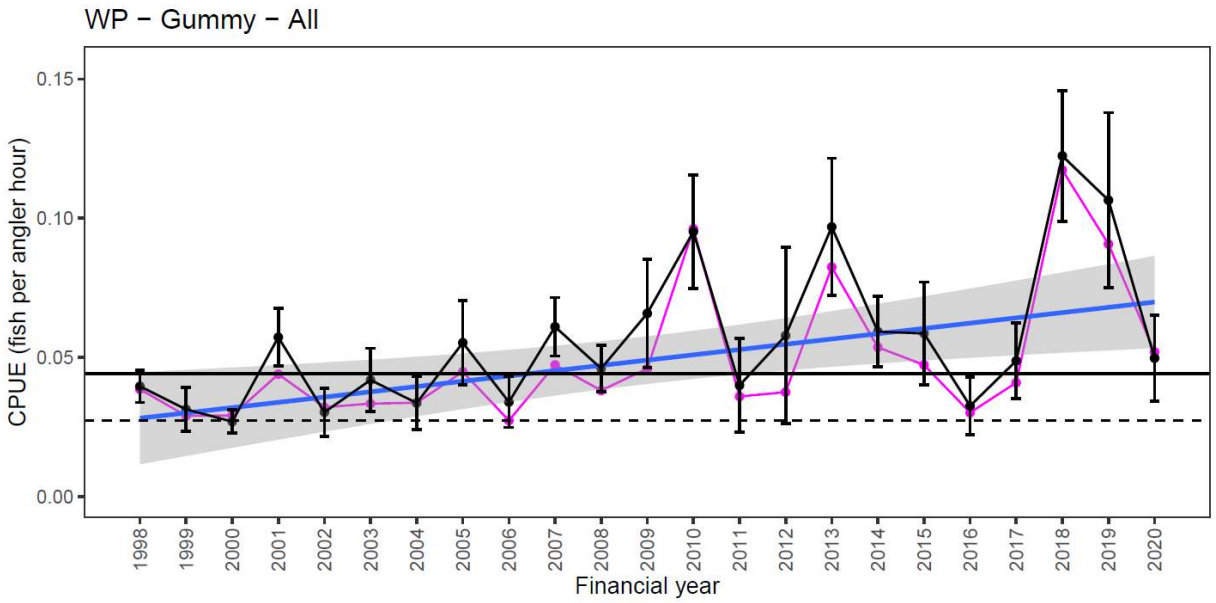


Figure 46 Catch-per-unit-effort (CPUE) of gummy shark by recreational anglers interviewed in creel surveys undertaken in Western Port (WP) from 1998–2020 financial years. Black line is nominal CPUE (±SE), magenta line is standardised CPUE, blue line is a generalised additive model (GAM) of the standardised CPUE trend with the shaded grey area representing the 95% confidence interval of the GAM. Horizontal black line is the mean standardised CPUE during the reference period and the dashed black line is the minimum standardised CPUE within the reference period.

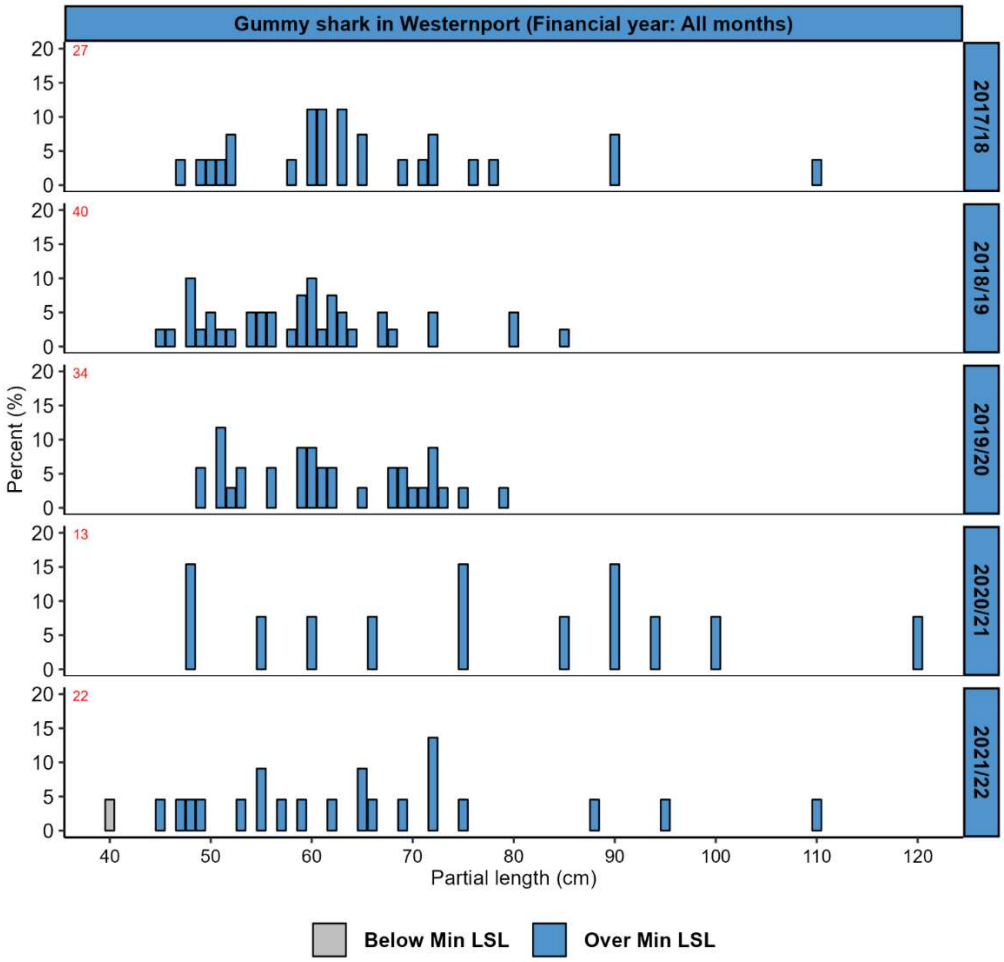


Figure 47 Frequency histograms of Corner Inlet length composition of gummy shark by fiscal years 2017/18 to 2021/22.

Southern Bluespotted Flathead (*Platycephalus speculator*): Corner Inlet-Nooramunga

Stock Structure and Biology

The stock structure of southern bluespotted flathead in Victorian waters is unknown. In Western Australian waters this species can live to at least 12 years and grow to 90 cm TL. Southern bluespotted flathead mature (50 percent) at 1–2 years (males 25 cm, females 32 cm), are highly fecund and have a moderate growth rate. Their main spawning period is spring/summer in marine bays and coastal waters. There is another closely related species, also named blue spotted flathead (*Platycephalus cearuleopunctatus*) reported to occur from southern Queensland to eastern Victoria. This species is not thought to contribute to the fishery in Corner Inlet-Nooramunga, however, there has been no recent assessment of the species composition of catches to confirm this perception.

Management/Assessment Unit

The Victorian component of the southern bluespotted flathead population supports a commercial fishery in Corner Inlet-Nooramunga. Commercial harvests from Port Phillip Bay have been negligible since 2016, when the removal of netting was instigated. Since 2017/18 the commercial harvest of southern bluespotted flathead was virtually all taken from Corner Inlet-Nooramunga (Figure 48). There are also recreational fisheries for this species in Port Phillip Bay, Western Port and Corner Inlet but there is no information of recent landings.

Assessment Summary

For this assessment, the status of the southern bluespotted flathead population was evaluated using:

- Nominal CPUE trends for mesh net and seine net methods in the Corner Inlet-Nooramunga, noting that prior to 2020 there appears to have been poor identification of this species as few were reported from Corner Inlet-Nooramunga.
- Commercial catch and effort.
- Standardised recreational CPUE from creel survey in the Port Phillip Bay recreational fishery (reference period 1998–2015).

This assessment found:

- *Fishing pressure* – Commercial harvests of southern bluespotted flathead have been almost entirely taken from Corner Inlet-Nooramunga since 2015/16 and have increased by approximately 10 tonnes from 2016/17 to 2020/21 (Figure 48) in response to increases in CPUE and greater mesh net effort (Appendix 2). The reported catches of southern bluespotted flathead from Corner Inlet-Nooramunga during the last five years are the highest reported since 1978, noting that the very low harvest earlier in the time series is due to poor species-specific reporting. Prior to 2015/16 at least half of the reported annual state-wide commercial harvest of blue spotted flathead came from Port Phillip Bay (Figure 48). The recent increase in harvest from Corner Inlet-Nooramunga represents a notable increase in fishing pressure.

- *Biomass* – CPUE for mesh net and seine net in Corner Inlet-Nooramunga have displayed similar patterns of variation since 2000, and both, while variable, have generally increased through time (Figure 50a, b), though mesh net CPUE has roughly halved since historic highs in 2008/09 and 2009/10. However, it must be noted that poor species level reporting may influence CPUE early in the time period. Recreational CPUE from Port Phillip Bay has been variable with the GAM suggesting that overall there has been a decline through time with the most recent year being below the reference period average.

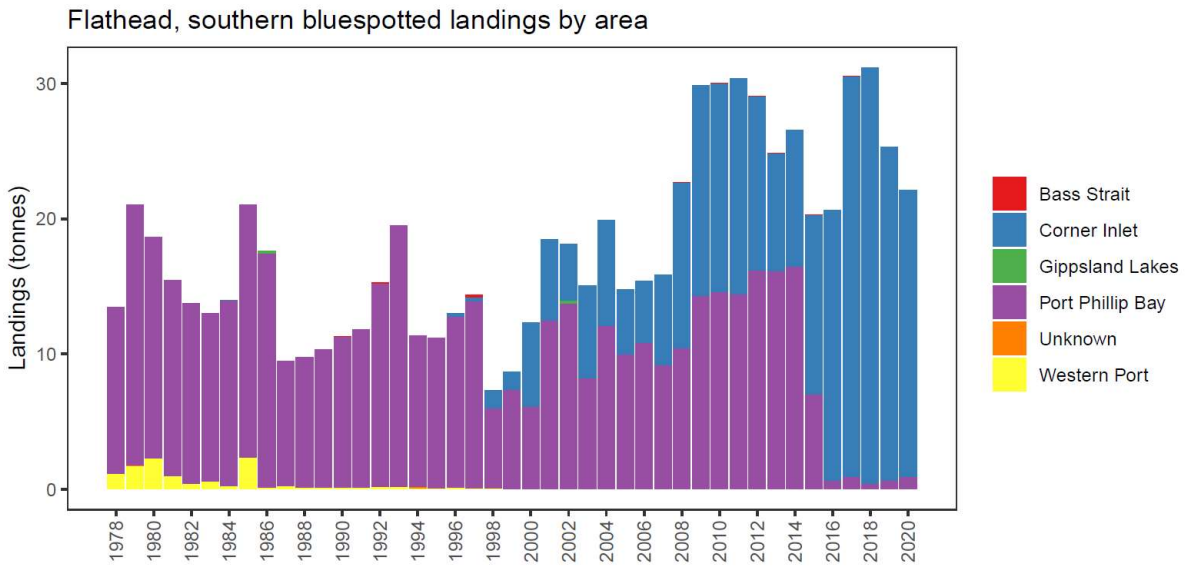


Figure 48 Total commercial catches of southern bluespotted flathead by area in Victorian waters, financial years 1978–2020.

Stock status summary: The recent increases in CPUE for both mesh and seine nets might be reflecting an increase in biomass in Corner Inlet-Nooramunga. However, increased mesh net effort has likely been associated with increased targeting of flathead species and this may be influencing the upward trends in mesh net CPUE. Continued increases in mesh net effort and catch of southern bluespotted flathead would be expected to eventually precipitate a decline in CPUE, and this may be the reason for the recent three-year declining trend in mesh net CPUE. There are several uncertainties around the harvest and commercial CPUE time series among the different flathead species in Corner Inlet. In particular, the accuracy of species and effort reporting. Uncertainty in catch history for southern bluespotted flathead makes it difficult to assess the risk associated with the recent historically high harvests, and primarily for this reason, there is uncertainty about stock status of southern bluespotted flathead in Corner Inlet-Nooramunga.

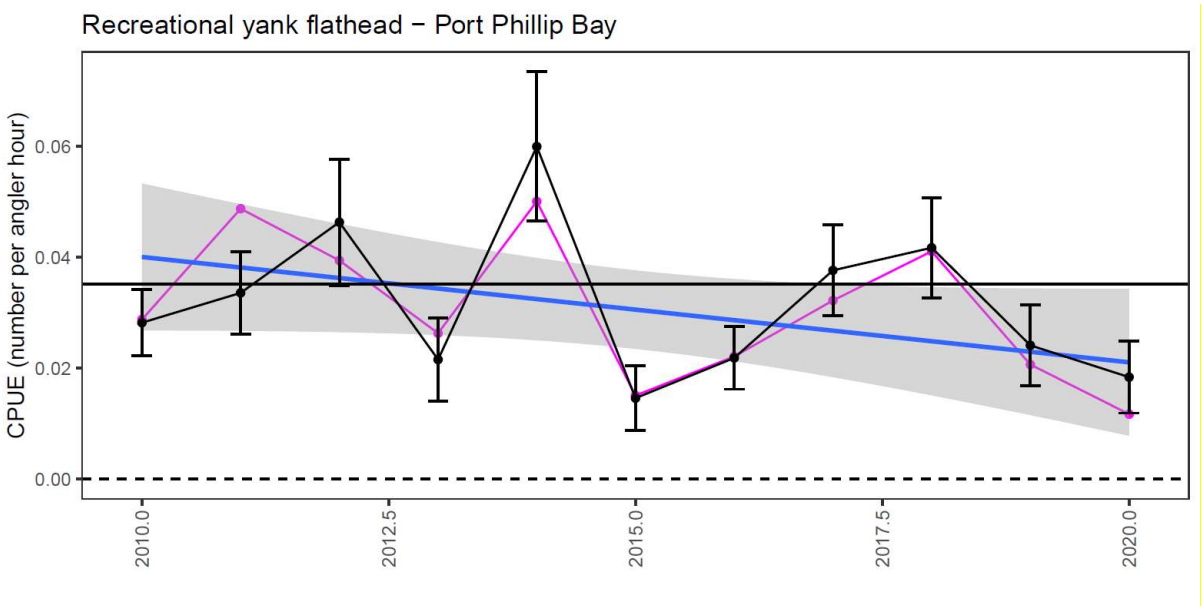


Figure 49 Creel southern bluespotted (yank) flathead CPUE during 2010–2020 standardised (GLMM) for geographic area, season and category of angler.

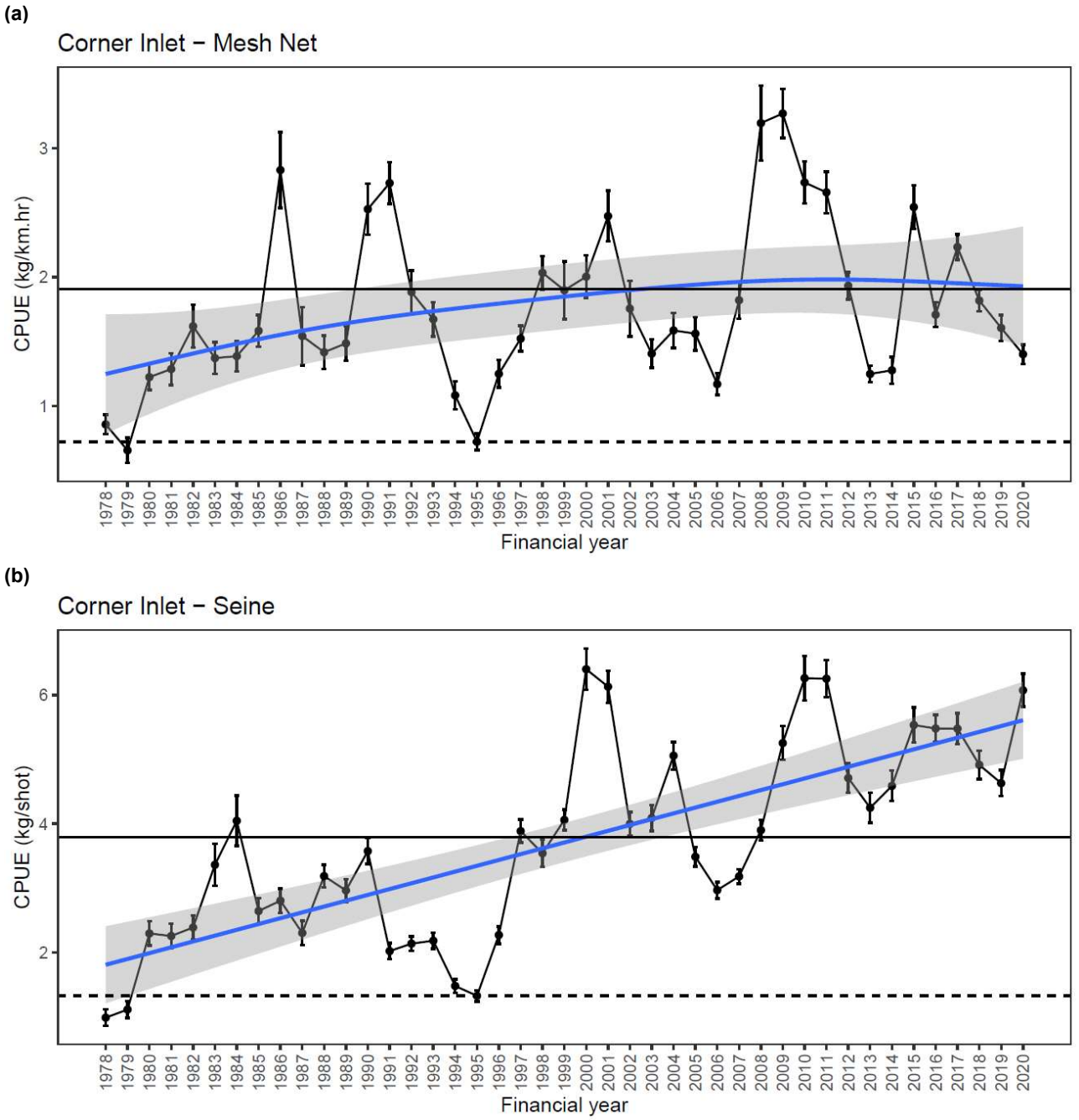


Figure 50 Catch-per-unit-effort (CPUE) (±SE) of southern blue spotted flathead (a) commercial mesh net and (b) commercial seine net Corner Inlet-Nooramunga (financial years 1978–2020). Blue line is a generalised additive model (GAM) of the standardised CPUE trend with the shaded grey area representing the 95% confidence interval of the GAM. Horizontal black line is the mean standardised CPUE during the reference period and the dashed black line is the minimum standardised CPUE within the reference period.

Australian Salmon (*Arripis trutta*, *A. truttaceus*): Eastern and Western Victorian Stocks

Stock Structure and Biology

In Victorian waters there are straddling stocks of eastern and western Australian salmon. Eastern and western Australian salmon can live to at least 12 years of age and reach 81 cm fork length (FL). Eastern Australian salmon mature (50 percent) at 2–4 years (30–40 cm FL). Western Australian salmon mature (50 percent) at 3–5 years (60–65 cm FL). The main spawning period for eastern Australian salmon occurs from November to February in near coastal waters along the east coast of Australia. Western Australian salmon migrate from Victoria back to Western Australia, where spawning occurs in near coastal waters during April–May.

Management/Assessment Unit

The Victorian component of the Australian salmon stocks supports the commercial purse seine ocean fishery, mostly off eastern Victoria, with small catches also taken from Corner Inlet. Recreational fisheries occur in Port Phillip Bay, Western Port, Corner Inlet, many estuaries and along coastal beaches. Although two separate stocks occur in Victorian waters, only the eastern stock is exploited (Corner Inlet and the ocean purse seine fishery) in sufficient quantities to warrant analysis. For this assessment, the status of the eastern Australia salmon stock was evaluated using nominal CPUE trends for the commercial purse seine ocean fishery off eastern Victoria. Australian salmon are frequently discarded by bay and inlet fishers which means that CPUE estimates generated by their catches are unlikely to provide a reliable proxy for stock biomass.

Assessment Summary

For this assessment, the status of the eastern Australian salmon stock was assessed using:

- Nominal trends in CPUE of the Bass Strait purse seine fishery that operates in eastern Victoria. These data were filtered to only include shots with >100 kg of Australian salmon to effectively exclude purse seine shots targeted at other small pelagic species. The performance of the CPUE biomass proxies was assessed in relation to the average and minimum CPUE during the reference period of 1986–2015.
- The impact of fishing pressure was assessed using time series of commercial catch and effort.

Insufficient data are available from Victorian commercial or recreational fisheries to assess the status of the western Australian salmon stock. However, anecdotal information exists from a variety of recreational fisheries (surf and estuarine). In addition, the western Australian salmon stock extends from Western Australia to Victoria and it is possible to draw inferences from South Australian and Western Australian monitoring to inform the status of the stock.

This assessment found:

Eastern Australian salmon

- *Fishing pressure* – Ocean purse seine fishing effort has remained relatively consistent since the development of the fishery in the mid-1990s (Appendix 2). Australian salmon landings from the eastern stock have been variable (Figure 51), and generally below average in recent years, with fluctuations likely driven by market

demand (i.e. for rock lobster bait) and purse seiners preferentially targeting a variety of other schooling pelagic species.

- *Biomass* – CPUE was high during the early years of this fishery before fishing ceased temporarily between 1988 to 1995. Upon recommencing, CPUE was lower than it was previously and remained consistently below the reference period average for around a decade. During the last decade CPUE has been above the average for the reference period (Figure 52). Reasons for the low CPUE period are likely to be related to the larger number of operators who may have been less efficient and were targeting species apart from salmon. In recent years gear efficiency and specific targeting are likely to have ensured that CPUE remained above the reference average. These changes in fishing behaviour make it somewhat problematic to interpret CPUE trends within the context of biomass, particularly because this species schools heavily and purse seine shots are only undertaken when a school is located. Nevertheless, the fact that such large quantities are being taken in each shot (10–20 t) means that the size of Australian salmon schools has not declined noticeably since the development of the fishery in the 1980s, implying that biomass is likely to still be relatively high. However, CPUE trends for schooling species, and purse seine fisheries in general, can be misleading so it is important to consider other information when assessing a species/fishery such as this.

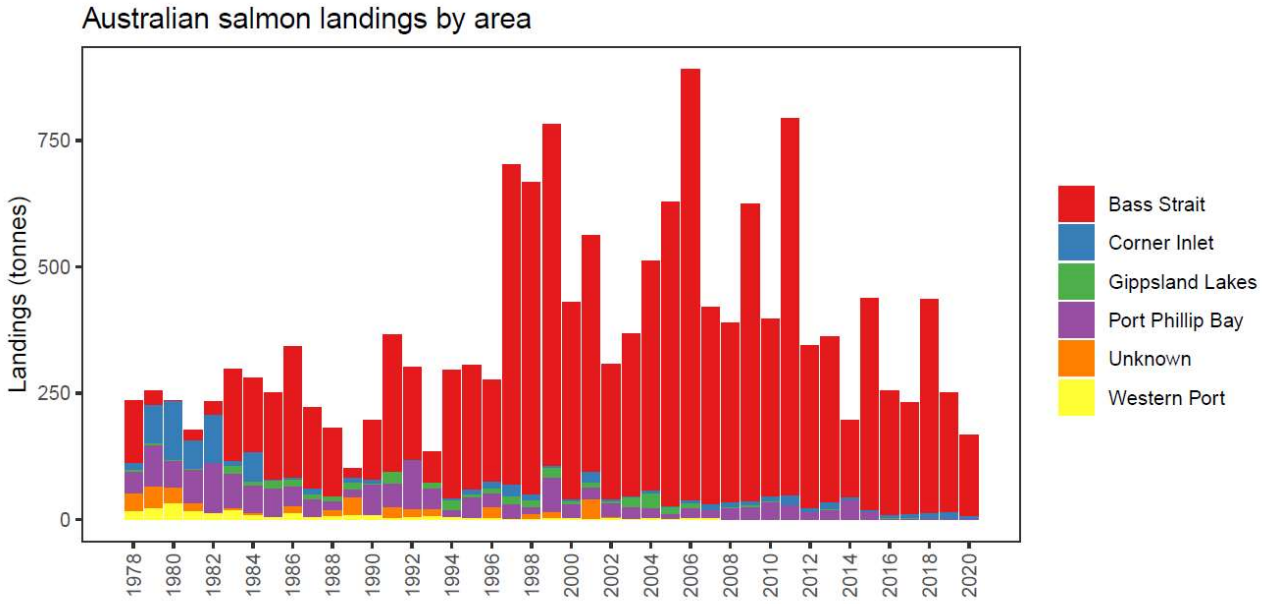


Figure 51 Total catch of Australian salmon in Victoria from the commercial fishery by area, financial years 1978–2020.

Stock status summary:

Eastern Australian salmon

The available evidence indicates that the eastern Australian salmon biomass has remained relatively stable since around 2005 and landings have been low to moderate during the last seven years, presumably due to low market demand for this species, which is predominantly used for rock lobster bait. Based on this evidence, the Eastern Victorian Australian salmon stock is considered to be sustainable.

Western Australian salmon

Insufficient data are available from Victorian commercial or recreational fisheries to assess the status of the western Australian salmon stock. The western Australian salmon stock is subject to very low exploitation by commercial fisheries in Victoria. The species is not a common target in the major Victrorian bay and inlet fisheries; for example, “Salmon” were listed as the primary target species in only 0.38% of recreational fishers interviewed in creel surveys in Port Phillip Bay. Western Australian salmon are targeted in small scale recreational fisheries elsewhere (e.g. in estuaries and along the coast), however these are small within the context of the species wide ranging behaviour and the diversity of habitats where they are found. The mature stock resides exclusively in Western Australia and a variety of modelling techniques indicate that the stock biomass is around target levels and unlikely to be recruitment impaired (Stewart *et al*., 2018). Based on the above, western Australian salmon in Victoria is considered to be sustainable.

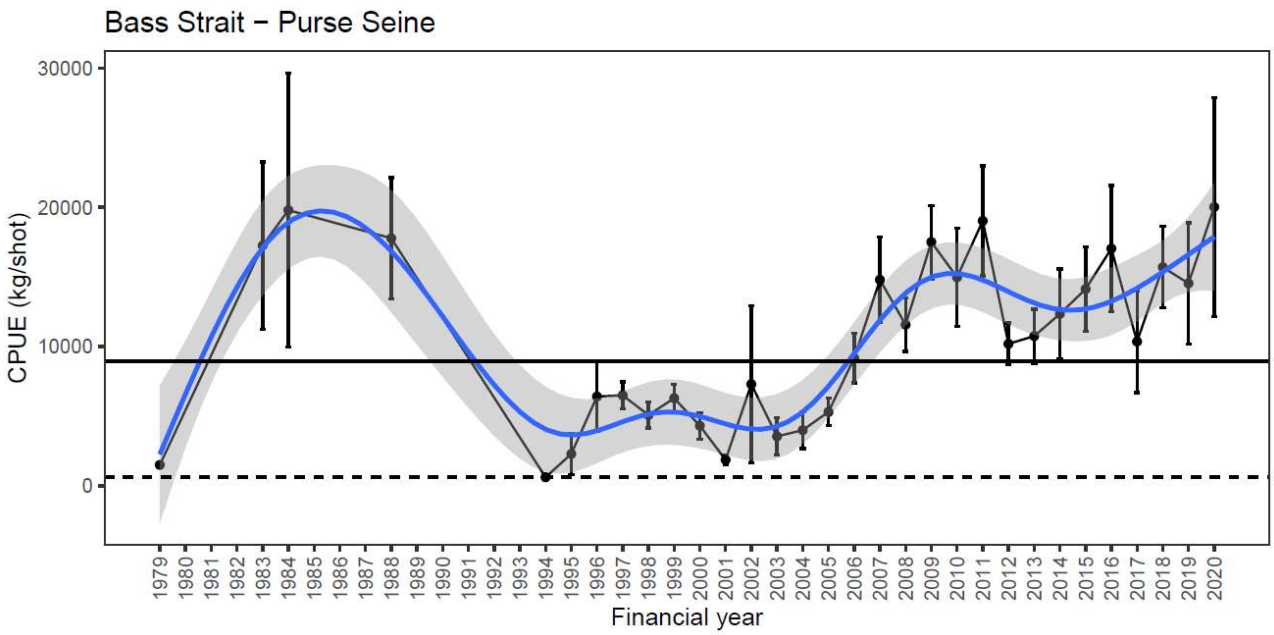


Figure 52 Nominal Catch-per-unit-effort (CPUE) (±95% CL) of catches of eastern Australian salmon for the commercial purse seine ocean fishery (1997–2020 financial years). The blue line is a generalised additive model (GAM) of the CPUE trend with the shaded area representing 95% confidence intervals of the model. The black horizontal line is the average of the reference period (1986–2015) and the dashed line is the minimum observed value during the reference period.

Silver Trevally (*Pseudocaranx georgianus*): State-wide

Stock Structure and Biology

The Victorian silver trevally population is part of a broader south-eastern Australian stock. Silver trevally live to 25 years and grow to 60 cm TL. Silver trevally reach maturity (50 percent) at 25–30 cm TL, are highly fecund, and have a slow-moderate grow rate (K = 0.1–0.4). The main spawning period is spring-autumn in coastal waters.

Management/Assessment Unit

The Victorian component of the silver trevally stock supports recreational and commercial fisheries. Commercial fisheries occur mainly in Corner Inlet and historically in Port Phillip Bay and the Gippsland Lakes but recreational fisheries occur throughout the state's bays, inlets, estuaries and coastal waters. This report considers Victorian silver trevally as single state-wide management unit.

Assessment Summary

For this assessment, the status of the silver trevally population was evaluated using:

- Nominal CPUE trends for the Corner Inlet-Nooramunga haul seine fishery. The performance of the CPUE biomass proxies was assessed in relation to the average and minimum values of standardised CPUE during reference period 1998–2015.
- The impact of fishing pressure was assessed using time series of commercial catch and effort.

This assessment found:

- *Fishing pressure* – Very large quantities of silver trevally were landed in Bass Strait using mesh nets up until 1991 (Figure 53), however the offshore mesh net fishery is now managed by the Commonwealth and has largely ceased. Since then, landings have been predominantly from seine nets in Gippsland Lakes, Port Phillip Bay and Corner Inlet-Nooramunga with a declining trend through time as effort with this gear has ceased in the latter two fisheries (see Appendix 2). Landings in Corner Inlet-Nooramunga are close to historic lows despite seine fishing effort being around average and relatively consistent for more than a decade.
- *Biomass* – There has been high variability in silver trevally CPUE using seines in Corner Inlet-Nooramunga (Figure 54). This is likely to be a combination of varying abundance in inshore waters as this species also frequents waters offshore, and generally represents a by- product while targeting other species. Since 2010, CPUE in Corner Inlet-Nooramunga has mostly been below the reference period average, and in 2020/21 is approaching the reference period minima suggesting the stock may be depleting/depleted.

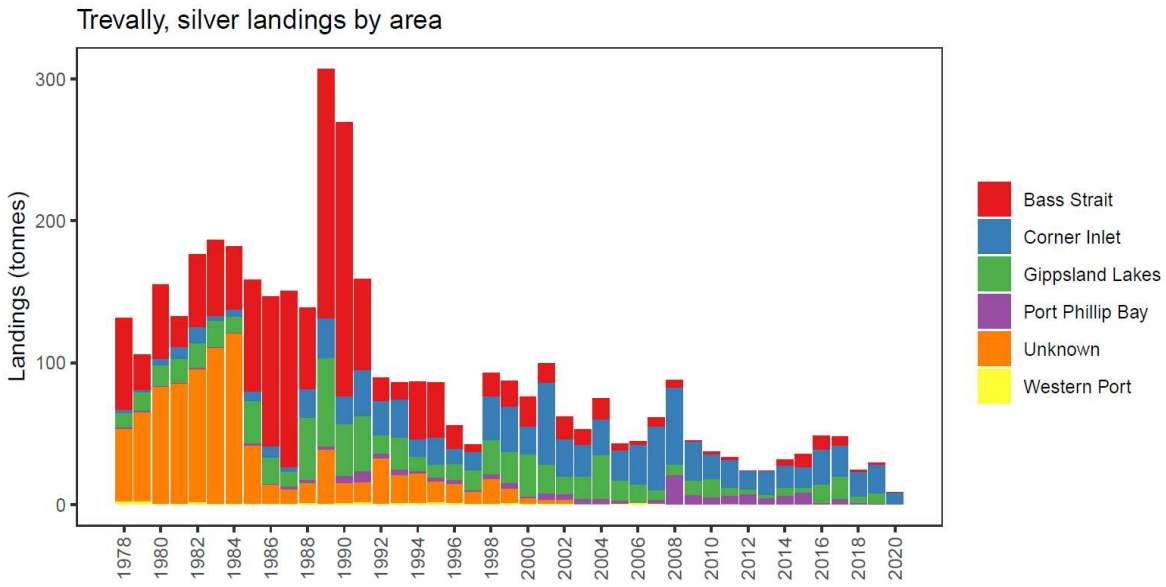


Figure 53 Total commercial catches of silver trevally by area in Victorian waters, 1978–2020 financial years.

Stock status summary: The low silver trevally catches in recent years, and low seine fishing effort, in Victorian fisheries means that fishing operations are unlikely to cause impaired recruitment under current practices. However, there is uncertainty surrounding the interconnectivity of silver trevally stocks and the most recent SAFS classification of silver trevally in New South Wales found that the species was depleting in their jurisdiction. The most recent Commonwealth stock assessment (Tuck, 2018), using data to 2013, showed that standardised CPUE had increased from low levels during the early 2000s, but was still below its long-term average. The available information from Victoria also suggests the stock could be depleting/depleted, though there is insufficient targeted fishing for the species to be certain so the status of the stock in Victoria is uncertain.

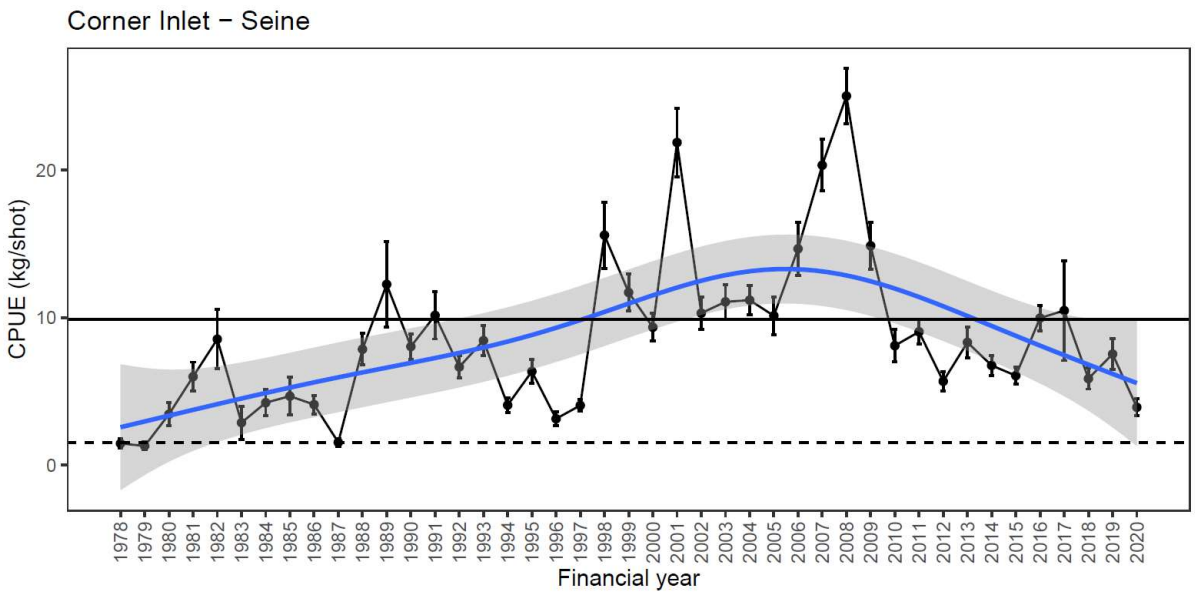
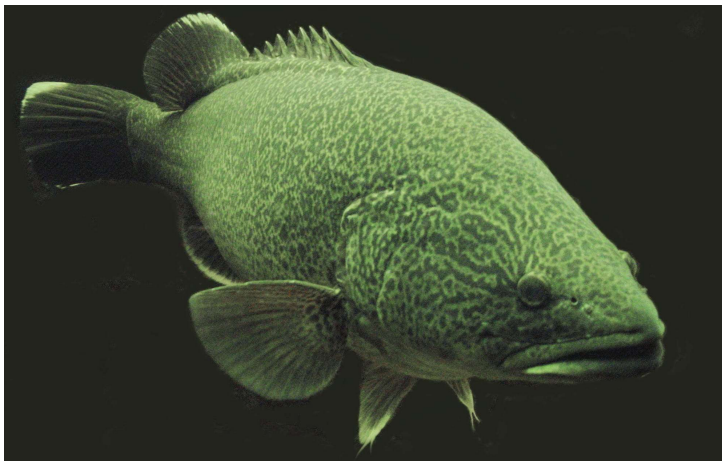


Figure 54 Nominal Catch-per-unit-effort (CPUE) (±95% CL) of catches of silver trevally taken by commercial seine from Corner Inlet (1978–2020 financial years). The blue line is a generalised additive model (GAM) of the CPUE trend with the shaded area representing 95% confidence intervals of the model. The black horizontal line is the average of the reference period (1986–2015) and the dashed line is the minimum observed value during the reference period.

Murray Cod (*Maccullochella peelii*): State-wide



Stock Structure and Biology

Murray Cod occurs throughout most of the Murray–Darling system of south-eastern Australia, with the exception of the upper reaches of some tributaries. In Victoria, the Murray cod population is considered to comprise a state-wide stock that occurs in the lower sections of river catchments north of the Great Dividing Range (Figure 55). These represent one genetically panmictic biological stock (Rourke *et al.* 2011). Murray cod have been translocated into waters outside their natural range and self-sustaining populations have established in some waters, including the Wimmera and Yarra rivers (Figure 55). Hatchery-bred juvenile Murray cod are also stocked into selected waters, mainly within its natural range and mainly within impoundments, to maintain and enhance the recreational fishery (Figure 55). Murray cod completes its lifecycle exclusively within freshwater. Spawning in Victoria occurs in response to rising temperature from late-September to mid-January. Populations in rivers are mostly self-replenishing, whereas populations in impoundments are sustained by stocking. Maturity occurs at about 4–6 years at a total length (TL) of 40 cm for males and 60 cm for females, although this varies across geographic regions. There is no commercial harvest of Murray Cod in the state, but the species is grown in aquaculture operations for human consumption and it supports a highly valued and popular recreational fishery. Recreational angling for Murray Cod is managed through strict recreational bag and slot size limits, restrictions on fishing methods such as set lines, and supplementation by stocking hatchery-bred fish.

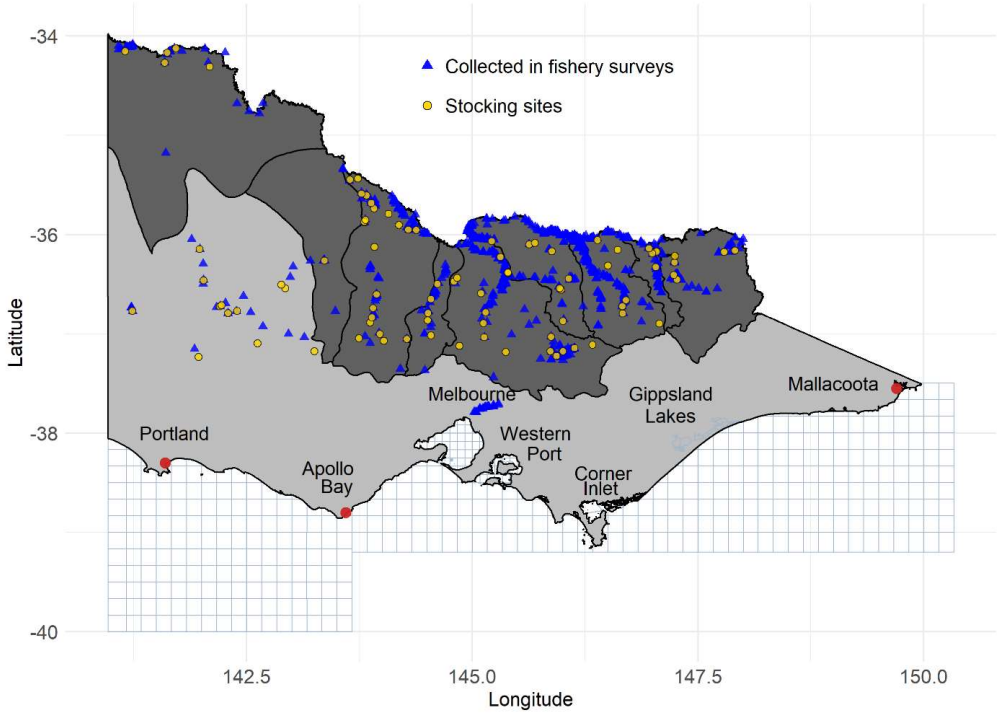


Figure 55 Victorian Murray Cod distribution and stocking sites.

Assessment Summary

In the absence of consistent, long-term estimates of population abundance and harvest by anglers, the status of Victoria's Murray Cod stock and its fisheries was evaluated using:

- Nominal CPUE estimates (fish per machine minute) and length composition (TL) from fishery-independent (electrofishing) surveys of four indictor riverine populations (Goulburn River, Gunbower Creek, Lindsay River/Mullaroo Creek and Ovens River) (Ingram et al. 2019). A reference period was selected from first record since 1990–2015 (Ingram et al 2019). Data were standardised to account for electrofishing selectivity among size classes.

This assessment found:

- *Fishing pressure* – commercial harvest of Murray cod in Victoria ceased in 2001. There is no recent information on recreational harvest or effort at state level.
- *Biomass* – Electro-fishing survey CPUE (as fish per machine minute) has generally increased in all indicator rivers and creeks (Figure 56). Since the early 2010s, nominal and standardised CPUE in the Goulburn River, Gunbower Creek and Ovens River are above the mean nominal CPUE for the reference period. In the Lindsay River/-Mullaroo Creek data quantity and variability prevented statistical model convergence, but the nominal point values for the past three years are comparable with recent values for Gunbower Creek.
  Although the Goulburn River is stocked annually with hatchery-bred juveniles, most of the Murray Cod sampled from these streams are naturally spawned (Tonkin *et al*. 2019), suggesting that changes in CPUE are due to natural recruitment rather than stocking. Similar proportions of stocked and naturally spawned Murray Cod have been sampled from the Gunbower Creek (Tonkin *et al*. 2019), indicating that both stocking and natural recruitment have contributed to changes in CPUE. In the Lindsay River/Mullaroo Creek system 77,000 Murray Cod were released during 2021, but as yet there is no information regarding population recruitment.
  The increase in the Ovens River CPUE is due solely to natural recruitment as no stocking occurs in this waterway. Note that the minimum CPUE for the reference period is zero for all three rivers due to the presence of zero catch in some years.
- *Length composition* – Long-term length composition data for electrofishing surveys is limited for much of the assessment (Figure 57). A wide range of fish size were observed in each waterway but in recent years most Murray Cod measured were below the minimum legal-size limit while Murray Cod over the maximum legal-size limit were uncommon but observed in all rivers, with slightly more evident in the Lindsay River/Mullaroo Creek than the other three streams (Figure 57). Small fish (recruits presumed to be less than one year old and <10 cm) were present in all waterways indicating either recent natural recruitment (Ovens River) or recent stockings of hatchery-bred fish to a lesser or greater extent along with natural recruitment (other rivers) (Figure 57). Mature fish (> 60 cm) were present but uncommon in all six rivers in recent years.

Stock status summary: As there is no consistent, long-term estimates of population abundances and recreational harvest for Murray Cod, state-wide stock status was based on assessment of six indicator riverine populations (Broken Creek and River, Campaspe River, Goulburn River, Gunbower Creek, Loddon River and Ovens River). Although information from these rivers is limited to infrequent and irregular annual electro-fishing surveys, CPUE appears to be either increasing or well above the reference line in all streams. There is no information on fishing pressure, biomass and size composition for Murray cod in impoundments but these populations are largely sustained by stocking hatchery-bred fish rather than natural recruitment. On the basis that CPUE appears to be increasing in all four indicator waterways the Murray Cod stock status has been assessed as **recovering**.

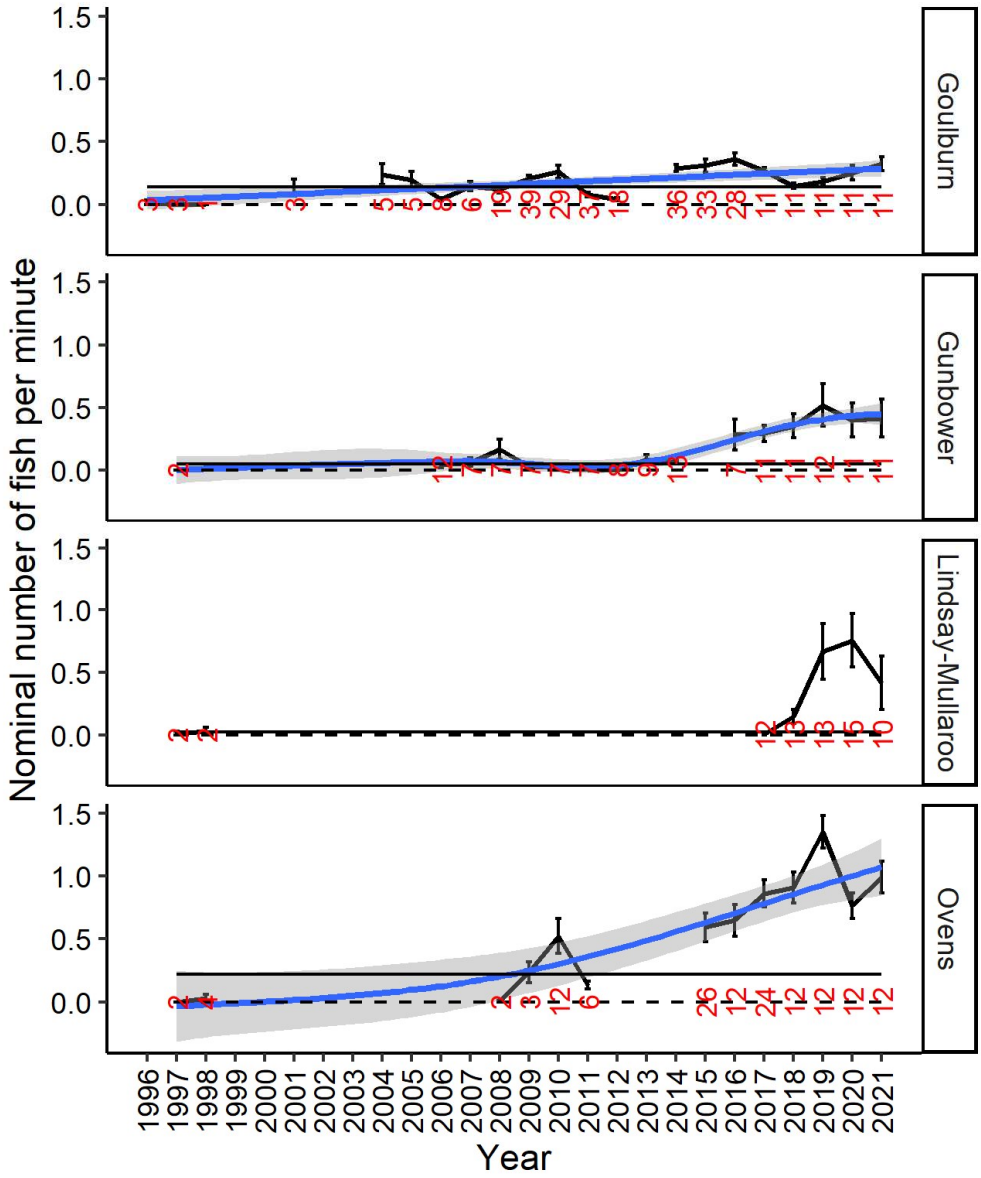


Figure 56 Electrofishing fishery survey catch-per-unit-effort (CPUE) (nominal) for Murray cod in four indicator rivers during 1997–2021. Horizontal black line is the mean nominal CPUE during the reference period (first record since 1990 to 2015) and the dashed black line is the minimum CPUE within the reference period. Blue line is a generalised additive model (GAM) of the nominal CPUE trend with the shaded grey area representing the 95% confidence interval of the GAM. Red numbers along x-axis are numbers of sites surveyed each year.

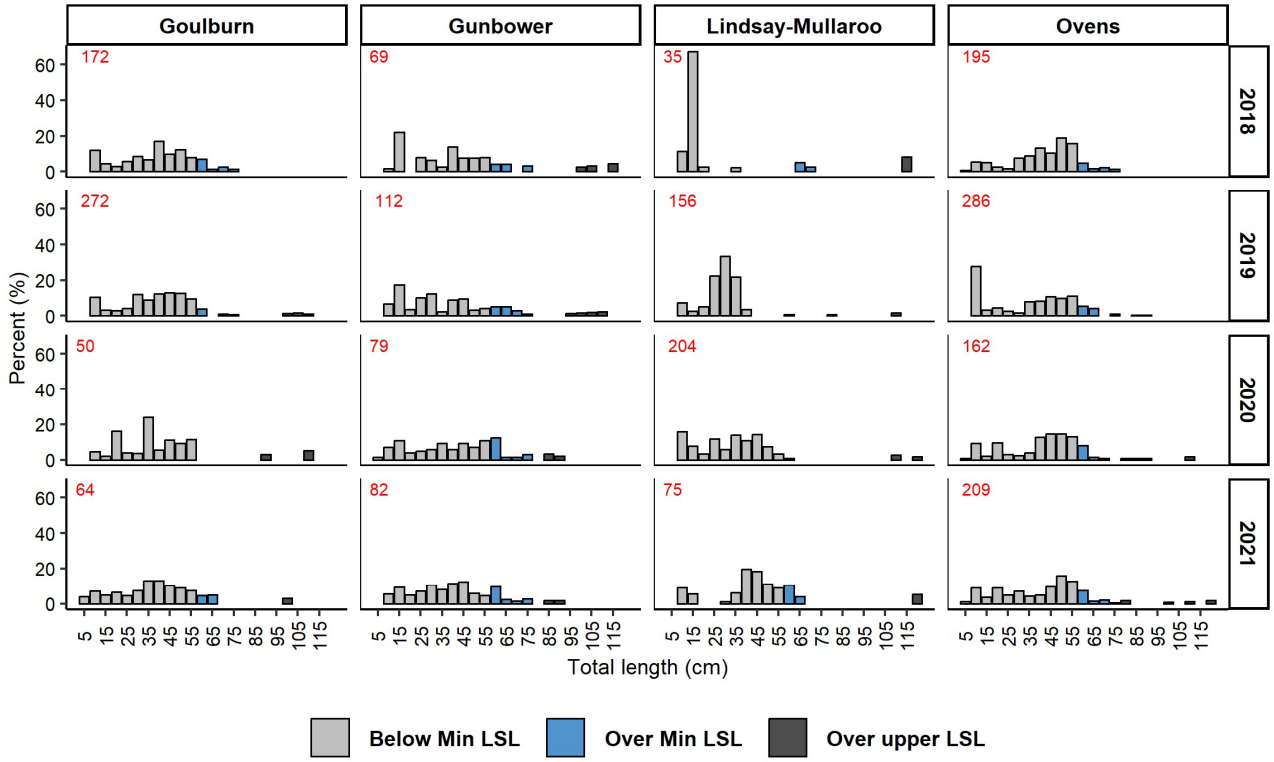


Figure 57 Length (TL) frequency histograms of Murray Cod electro-fishing survey catches from 2018–2021 for four indicator creeks and rivers. Red numbers indicate quantity of fish measured.

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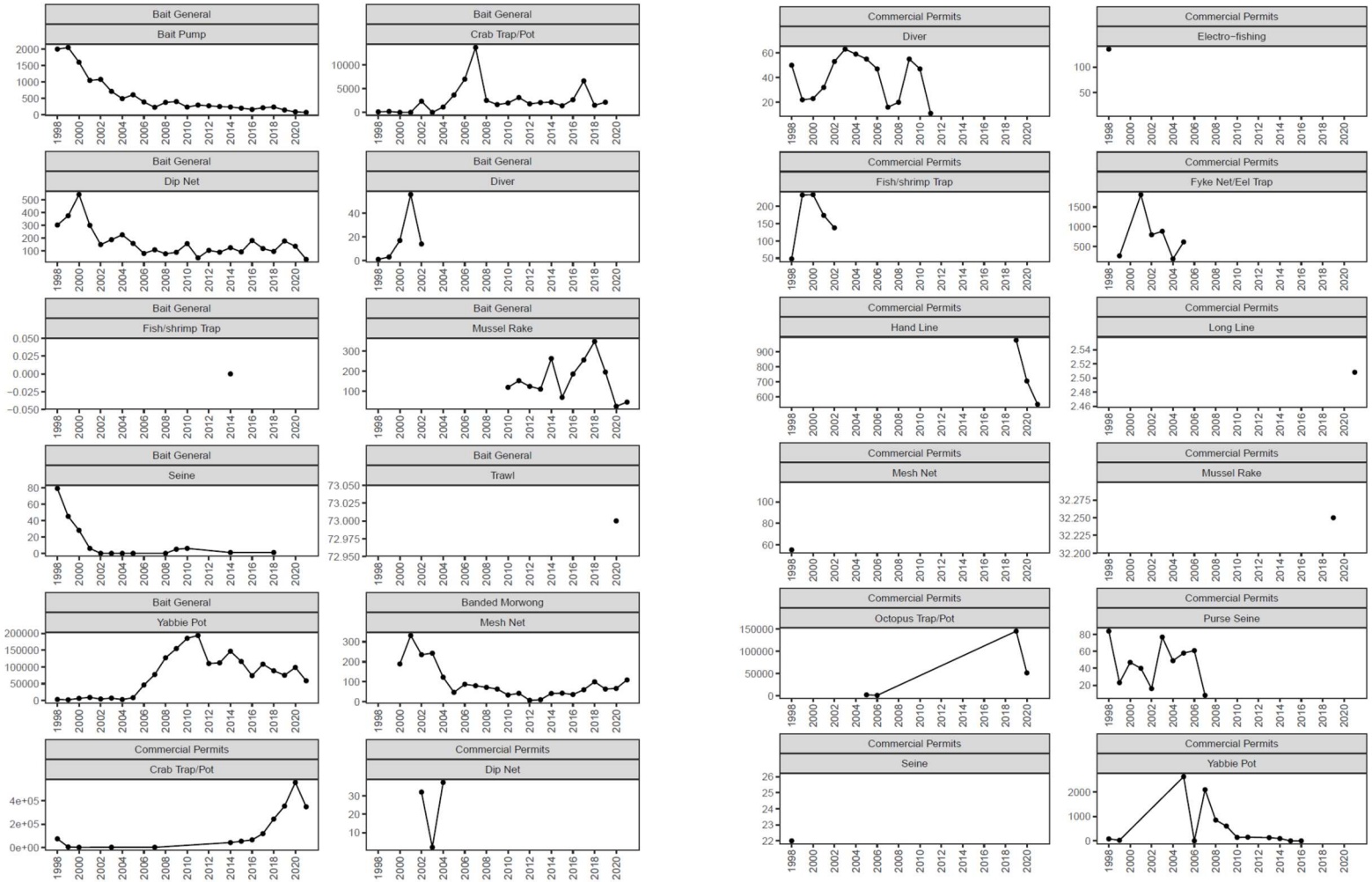
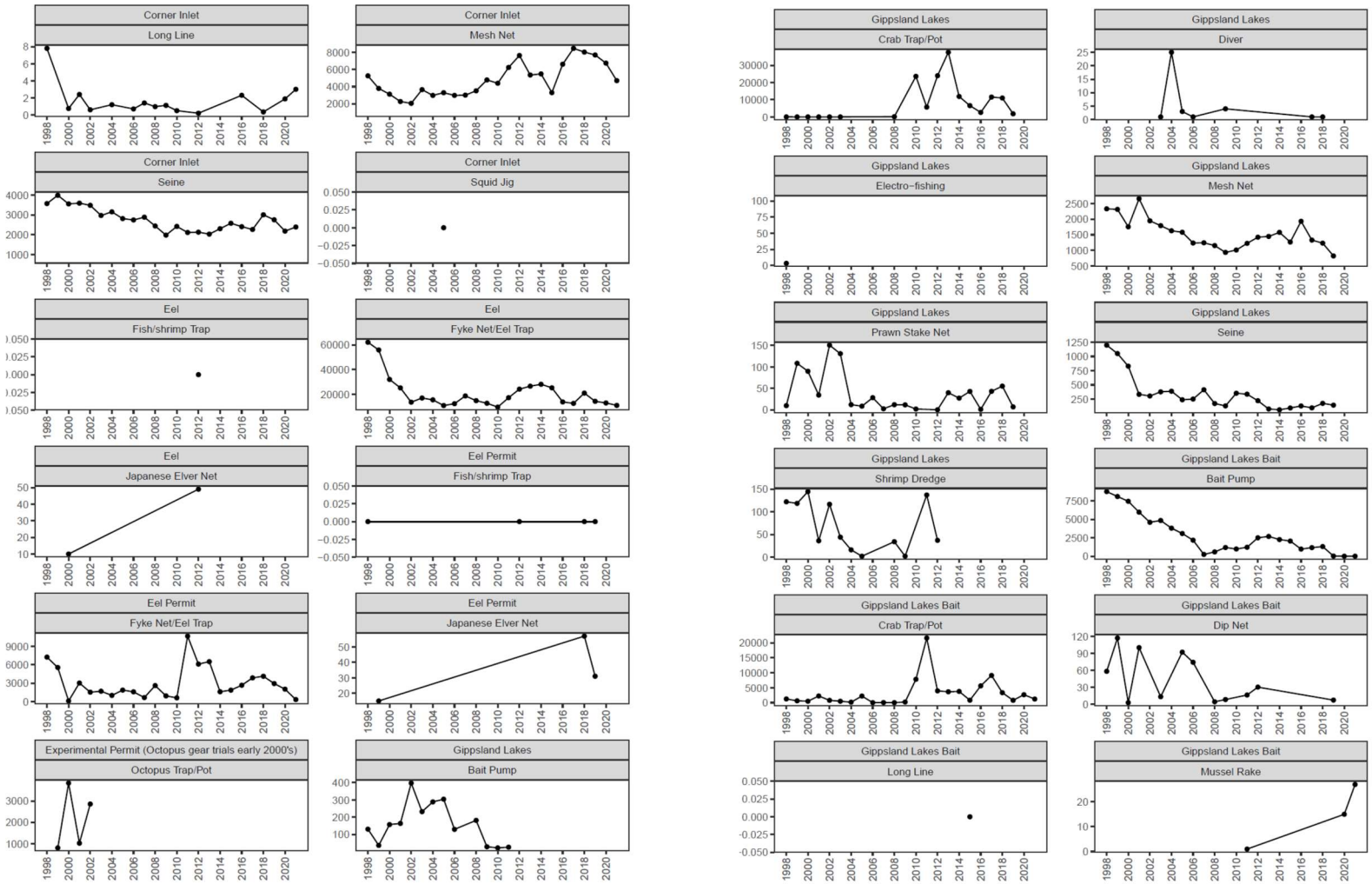
Appendix 1 – Methods

Standardisation and GAMs

CPUE trends are notoriously noisy due to a variety of biological (e.g. migratory behaviour), environmental (e.g. river flows) and fishery related (e.g. changes in targeting or retaining species) factors. Previous assessments have smoothed CPUE trends by using three-year moving averages, that is, the average value of the current and two preceding years. While this technique is generally successful at smoothing trends, it also creates a lag in the time series, which may result in a failure to respond to changing abundance in a timely fashion. As such, in the current assessment, generalised additive models were fitted to the standardised (where available) or nominal CPUE time series using the default setting of the 'stat_smooth' function of the ggplot2 R package, which uses the functions within the mgcv R package. GAMs are particularly appropriate for smoothing noisy time series as the addition of additional parameters to the model (splines) is tested using Akaike's Information Criteria, which penalises each additional parameter meaning the model does not overfit the available data. As such, when the data are particularly noisy, or when the first additional parameter does not improve the fit of the model, it will default to a simple linear model.

Appendix 2 – Effort in Victorian fisheries

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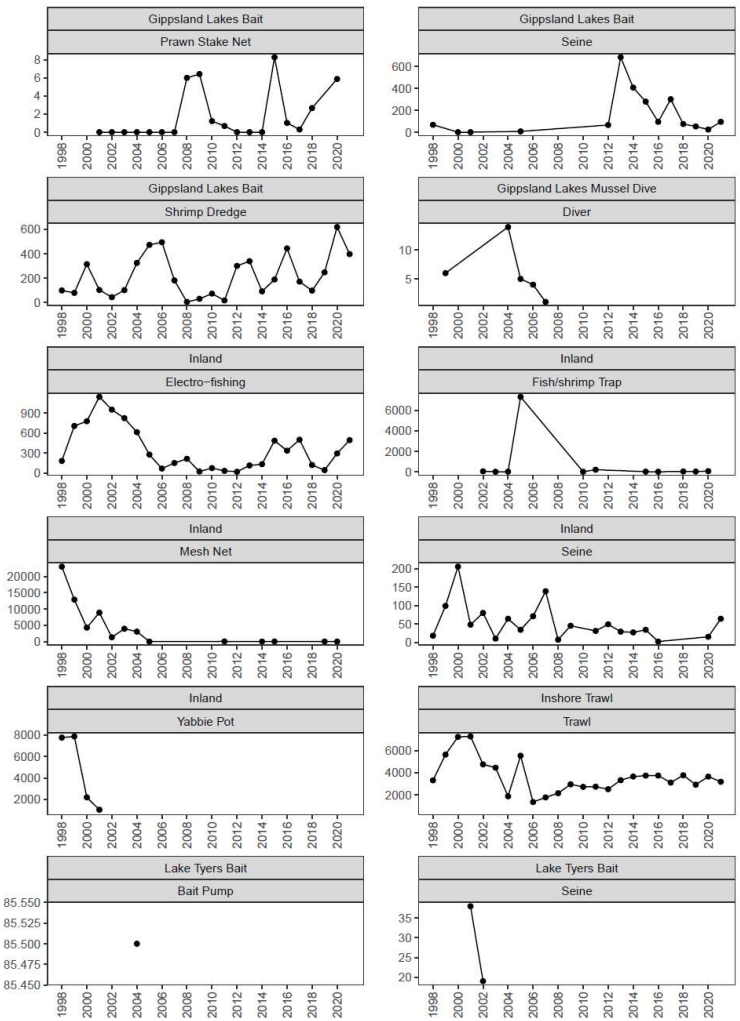
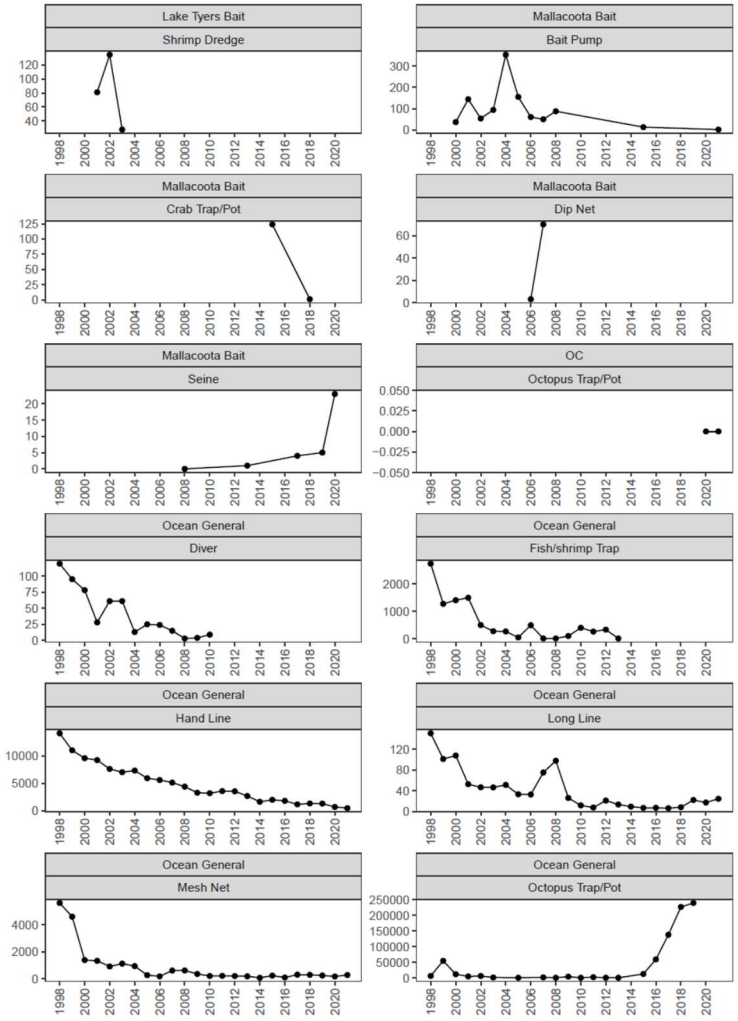
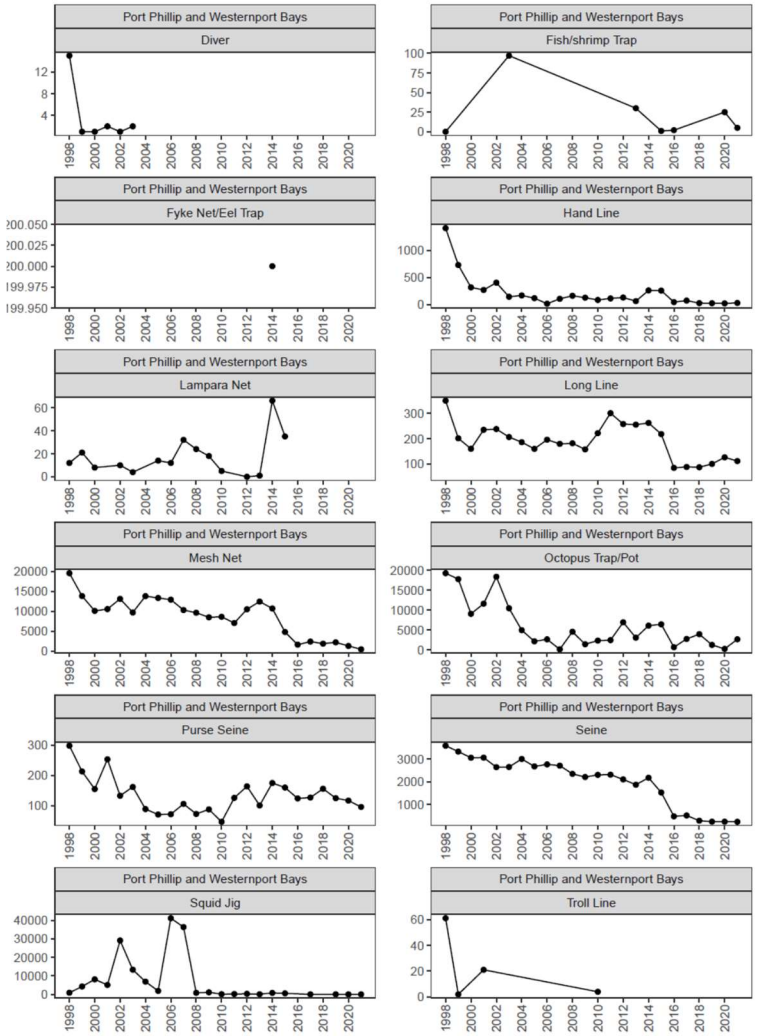
Long Line
Corner Inlet
Mesh Net
Corner Inlet
Seine
Corner Inlet
Squid Jig
Eel
Fish/shrimp Trap
Eel
Fyke Net/Eel Trap
Eel
Japanese Elver Net
Eel Permit
Fish/shrimp Trap
Eel Permit
Fyke Net/Eel Trap
Eel Permit
Japanese Elver Net
Experimental Permit (Octopus gear trials early 2000's)
Octopus Trap/Pot
Gippsland Lakes
Bait Pump
Gippsland Lakes
Crab Trap/Pot
Gippsland Lakes
Diver
Gippsland Lakes
Electro-fishing
Gippsland Lakes
Mesh Net
Gippsland Lakes
Prawn Stake Net
Gippsland Lakes
Seine
Gippsland Lakes
Shrimp Dredge
Gippsland Lakes Bait
Bait Pump
Gippsland Lakes Bait
Crab Trap/Pot
Gippsland Lakes Bait
Dip Net
Gippsland Lakes Bait
Long Line
Gippsland Lakes Bait
Mussel Rake


Gippsland Lakes Bait
Prawn Stake Net
Gippsland Lakes Bait
Seine
Gippsland Lakes Bait
Shrimp Dredge
Gippsland Lakes Mussel Dive
Diver
Inland
Electro−fishing
Inland
Fish/shrimp Trap
Inland
Mesh Net
Inland
Seine
Inland
Yabbie Pot
Inshore Trawl
Trawl
Lake Tyers Bait
Bait Pump
Lake Tyers Bait
Seine


Lake Tyers Bait
Shrimp Dredge
Mallacoota Bait
Bait Pump
Mallacoota Bait
Crab Trap/Pot
Mallacoota Bait
Dip Net
Mallacoota Bait
Seine
OC
Octopus Trap/Pot
Ocean General
Diver
Ocean General
Fish/shrimp Trap
Ocean General
Hand Line
Ocean General
Long Line
Ocean General
Mesh Net
Ocean General
Octopus Trap/Pot


Ocean General
Purse Seine
Ocean General
Seine
Ocean General
Squid Jig
Ocean General
Troll Line
Ocean Purse Seine
Purse Seine
Ocean Scallop
Scallop Dredge
OCommercial Permits
Octopus Trap/Pot
OCommercial Permits
Trawl
PCommercial Permits
Dip Net
Pipi
Dip Net
Pipi
Hand Line
Port Phillip and Westernport Bays
Crab Trap/Pot


Port Phillip and Westernport Bays
Diver
Port Phillip and Westernport Bays
Fish/shrimp Trap
Port Phillip and Westernport Bays
Fyke Net/Eel Trap
Port Phillip and Westernport Bays
Hand Line
Port Phillip and Westernport Bays
Lampara Net
Port Phillip and Westernport Bays
Long Line
Port Phillip and Westernport Bays
Mesh Net
Port Phillip and Westernport Bays
Octopus Trap/Pot
Port Phillip and Westernport Bays
Purse Seine
Port Phillip and Westernport Bays
Seine
Port Phillip and Westernport Bays
Squid Jig
Port Phillip and Westernport Bays
Troll Line

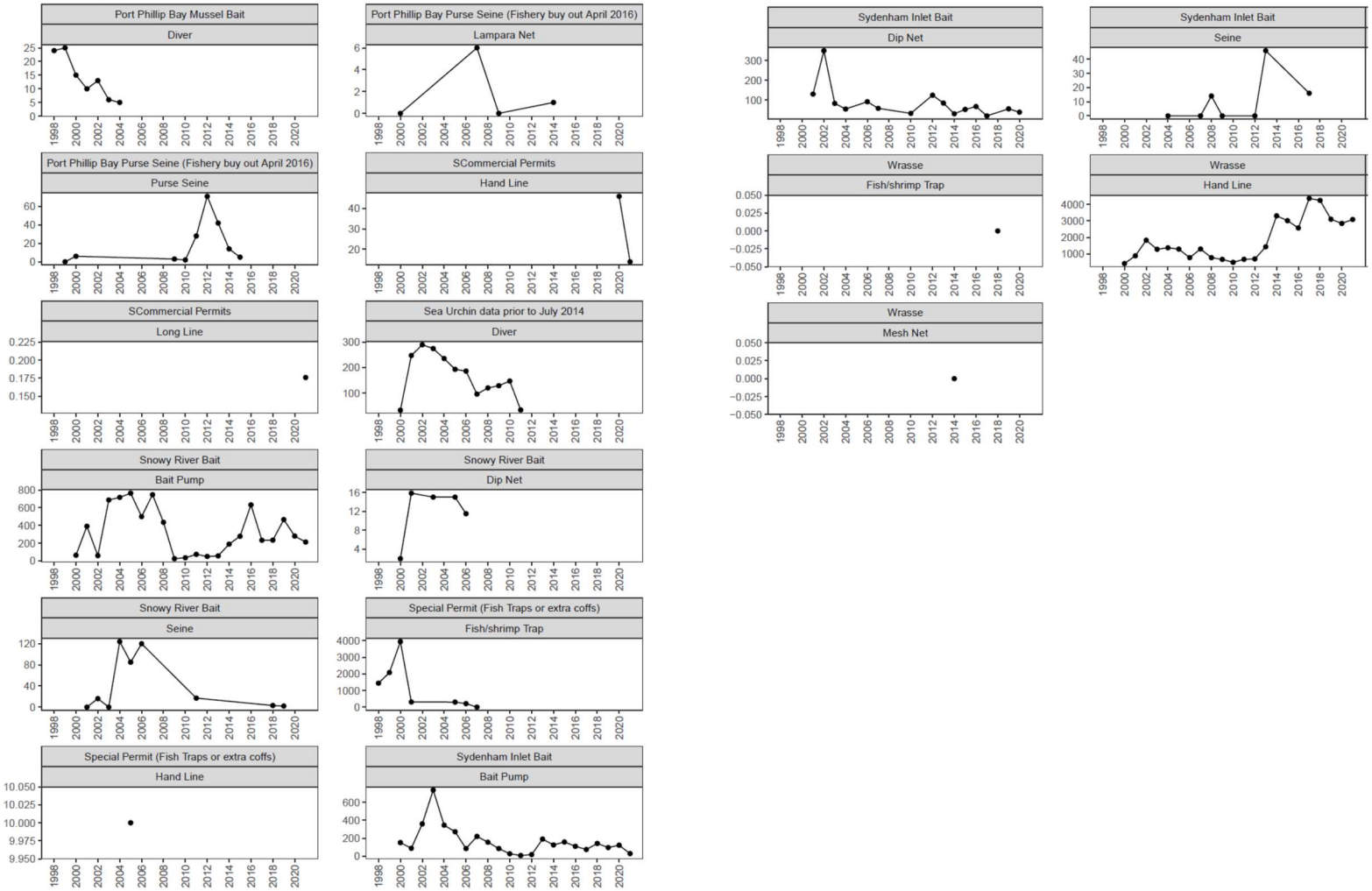


Figure A3.1: Commercial fishing effort by various gears in Victorian waters. Effort units are: hrs for handline and squid jig, ‘000 hooklifts for long line, km.hrs for mesh net and number of shots for seine and trawl.

Appendix 3 – Standardisation and filtering

Table: Details of the models fit to the available data (species X water body X gear). All models were fit using the default settings of the glmmTMB package in R. Model selection and implementation was undertaken following Giri and Gorfine (2018).

Species	Water body	Fishery	Filters	Model details	Response	Fixed effects	Random effects
Snapper (done seasonally)	Port Phillip Bay	Commercial longline	Month from October – March Snapper longline gear only >100 hooks & <600 hooks #shots 1 – 12 only	Model: GLMM. Error distribution: Gamma. Link: Log.	CPUE + 0.01	Financial year	Month + Area:FinancialYear + Fisher:FinancialYear
Snapper (done seasonally)	Port Phillip Bay and Western Port	Recreational creel	Month from October – March Targeting snapper. Fished > 0.5 hours. Number of fishermen >0. Number fishermen <20. Area != Bass Strait.	Model: GLMM Error distribution: Negative binomial. Link: Log. Offset: Log(angler hours).	Retained snapper per hour	Financial year	Avidity + Area + Area:FinancialYear
KGW	Port Phillip Bay and Western Port	Recreational creel	Targeting KGW. Fished > 0.5 hours. Number of fishermen >0. Number fishermen <20. Area != Bass Strait.	Model: GLMM. Error distribution: Negative binomial. Link: Log. Offset: Log(angler hours).	Retained KGW per hour	Financial year	Area + Season + Season:FinancialYear
Sand flathead	Port Phillip Bay and Western Port	Recreational creel	Targeting KGW. Fished > 0.5 hours. Number of fishermen >0. Number fishermen <20. Area != Bass Strait.	Model: GLMM. Error distribution: Negative binomial. Link: Log Offset: Log(angler hours).	Retained flathead per hour	Financial year	Targeting* + Avidity + Area + Area:FinancialYear + Season:FinancialYear
Black bream	Gippsland Lakes	Commercial mesh net	CPUE is catch/net length as soak time not recorded prior to 1998. Mesh size M3 and M4 only. Net length >100 m only	Model: GLMM. Error distribution: Gamma. Link: Log.	CPUE + 0.01	Financial year Inflow**	Fisher + Area + Month + MeshSize + Fisher:MeshSize
Black bream	Gippsland Lakes	Recreational creel	Month from July – November Targeting bream. Fished > 0.5 hours.	Model: GLMM Error distribution: Negative binomial. Link: Log. Offset: Log(angler hours).	Retained black bream	Calendar year Inflow**	Avidity + Year:Season

*Anglers are asked whether they have two target species. In most instances, this indicates two separate fishing methods, however, for flathead, they are readily caught while targeting most other species. However, they are not caught as frequently as when they are the primary target species. Thus, 'target species' was included as a factor in the model to prevent filtering to primary target species only.

**Combined mean monthly river flow from the Tambo (station #223205), Mitchell (station #224203) and Nicholson (station #223204) Rivers (Source: http://data.water.vic.gov.au/).

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