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J. D. Bell, B. A. Ingram, H. K. Gorfine & S. D. Conron
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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 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), as well as Victoria's State of Marine Environment reporting.

This review 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/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/integrated risk assessments. Relative importance of each species/stock was 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). Recent Status of Australian Fish Stocks classifications (Table 1) are also included together with key points about each species' performance.

Abalone (central, eastern zones & western zones), Bass Strait commercial scallop, giant crab and southern rock lobster fisheries, for which assessments have been outsourced and are reported separately, are not covered by this report.

Thirty-five species each comprising one or more of the main stocks were assessed as follows:

- Relative importance of the stocks in accordance with an internal VFA index was 13 high, 9 moderate and 19 low, and the remaining three (1 × octopus and 2 × sea urchin species) classed as developing or recently developed;
- Twenty-three of the 44 stocks (52%) have been classed as 'sustainable in accordance with the SAFS classification system and six of the stocks (5 species) in this report were not assessed for SAFS 2022;
- None of species was classed as 'depleted' or 'depleting' and five, Murray Cod, Southern Sand Flathead, Golden Perch, Black Bream (Gippsland Lakes stock), and Yelloweye Mullet have been assigned a 'recovering' classification for the 2022 SAFS assessment, noting that this is an external process where SAFS classifications in a limited number of instances may be at variance with VFA classifications, especially where a stock is shared among interstate or Commonwealth jurisdictions.

Stocks excluded from this report which are included in the SAFS assessment are the geographically marginal species Cobia, Bronze Whaler Shark, and Striped Trumpeter that naturally occur in only low abundance in Victorian waters. These last three are not classified in SAFS but instead are described qualitatively by a simple generic statement. Five Victorian-managed shellfish species that are assessed externally under contract to VFA, and those finfish coming Commonwealth jurisdiction are reported separately, so information from those assessment reports is used by SAFS authorship teams for classifications. As more species are included in SAFS (in the 2022 SAFS report there will be approximately 522 stocks comprising 158 species) the number of data poor stocks that will be classified as undefined or less commonly negligible will invariably increase despite the development of a data limited methods. In Victoria, Bastard Trumpeter is classified as 'Negligible' under strict criteria overseen by a designated SAFS committee, and 10 species in this report were 'Undefined' due to high uncertainty and/or lack of data. More recently, Wavy Periwinkle, previously classified as 'Negligible' is now 'Undefined due to increasing catches, but the small scale, limited number of operators and data preclude assessment of this niche fishery.

The outcomes of this review of the status of Victorian fish stocks will be used 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.

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 the 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 in general catch and effort for recreationally dominated fisheries is not routinely reported as is the case for most commercial fisheries.

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.

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, for example a trial of a phone application catch-reporting system for recreational fishers (GoFishVic app) and installation of boat ramp cameras to track effort. The assessments in this report are based on available information considered to be informative about the recent biological status of the specific species/stock/management units.

Non-quota Victorian fisheries do not have formal management plans, harvest strategies or defined management objectives with agreed performance indicators and reference points for their assessment. In lieu of such prescribed approaches to assessment and management, this annual review uses available and relevant information to provide evidence-based advice on the status of species and their stocks or management units, uncertainties in status, and issues over performance of associated recreational and commercial fisheries. As the amounts and types of information vary among species assessed, so expert opinion and knowledge about each fishery and its data is important in 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. It is expected that the species summaries provided in this report will underpin the biennial SAFS classifications for 2020. This report is more expansive in scope than SAFS and includes species and spatial scales not reported in SAFS but nevertheless relevant to localised operational fisheries management in Victoria. Where a species/stock/management unit has also been assessed in the most recent 2018 SAFS assessment, that classification is indicated in the review table (Table 1) for easy reference.

Purpose

The purpose of this report is to:

- Extract, refine, summarise and present key data on the status and performance of selected non-quota and recently developing species/stocks/management units;
- Review the status of selected non-quota species/stocks/management units and indicate levels of uncertainty;
- Provide fisheries managers and policy makers with information to help inform their decisions about work prioritisation, and identify 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;
    - SAFS reporting;
    - Input to state of marine environment and biodiversity reporting by other government agencies;
    - 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 and effort or 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;
- Fishery dependent creel surveys of recreational catch and effort, and length/size composition;
- Angler Diary Program of 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 frequently used proxy for biomass trends in fisheries assessments and is usually 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 lies 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 (e.g. wrasse licences becoming transferable); the time series of data is limited (e.g. recreational fisheries in Port Phillip Bay, Western Port and 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

The 35 species and their 44 stocks or management units included in this most recent review are:

1. Snapper (*Chrysophrys auratus*): 2 stocks, Western and Eastern Victorian Stocks
2. King George Whiting (*Sillaginodes punctatus*): State-wide
3. Southern Sand Flathead (*Platycephalus bassensis*): 3 stocks, Port Phillip Bay, Corner Inlet, Vic other
4. Black Bream (*Acanthopagrus butcheri*): 5 stocks, Gippsland Lakes, Glenelg Estuary, Hopkins River, Mallacoota Inlet, Lake Tyers
5. Southern Sea Garfish (*Hyporhamphus melanochir*): Corner Inlet-Nooramunga
6. Pipi (*Donax deltoides*): State-wide
7. Yellow-Eye Mullet (*Aldrichetta forsteri*): State-wide
8. Rock Flathead (*Platycephalus laevigatus*): Corner Inlet-Nooramunga
9. Southern Calamari (*Sepioteuthis australis*): State-wide
10. Blue Throat Wrasse (*Notolabrus tetricus*)
11. Purple Wrasse *N. fucicola*): State-wide, coastal waters
12. Gummy Shark (*Mustelus antarcticus*): State-wide
13. Silver Trevally (*Pseudocaranx georgianus, …*
14. *… P. dentex, and*
15. *… P. wrighti*): State-wide
16. Southern Bluespotted Flathead (*Platycephalus speculator*): State-wide
17. Sand Crab (*Ovalipes australiensis*): State-wide
18. Eastern Australian Salmon (*Arripis trutta*): Eastern Victoria
19. Western Australian Salmon (*A. truttaceus*): Western Victoria
20. Tailor (*Pomatomus saltatrix*): Gippsland Lakes
21. Elephant Fish (*Callorhinchus milii*): State-wide
22. Dusky Flathead (*Platycephalus fuscus*): 3 stocks, Gippsland Lakes, Lake Tyers and Mallacoota Inlet
23. Long-spined (*Centrostephanus rodgersii*): Eastern Victoria
24. Short-spined (*Heliocidaris erythrogramma*): 2 stocks, Central and Eastern Victoria
25. Estuary Perch (*Maquaria colonorum*): 2 stocks, Glenelg and Hopkins Rivers
26. Pale Octopus (*Octopus pallidus*): Eastern Victoria
27. Banded Morwong (*Cheilodactylus spectabilis*): Eastern Victoria
28. Commercial Scallop (*Pecten fumatus*): Port Phillip Bay
29. Mulloway (*Argyrosomus japonicus*): Glenelg River
30. Murray Cod (*Maccullochella peelii*): State-wide
31. Snook (*Sphyraena novaehollandiae*): State-wide
32. Golden Perch (*Macquaria ambigua*): State-wide
33. Greenback Flounder (*Rhombosolea tapirina*): Corner Inlet-Nooramunga
34. Southern Shortfin Eel (*Anguilla australis*): State-wide
35. Longfin Eel (*Anguilla reinhadtii*): State-wide

Stock Review Summary

This review covers the period 1978/79 – 2021/22 (fiscal years) updating previous assessments of stock status for non-quota managed species and those for developing fisheries 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 2. Where available the most recent Status of Australian Fish Stocks (SAFS) classifications (https://fish.gov.au/) are also included together with key points about each species' performance.

Thirty-five out of the 55 Victorian SAFS 2022 species, comprising 44 stocks/management units were assessed (Table 1). Relative importance of the stocks had a roughly even distribution among categories with 13 high, 9 moderate and 19 low, and the remaining three (one octopus and two sea urchin species) were categorised as developing.

Twenty-two species in this report were classed as sustainable in accordance with the SAFS 2022 classification system (63%, compared with 55% two years ago), and 14% were not included in SAFS. Out of those not classed as sustainable, none were classed as depleting, or depleted, and five (Southern Sand Flathead, Murray Cod, Golden Perch, Yelloweye Mullet and Gippsland Lakes Black Bream) were assessed as recovering from previous depletion or from a reversal of depleting trends. Ten were classed as undefined i.e., uncertain, due to insufficient or highly variable data. The Eastern Snapper stock was also undefined; however, the Western Snapper stock was classed as sustainable. In the current submission for the 2022 SAFS assessment, including species or stocks not in this report, two thirds of Victorian stocks have been assigned to the sustainable category, one fifth are considered undefined or negligible, two percent are recovering, and eight percent are depleted or depleting. The remaining six percent (3 species) are geographically marginal and so seldom taken from Victorian waters and six of the stocks (5 species) in this report were not assessed for Victoria in the respective SAFS species chapters for 2022.

Although the COVID-19 pandemic impacted some fisheries, such as wrasse, the effect was transient (Ogier et al. 2023). In several fisheries, such as sea urchins and Eastern Australian Salmon, market demand not availability is the main driver of fishing effort, and for some (Black Bream, Southern Calamari, and both species of eels) environmental factors strongly influence available biomass.

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

Species	Management Unit/Stock	Relative importance	SAFS 2022 classification	VFA assessment of recent performance (2020–2022)
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.
	Eastern stock	Moderate	Undefined	Now a stand-alone Victorian jurisdiction stock, no information to assess status, anecdotal stakeholder reports about high recreational pressure on spawning aggregations.
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.
	Corner Inlet	Low	Undefined	Limited data
	Victoria other	Low	Sustainable	Low data but catches are very low
Black Bream	Gippsland Lakes	High	Recovering	Recent increase recreational fishery CPUE are apparent, and now just below reference period average. Angler diary CPUE increased in 2022 to be well above reference period average. Size composition data confirms a significance portion of the stock is above and below the slot limit. Stronger juvenile recruitment in recent years and the removal of commercial fishing pressure in is expected to continue to drive stock recovery over the next 5 years.
	Mallacoota Inlet	Moderate	Undefined	Diary angler targeted CPUE has declined to below the reference period average in recent years, but in 2018 was above the reference minimum. Uncertainty over recruitment and decreased diary angler reporting.
	Lake Tyers	Moderate	Undefined	Diary angler targeted CPUE has declined to below the reference period average in recent years but in 2018 was above the minimum. A lower number of sampling trips has been recorded in recent years due to less diary anglers and CPUE data is become unreliable.
	Glenelg River	Moderate	Undefined	For the last decade CPUE trend has been stable at about or above reference period average with the exception 2022.
	Hopkins River	Moderate	Undefined	Diary angler targeted CPUE has fluctuated in recent years above or just below the reference period average.
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.
Blue throat Wrasse	Coastal waters	High	Sustainable	Uncertainty in how CPUE is responding under new licence arrangements, i.e. consistency of the indicator. Potential for catch to increase quickly if licences all become active.
Purple Wrasse				
Gummy Shark	State-wide	Low	Sustainable	Gummy Shark are a commercial by-product in Victoria and potentially discarding from transition to mixed species quota in the Port Phillip Bay longline fishery implies catch rates may now be unreliable. Thus, there is little information from the Victorian Commercial fleet to supplement the Commonwealth assessment. Nevertheless, commercial catch rates remain relatively high in PPB and catch rates from the main recreational Gummy Shark fishery in Western Port Bay, are variable but show an increasing trend through time, both consistent with the Commonwealth assessment.
Dusky Flathead	Gippsland Lakes	High	Sustainable:	Catch rates stabilised just below reference period average, but no information on recruitment or length composition. Improved monitoring required through angler diary or creel survey programs.
	Lake Tyers	High	Sustainable	Recent low recruitment may impact on larger fish abundance in future. Current length composition shows larger female fish are

				common. Improved monitoring required through angler diary or creel survey programs.
	Mallacoota Inlet	High	Undefined	Possible growth-overfishing; uncertainty in status of the larger female population component; lack of reliable CPUE data due to the angler diarists mostly targeting bream.
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.
Golden Perch	State-wide	High	Recovering	State-wide stock status was based on assessment of six indicator riverine populations. CPUE is increasing in five rivers and declining in one. It is anticipated that the stock will progressively improve under favourable environmental conditions.
Short-spined Urchins	Port Phillip Bay Eastern Zone	Developing	Sustainable	Market primarily dictates amount of fishing effort and species is very abundant, but only a proportion of the stock is of acceptable quality for processing. The fishery could maximise production without posing a risk to the stock as a whole.
Long-spined Urchins	Eastern Zone	Developing	Sustainable	Market primarily dictates amount of fishing effort and species is very abundant, but only a proportion of the stock is of acceptable quality for processing. The fishery could maximise production without posing a risk to the stock as a whole.
Eastern Australian Salmon	Eastern Victoria	Moderate	Sustainable	In Victoria, the eastern Australian Salmon stock is targeted by the commercial purse seine ocean fishery, mostly off eastern Victoria, with small catches also taken from Corner Inlet and the Ocean Fishery. No commercial landings are taken from other bays and inlets because of buyouts. Highly variable landings reflect market demand and preference for other pelagic species. The species is opportunistically targeted by recreational fishers in estuaries, bays and inlets, beaches, but catch data are limited.
Western Australian Salmon	Western Victoria	Moderate	Sustainable	This is a straddling stock that in Victoria, is subject to very low exploitation by recreational and commercial fisheries.
Southern Garfish	State-wide	Moderate	Sustainable	Recent increase in CPUE for Corner Inlet, now above the reference period average.
Pipi	State-wide	Moderate	Undefined	Not enough fishery data for drawing inferences from CPUE to assess the sustainability of current catches. Improved effort reporting via e-Catch will be important.
Yellow-eye Mullet	State-wide	Low	Recovering	Reduced catches due to low retention. Low catch risk. In this instance commercial CPUE is not an accurate proxy for biomass.
Silver Trevally (3 species)	State-wide	Low	Sustainable	Suggestion that broader stock of 3 species might be depleted, but it is unlikely that Victorian fishing is a major contributor given the low catch. No change in status. 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	Corner Inlet	Low	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
Sand Crab	State-wide	Low	Not assessed	Low risk, but not enough fishery data for making inferences from CPUE or on the sustainability of current catches.
Tailor	Gippsland Lakes	Low	Sustainable	Broader stock is considered stable although it is on IUCN Red List as Vulnerable reflecting global declines.
Elephant Fish	State-wide	Low	Sustainable	Current low catch appears stable. Western Port fishery remains unproductive. Lack of recovery after 10 years. Possible habitat/environmental influences depressing recruitment.
Estuary Perch	Glenelg River	Low	Not assessed	Catch rates have been high in recent years. However, a lack of juveniles among observations could mean poor recruitment in recent years. More targeted sampling is required to determine whether there has been a lack of recruitment, or alternatively that the fisher's practices are responsible for the lack of juveniles in the sample.

	Hopkins River	Low	Not assessed	Catch rates have, on average, increased throughout the time series and have remained relatively stable for the last three years at historic highs well above the reference period average. However, like the Glenelg River, there is a lack of data on juveniles. This could also be more due to the selective fishing practices of the angler collecting the data in recent years than to recent poor recruitment.
Pale Octopus	Eastern Victoria	Developing	Undefined	Developing fishery, sustainable catch levels unclear.
Banded Morwong	Eastern Victoria	Low	Undefined	Declines in CPUE to below the reference period average in the last two years are associated with increasing fishing effort. Evidence indicates that the fishery is depleting but not recruitment impaired.
Commercial Scallop	PPB	Low	Sustainable	Low risk.
Snook	State-wide	Low	Sustainable	No indication of recruitment impairment and generally appears to be stable throughout the State.
Mulloway	Glenelg River	Low	Not assessed	Currently insufficient evidence to reliably assess.
Greenback Flounder	Corner Inlet-Nooramunga	Low	Sustainable	If haul seine CPUE is considered reflective of biomass and mesh net CPUE reflects targeting, then there is no indication of depletion.
Southern Shortfin Eel	State-wide	Low	Sustainable	Strong environmentally driven with changes that can severely reduce productivity. Nonetheless, the current level of fishing mortality is unlikely to cause the stock to become recruitment impaired.
Longfin Eel	State-wide	Low	Sustainable	Strong environmentally driven with changes that can severely reduce productivity. Nonetheless, the current level of fishing mortality is unlikely to cause the stock to become recruitment impaired.

Snapper (*Chrysophrys auratus*)

Stock Structure and Biology

The Victorian snapper population is comprised of two stocks (Figure 1):

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

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 do emigrate into eastern Victoria (Figure 1).

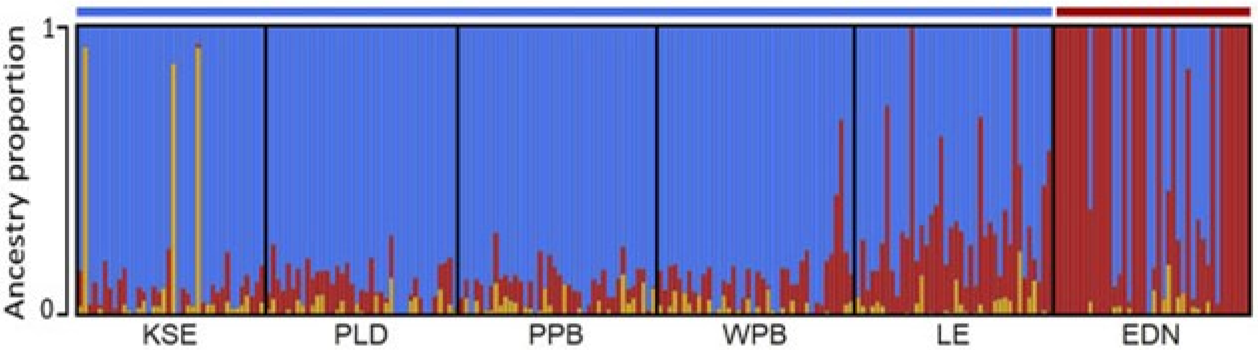


Figure 1 Heritage of snapper sampled from different regions of southeaster Australia. Each vertical line represents the ancestry of an individual fish. KSE = Kingston South-East, PLD = Portland, PPB = Port Phillip Bay, WPB = Western Port Bay, LE = Lakes Entrance, EDN = Eden. Yellow bars = South Australian stock heritage, blue bars = western Victorian stock heritage, red bars = East Australian stock heritage (Bertram et al. 2023).

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.

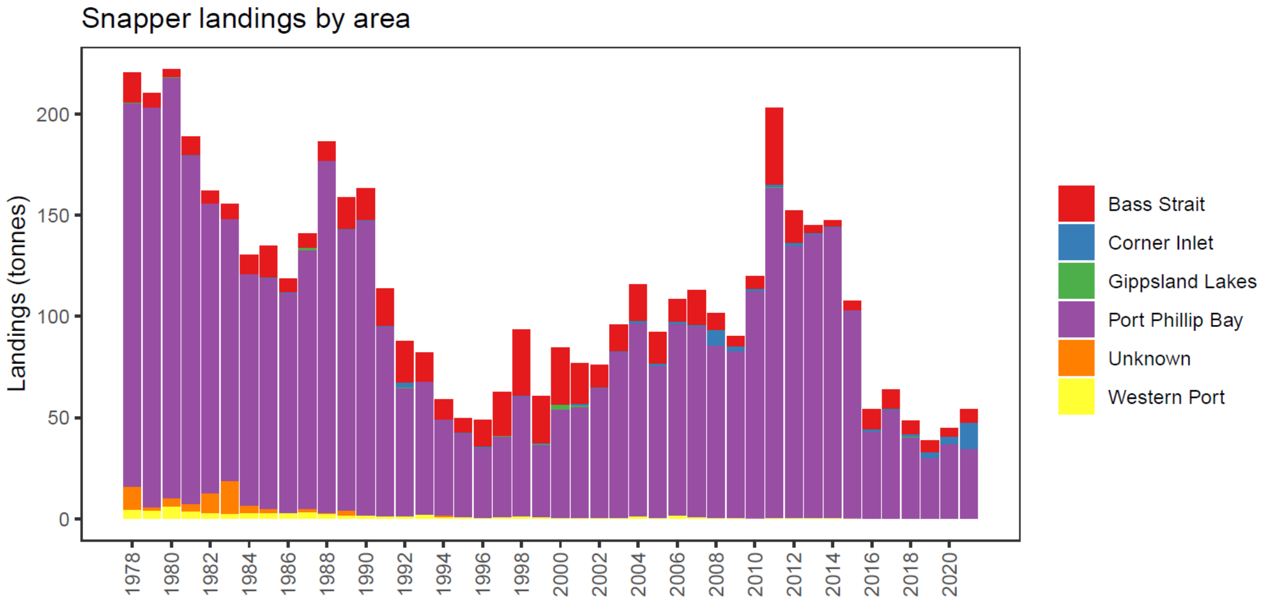


Figure 2 Snapper harvest by Victorian licenced commercial operators by fishing areas during financial years 1978/79–2021/22.

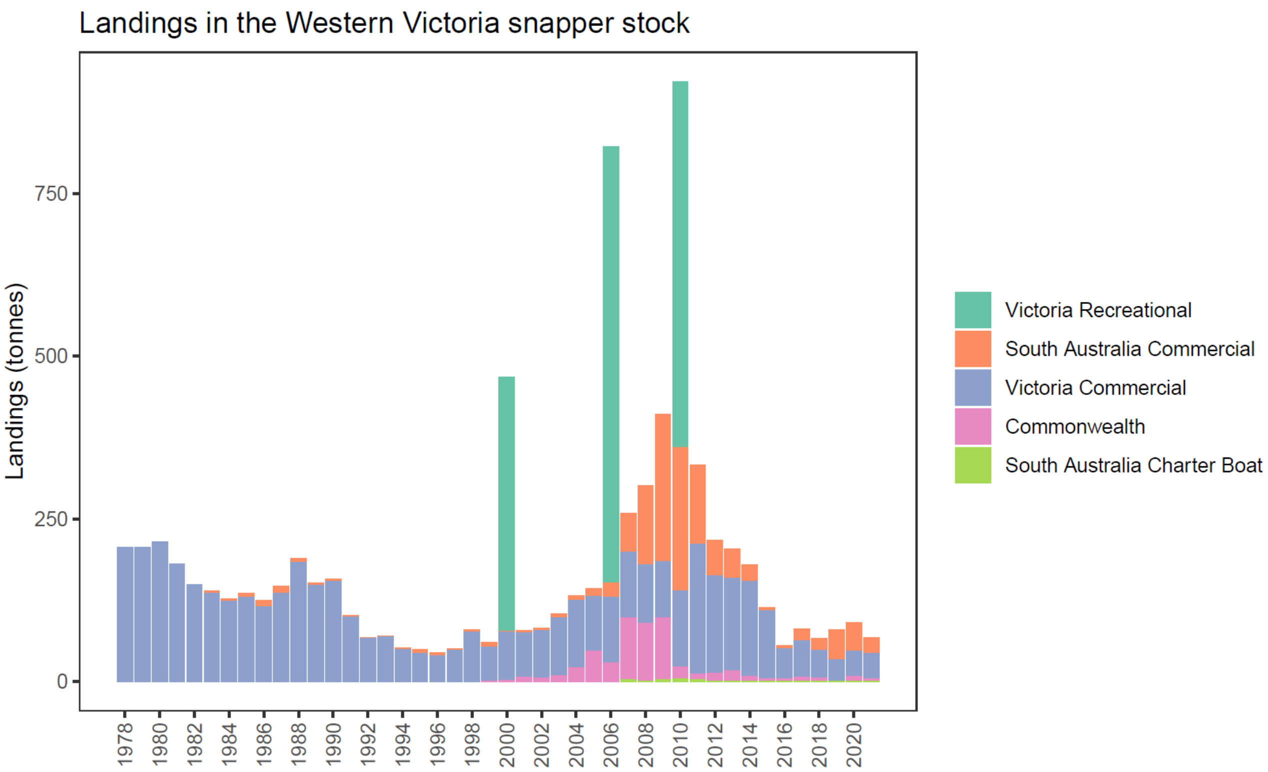


Figure 3 Total national catch of snapper including landings from the Western Victorian stock, financial years 1978–2021.

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 2). Since 2009/10 harvests by non-Victorian licensed operators from the western stock region have also declined to very low levels (Figure 3). 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 4 and Figure 5). Standardised CPUE for recreational anglers in Port Phillip Bay for the October-December period in 2021 was just below the reference period average, up slightly from 2020 (Figure 5).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-May 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 6). Nevertheless, the long-term trend among pinkie snapper in Port Phillip Bay is increasing and in 2021 was above the reference line (Figure 6). Western Port recreational snapper CPUE showed slightly different patterns with the larger adults (Oct-Dec) having declined 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, before falling again in 2021 to approximately half way between the reference period and minimum standardised CPUE (Figure 7). Pinkies in contrast, showed a decade of shallow decline which began levelling out between the standardised minimum and the reference line before sharply increasing in 2021/22 (Figure 8), bearing in mind the variability in abundance of these juveniles – sub-adults. In this instance, standardised CPUE has increased over the three years to 2021. Forecasts based on the recreational creel in Port Phillip Bay indicate increased abundance is expected for the 5-year period after 2023 (Figure 9, Figure 10, Figure 11 and Figure 12). However, the median length for the October-December period has been lower since 2014 for the Port Phillip Bay recreational fishery. This is 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 10a). The diary angler length compositions showed that the upper range of the length compositions has been consistent at approximately 100 cm since 2013 (Figure 10b).
- *Recruitment* – Recruitment of 0+ age snapper was low from 2015–2017 after moderate recruitments in 2014 and 2015 (Figure 11). In 2018, recruitment of 0+ age snapper was the highest recorded since trawl surveys began in 1993 (Figure 11). It then fell again for the three years 2019–2021 followed by a sizeble peak in the most recent survey in 2022 (Figure 11). With two very large cohorts to enter the fishery in coming years, it is expected that the overall biomass of the stock will increase.

Recreational catch

Recreational harvest in 2000/01, 2006/07 and 2009/10 for the Victorian region of the western stock were estimated at approximately 389, 670 and 561 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 years is expected to reverse any declining biomass trends and drive a rebuilding of adult biomass over the next 5–10 years with increases in sub-adult catch rates from January to May already apparent in both Port Phillip Bay and Western Port. 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.

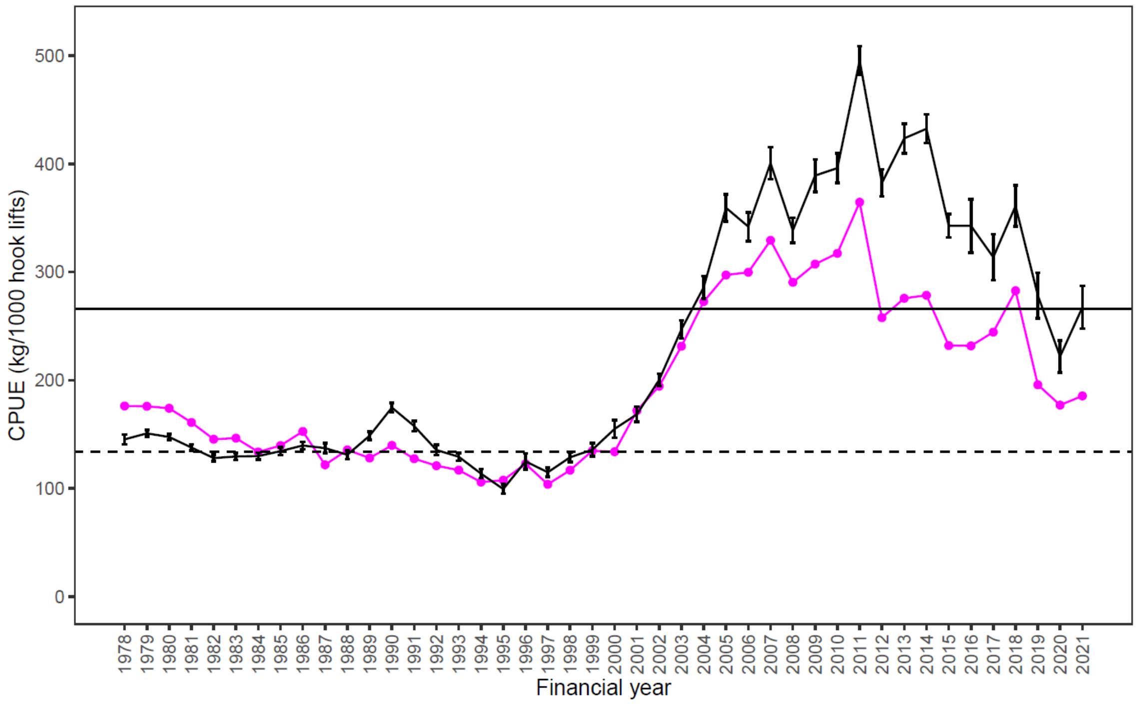


Figure 4 Catch-per-unit effort (CPUE) of snapper by commercial long-line fishers in Port Phillip Bay from 1978–2021 financial years. Black line is nominal CPUE (±SE), and magenta line is standardised CPUE.

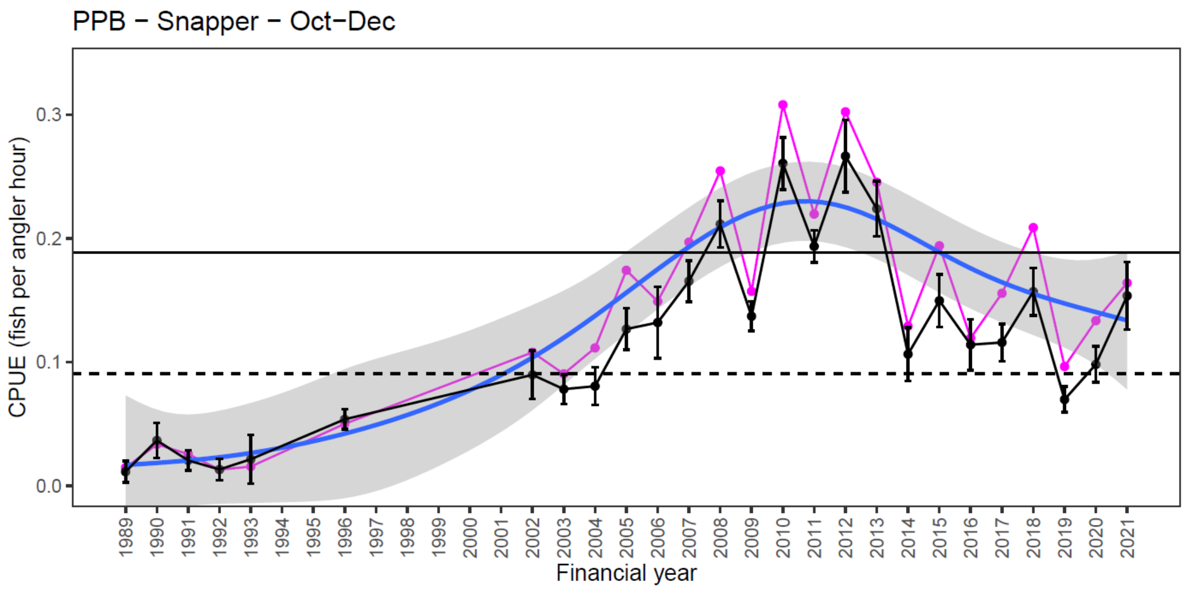


Figure 5 Catch-per-unit effort (CPUE) of snapper by recreational anglers interviewed in creel surveys undertaken in Port Phillip Bay between October – December during 1997/98–2021/22 financial years. Black line is nominal CPUE (±SE), magenta line is standardised CPUE, blue line is a generalised additive 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.

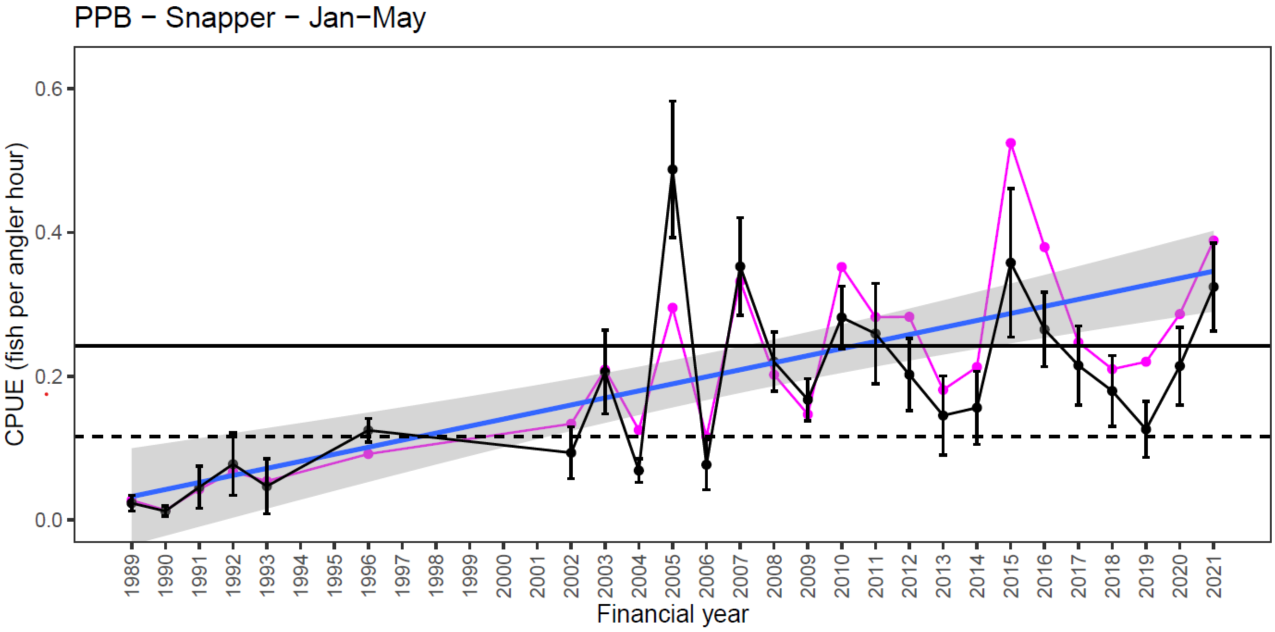


Figure 6 Catch-per-unit effort (CPUE) of snapper by recreational anglers interviewed in creel surveys undertaken in Port Phillip Bay (PPB) between January – May during 1997/98–2021/22 financial years. Black line is nominal CPUE (±SE), magenta line is standardised CPUE, blue line is a GAM of the standardised 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.

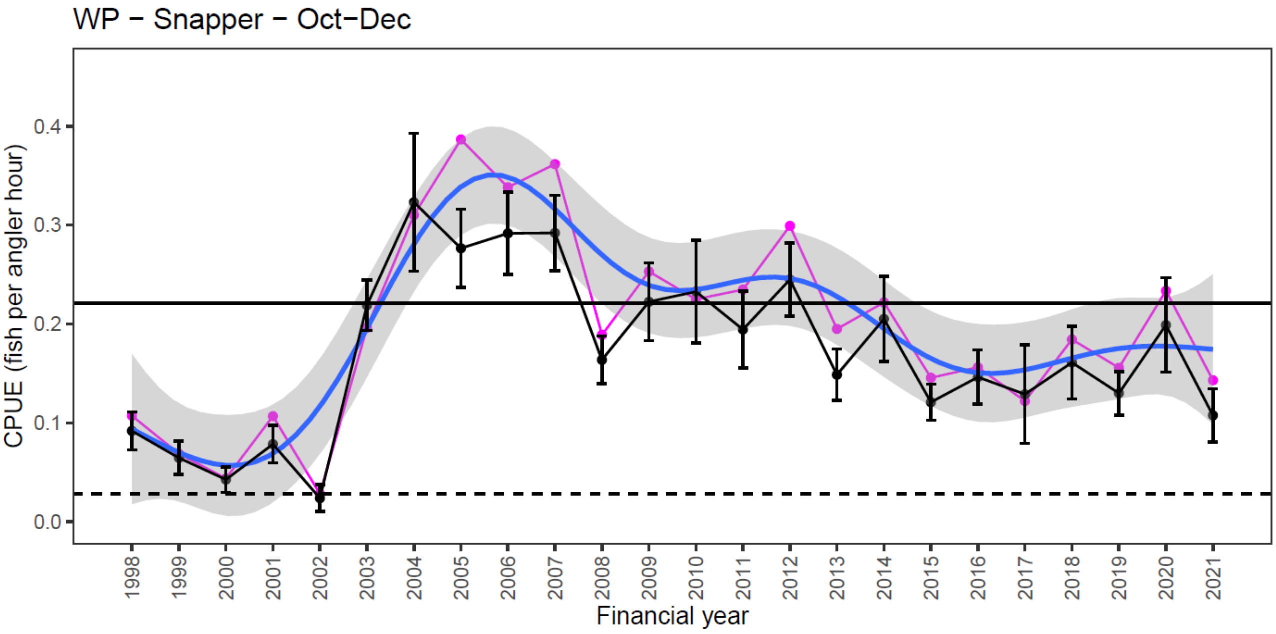


Figure 7 Catch-per-unit effort (CPUE) of snapper by recreational anglers interviewed in creel surveys undertaken in Western Port (WP) October – December during 1997/98–2021/22 financial years. Black line is nominal CPUE (±SE), magenta line is standardised CPUE, blue line is a generalised additive model 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.

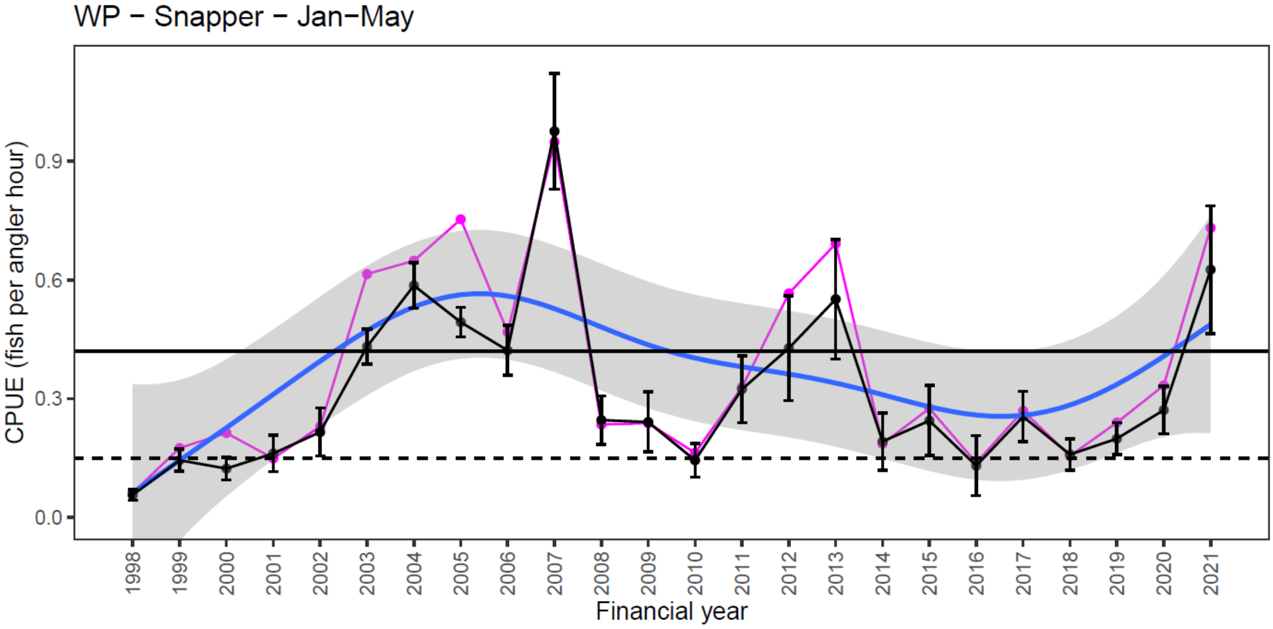


Figure 8 Catch-per-unit effort (CPUE) of snapper by recreational anglers interviewed in creel surveys undertaken in Western Port (WP) January – May during 1997/98–2021/22 financial years. Black line is nominal CPUE (±SE), magenta line is standardised CPUE, blue line is a generalised additive model GAM 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.

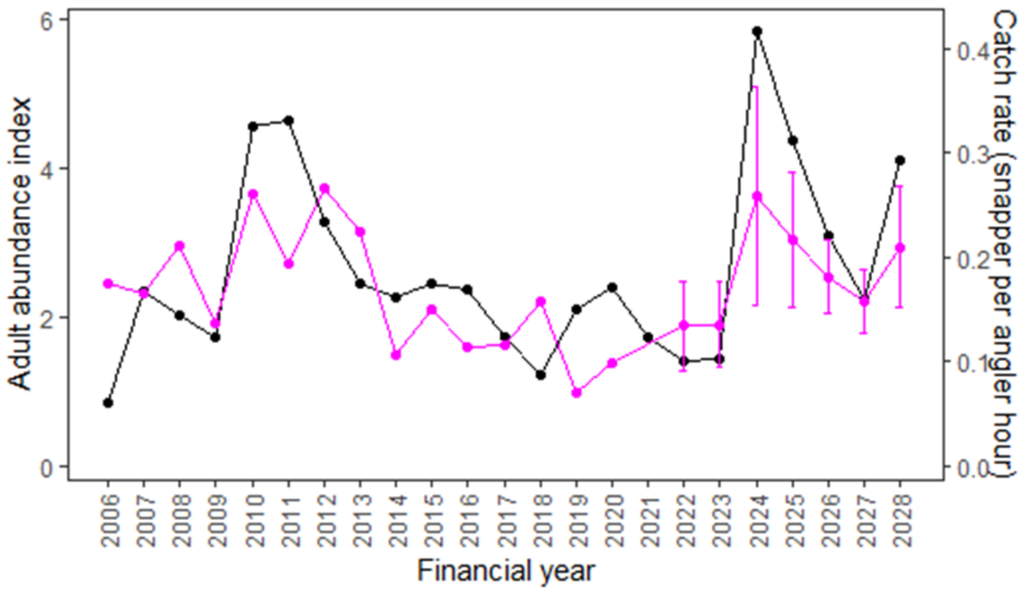


Figure 9 Port Phillip Bay snapper creel observed (2006–2021) and forecast CPUE (pink) and abundance index (black) over the same observed and forecasted (2022–2028) periods.

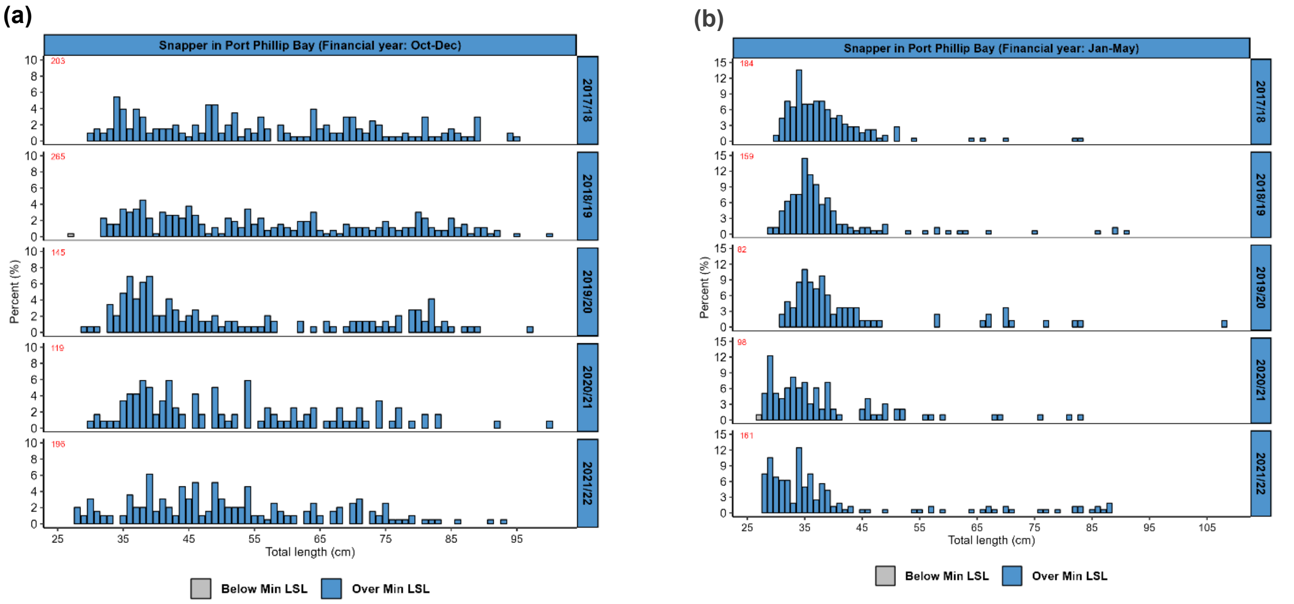


Figure 10 Frequency histograms of Port Phillip Bay recreational fishery snapper creel survey length composition (a) Oct-Dec, (b) Jan-Apr. Red numbers indicate numbers of fish measured. LSL = legal size limit.

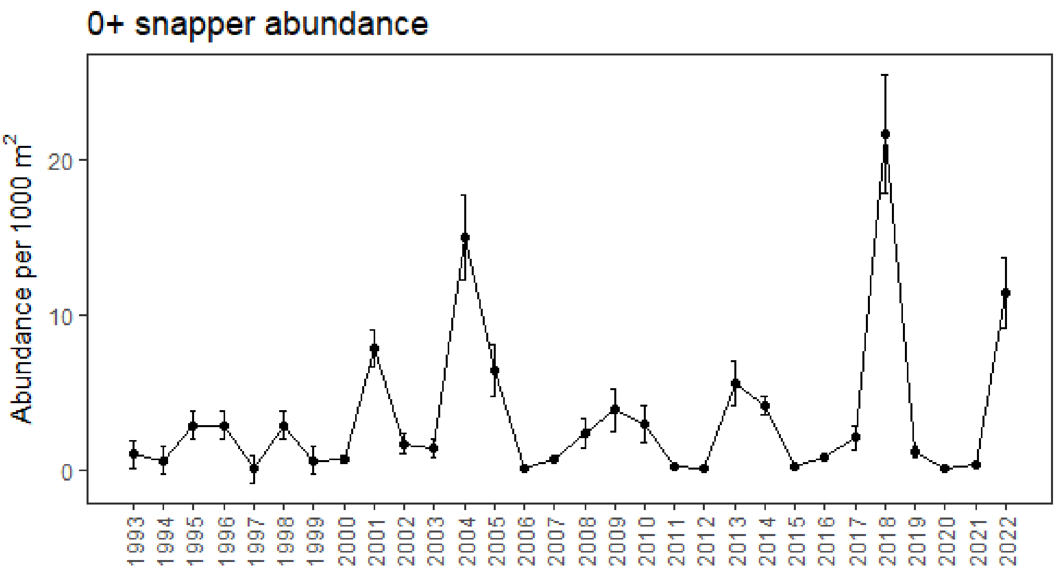
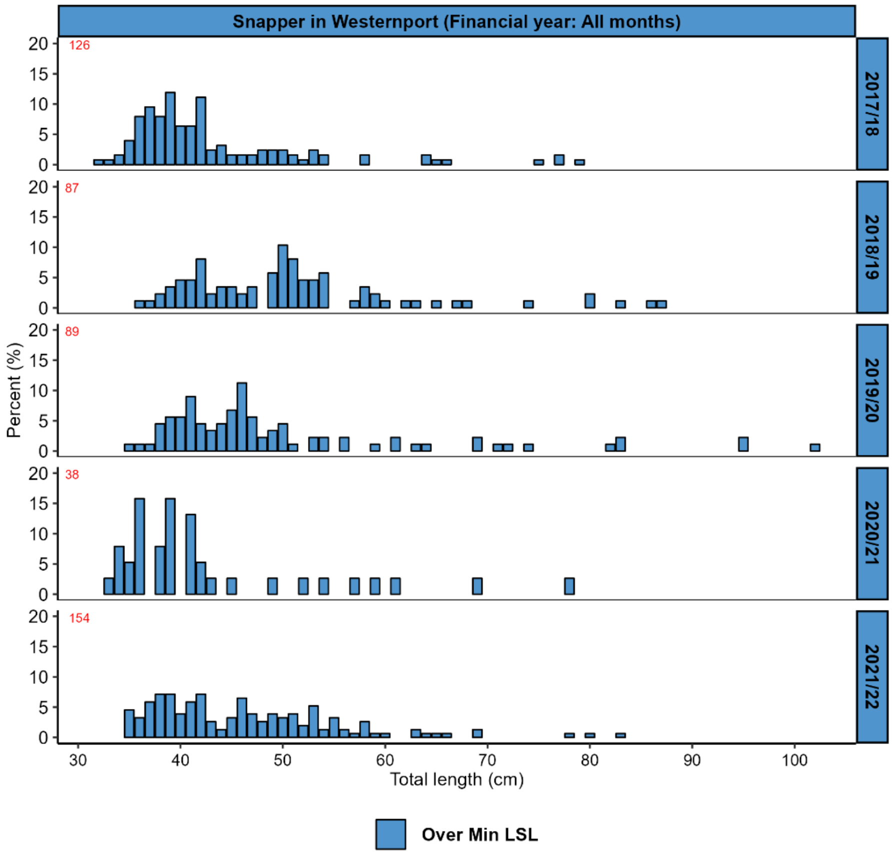


Figure 11 Port Phillip Bay snapper pre-recruit (0+ age) trawl survey catch rates (±SE) 1993–2022. Note: SE can only be calculated from 2000 onwards, data prior is based on extrapolation of beam trawl to earlier otter trawl data using a regression relationship from 11 years when the otter trawl and beam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

(a)



(b)

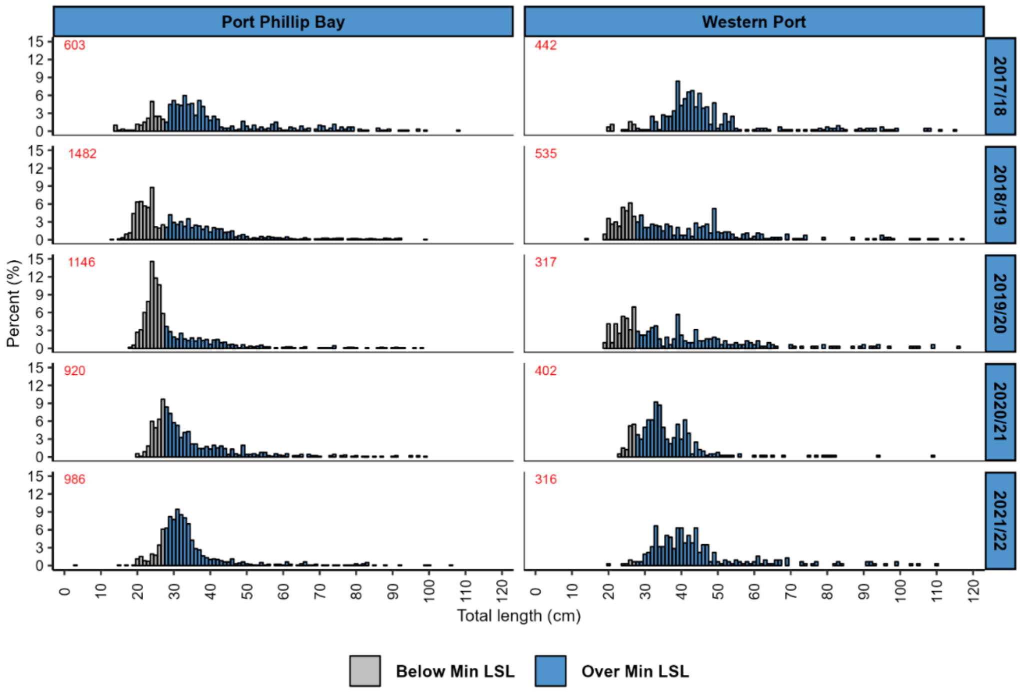


Figure 12 Frequency histograms of Western Port recreational snapper length composition (a) creel surveys all months, (b) diary angler all months (incl. PPB for comp.), fiscal years 2017/18–2021/22. Red numbers are numbers sampled. LSL= legal size limit.

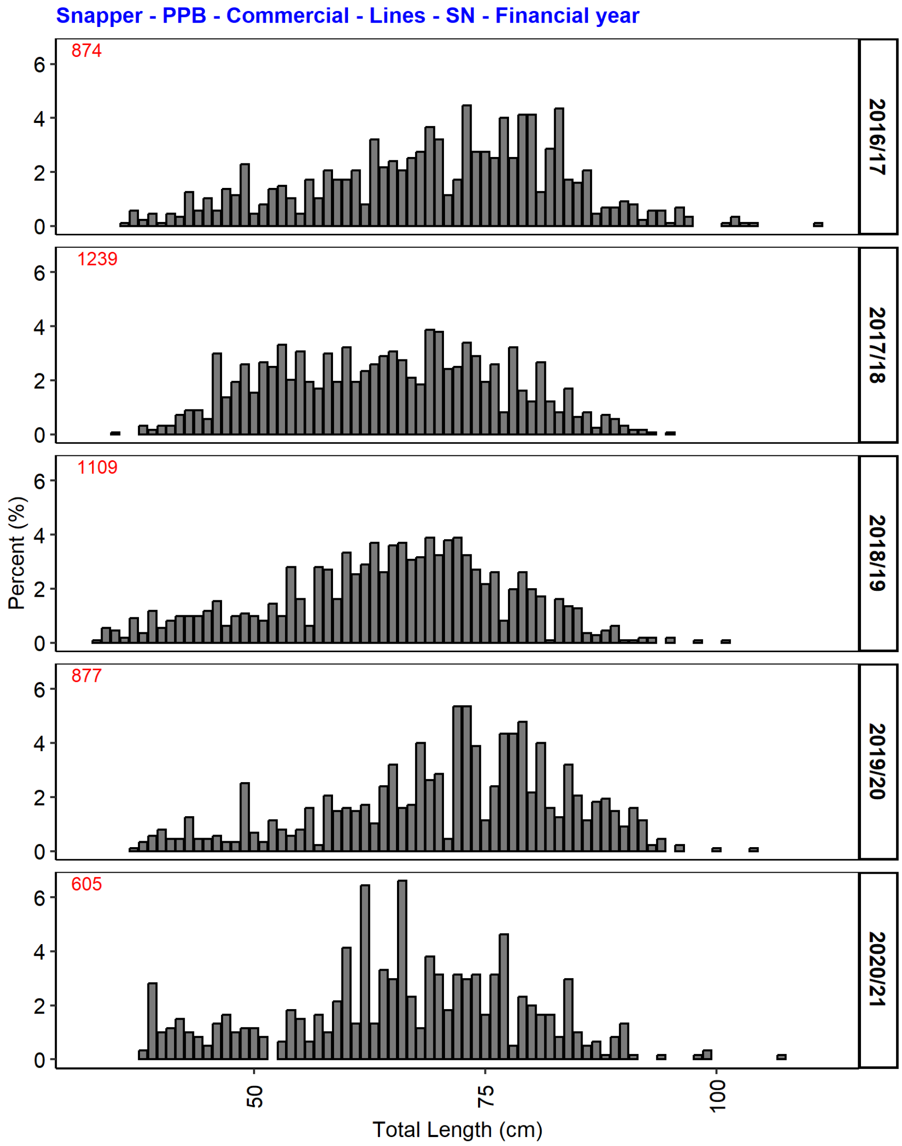


Figure 13 Frequency histograms of Port Phillip Bay line caught commercial snapper length composition (%) for fiscal years 2016/17–20120/21. Red numbers are numbers sampled.

Eastern Victorian snapper stock

There are no suitable proxy measures for stock biomass or pre-recruit abundance of the eastern Victorian snapper stock. Commercial catch is mostly taken by Commonwealth operators and has decreased since a peak in 2011/12 in response to Commonwealth industry-imposed rules to limit snapper harvest (Figure 14). There are no recent data on recreational harvest or any data on effort trends for the eastern Victorian stock. Recreational catch estimates in 2000/01 and 2006/07 indicated catches were in the order of around 30 t/year (Henry and Lyle 2003; Ryan et al. 2009), but anectdotal information suggests that increased fishing pressure on spawning aggregations close to Lakes Entrance is an emerging issue among local stakeholders.

Stock status summary: Recent recognition of the eastern Victorian stock as a stand-alone stock for SAFS reporting and a lack of information to make any confident judgement of status, along with reports of increased fishing pressure on spawning aggregations by local stakeholders, imply that the current status of eastern Victorian snapper stock is uncertain.

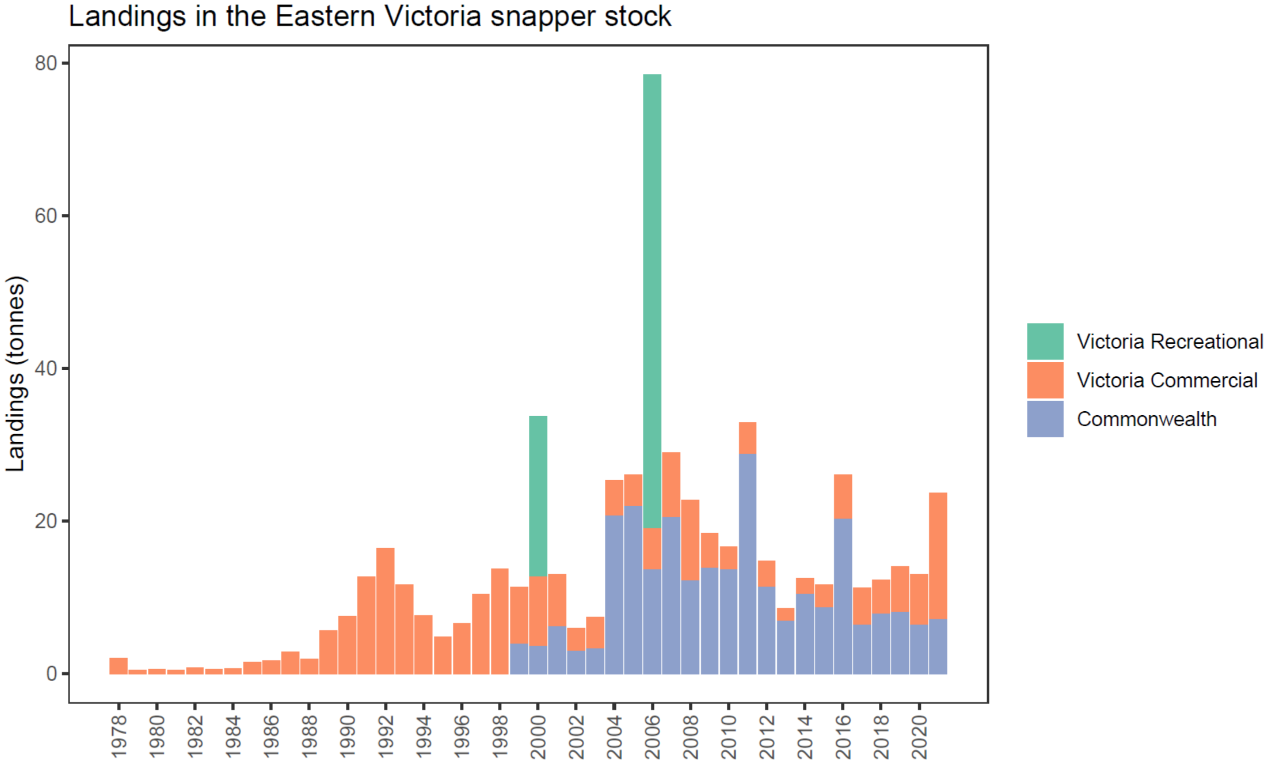


Figure 14 Total catch of snapper from the Eastern Victoria stock. fiscal years 1978–2021.

King George Whiting (*Sillaginodes punctatus*)

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 commercial fishing now restricted to Corner Inlet following the buyout of commercial net fishing in Port Phillip Bay. In Victorian bays and inlets most King George whiting are harvested as immature fish < 5 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 2.5 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 15). 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 in 2021/22 (Figure 16). These commercial fishery observations were consistent with results from the Port Phillip Bay recreational creel surveys that showed CPUE trending strongly upward since 2018–2020 to be well above the reference line (Figure 17). Creel survey CPUE from 2021/22 showed a decline in catch, though it is still well above reference period (Figure 17). Similarly, there was an overall

increasing trend in creel survey CPUE for Western Port (Figure 18). Creel surveys in Corner Inlet have only recently been introduced, with only 5 years of data (Figure 19), however data shows a consistent trend over the past 3 years. 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 23). The Port Phillip Bay survey data are generally indicative of post-larval recruitment to other Victorian bays and inlets. Consistent moderate to high recruitment between 2016 and 2019 has been responsible for the high catch rates observed throughout the Victoria's bay and inlets fisheries. Due to modest recent recruitment, 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 20, Figure 21, and Figure 22) are consistent with the passage of the strong 2013 cohort (Figure 23) through the bay and inlet fisheries with moderate numbers of large fish present in the most recent couple of years due to the moderate to good recruitment from 2016–2019.

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 continuing to be replenished at rates that are sufficient to prevent declines in recruitment potential/egg production. There is no reason to believe this will not continue as fishing mortality is declining as a result of commercial fishery buyouts and the cessation of netting in Port Phillip Bay, the main gear used to targe this species. 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.

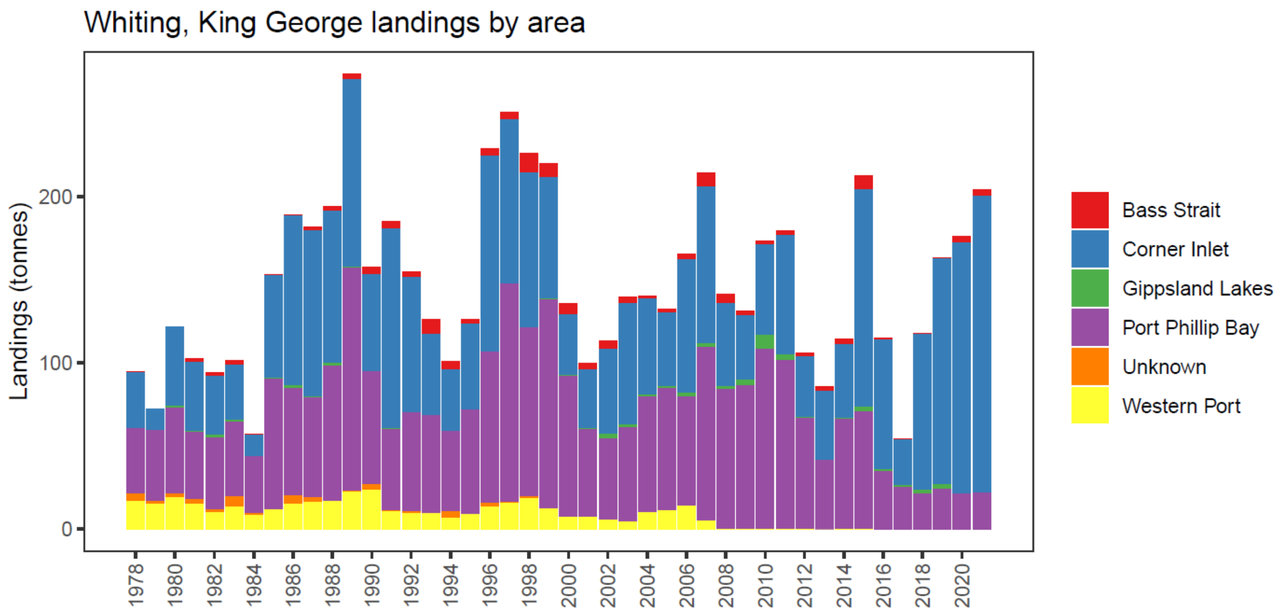
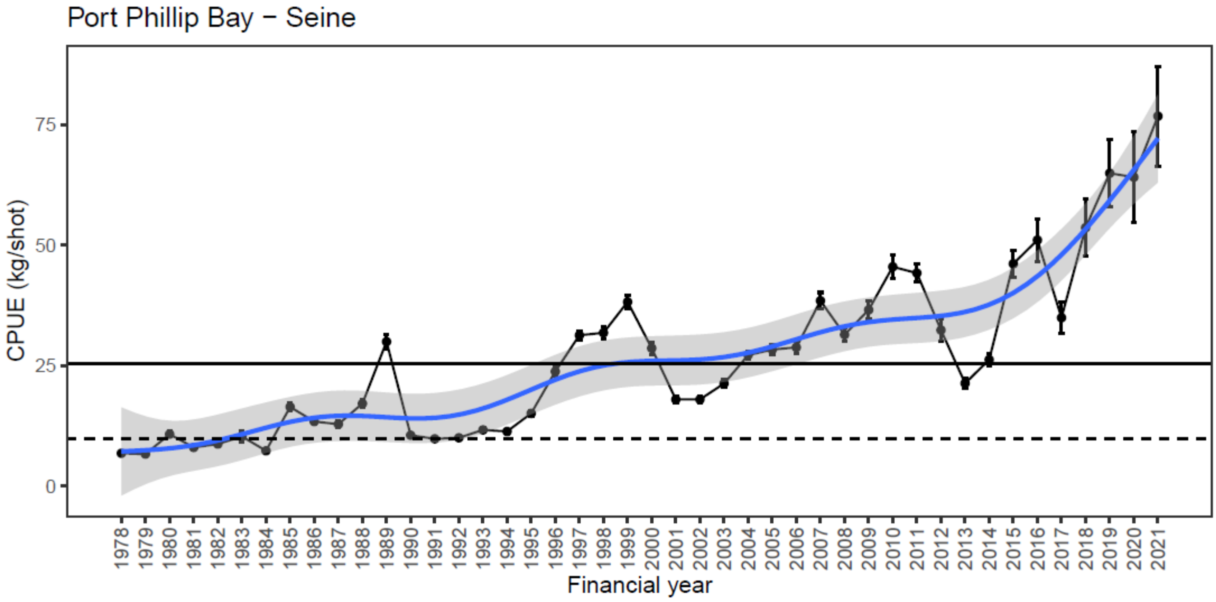


Figure 15 Commercial catch of King George whiting by area in Victorian waters, financial years 1978–2021.

(a)



(b)

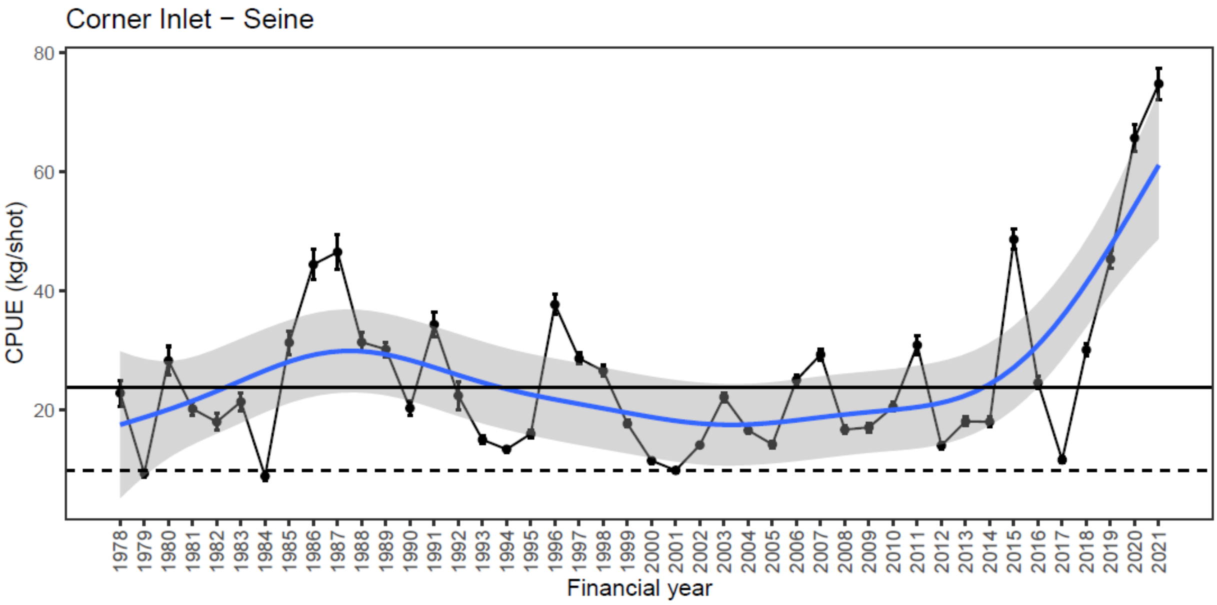


Figure 16 Commercial haul seine catch-per-unit-effort CPUE (nominal) for King George whiting in (a) Port Phillip Bay (PPB) and (b) Corner Inlet (CI), 1977/78–2021/22. Horizontal black line is the mean nominal CPUE during the reference period (1985–2015) and the dashed black line is the minimum CPUE within the reference period. The blue line is a generalised additive model GAM of the CPUE trend with the shaded grey area representing the 95% confidence interval of the GAM.

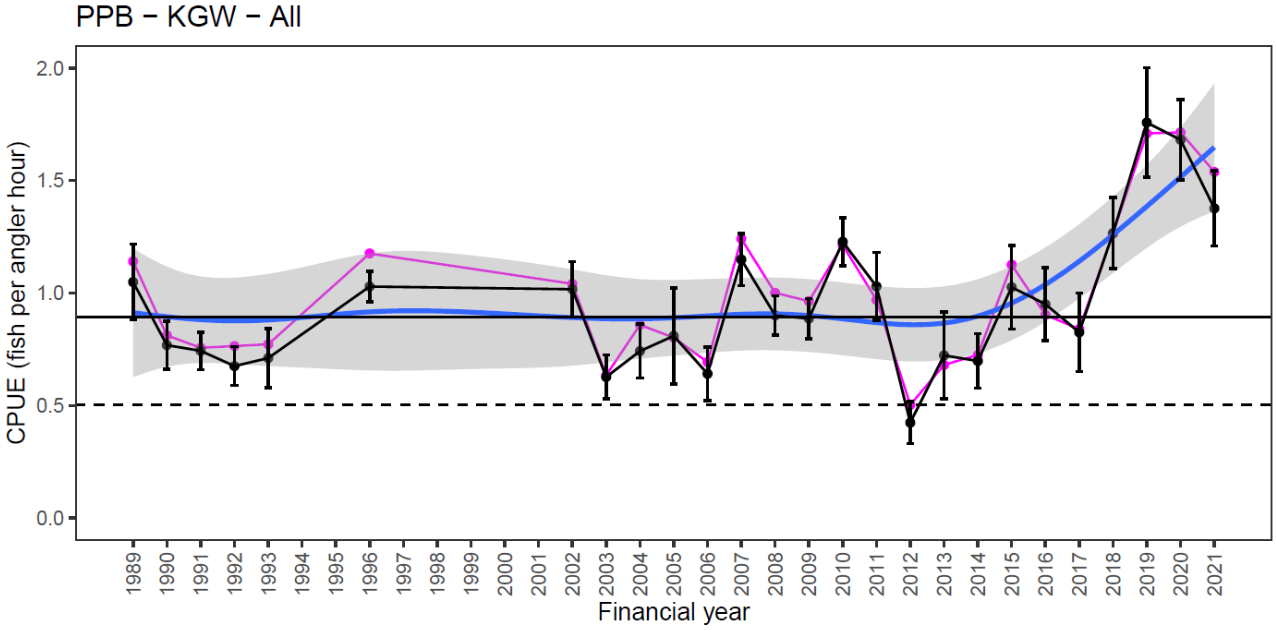


Figure 17 Catch-per-unit-effort (CPUE) of King George whiting (KGW) by recreational anglers interviewed in creel surveys undertaken in Port Phillip Bay (PPB) from 1988/89–2021/22 financial years. Black line is nominal CPUE (±SE), magenta line is standardised CPUE, blue line is a generalised additive 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.

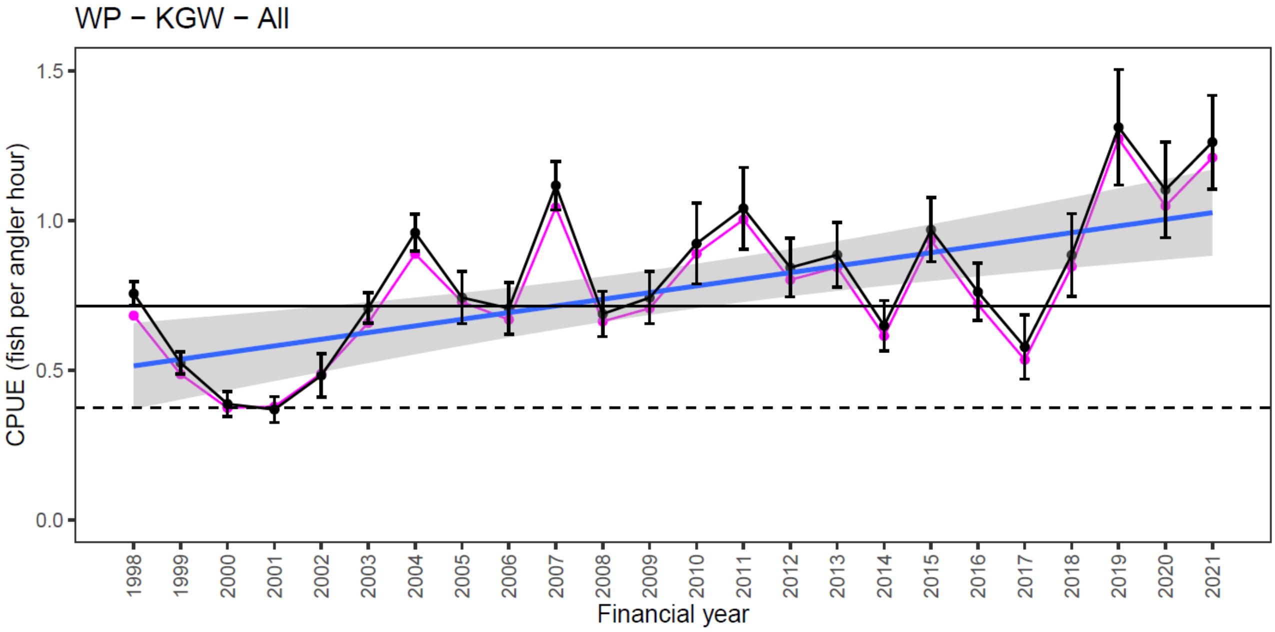


Figure 18 Catch-per-unit-effort (CPUE) of King George whiting (KGW) by recreational anglers interviewed in creel surveys undertaken in Western Port Bay (WP) from 1997/98–2021/22 financial years. Black line is nominal CPUE (±SE), magenta line is standardised CPUE, blue line is a generalised additive model (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.

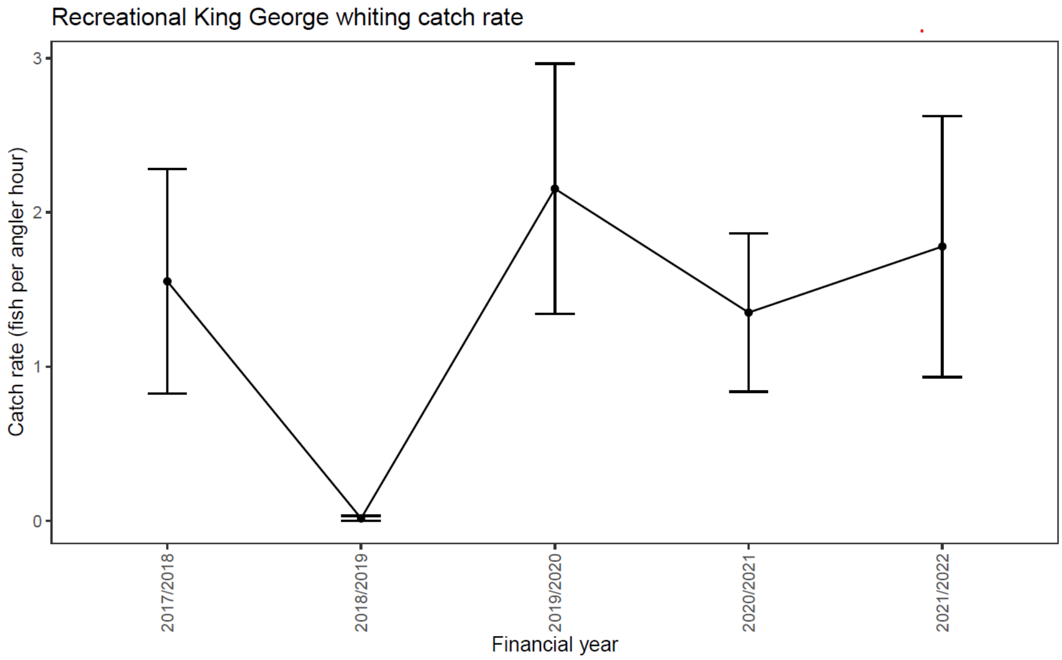


Figure 19 Catch-per-unit-effort (CPUE) of King George whiting (KGW) by recreational anglers interviewed in creel surveys undertaken in Corner Inlet (CI) from 2017/18–2021/22 financial years.

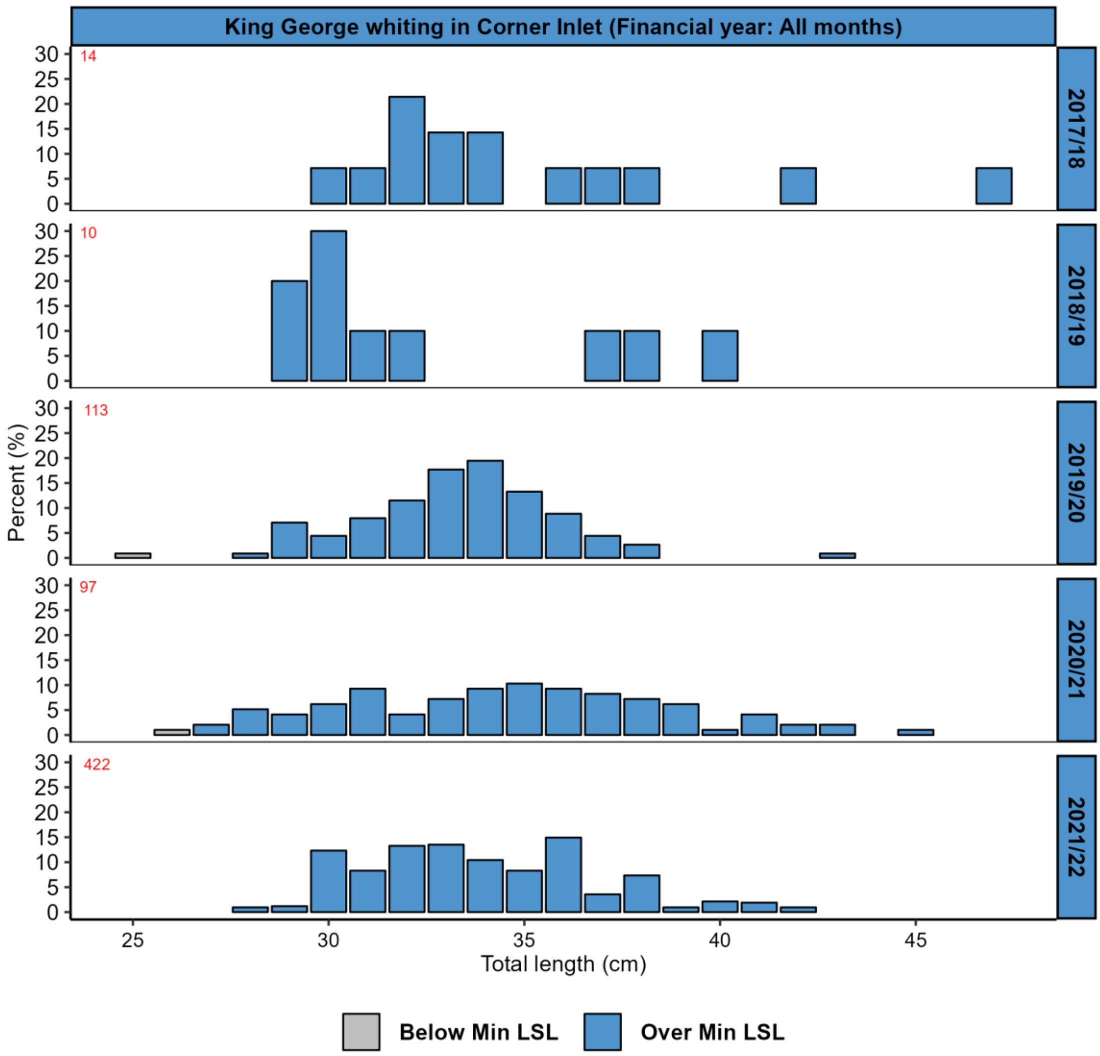


Figure 20 Length frequency histograms for Corner Inlet (CI) King George whiting a) haul seine (H6) catches from 2016/17–2020/21 fiscal years, and b) creel surveys. Red numbers on x-axis indicate numbers of fish measured scaled to sampled catch weights.

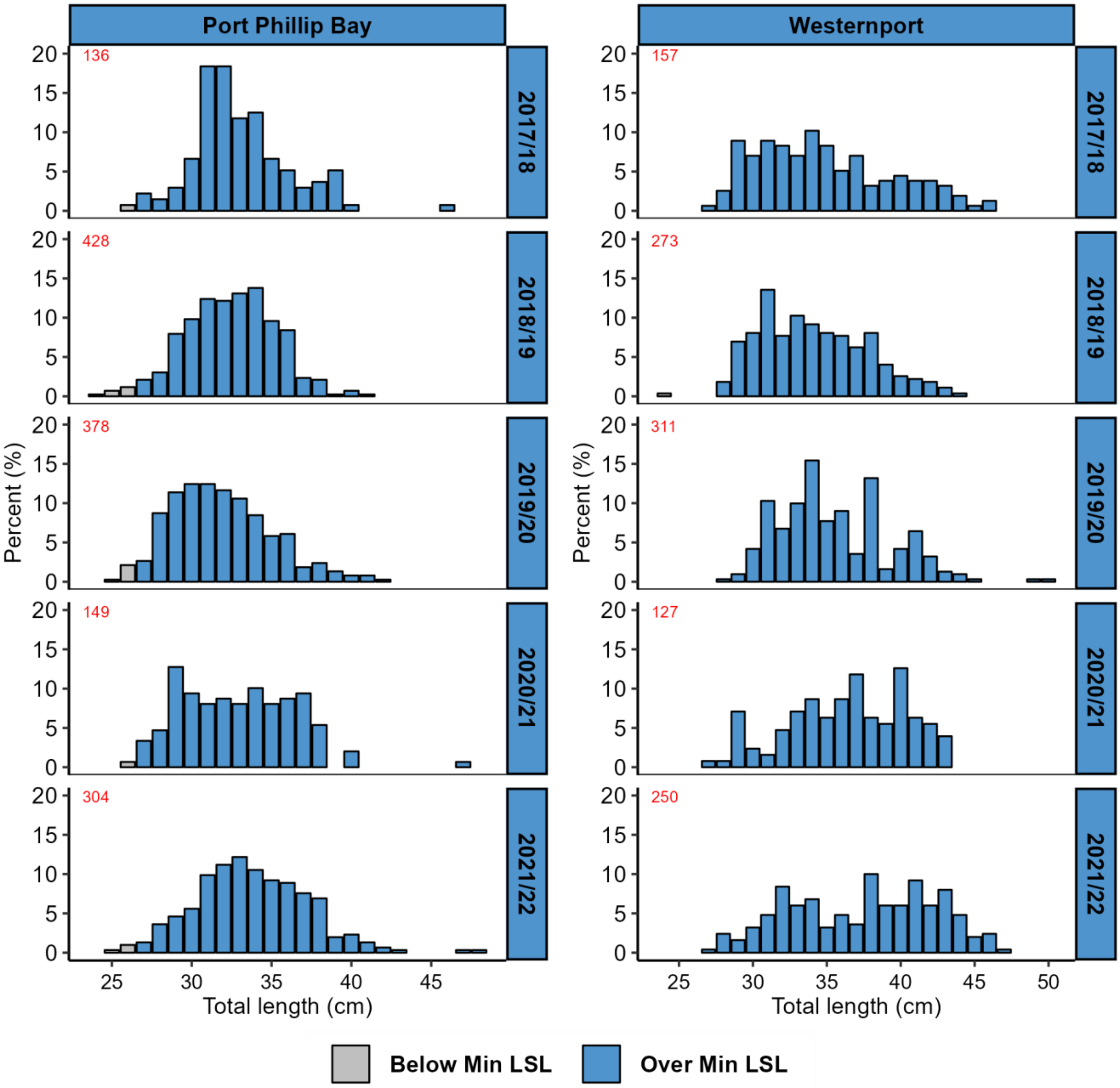
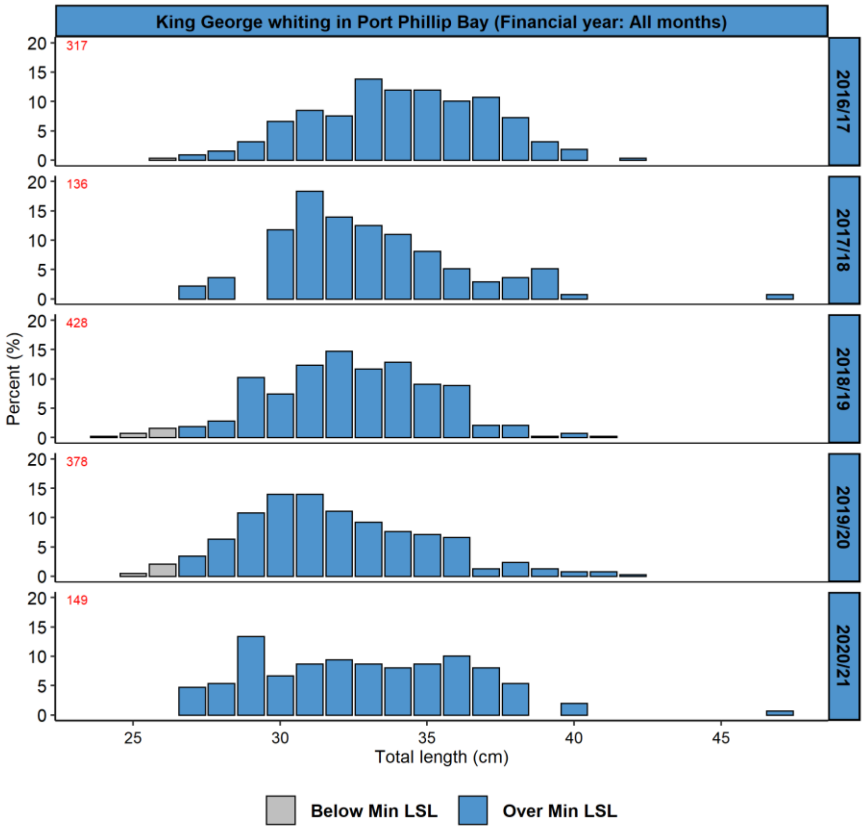


Figure 21 Frequency histograms of recreational King George whiting length composition from Port Phillip Bay and Western Port 2017/18–2021/22. Red numbers indicate numbers of fish measured. Grey bars are those fish equal to or larger that the Legal-Size Limit (LSL) and white bars are sub-legal sized fish less than the LSL.

(a)



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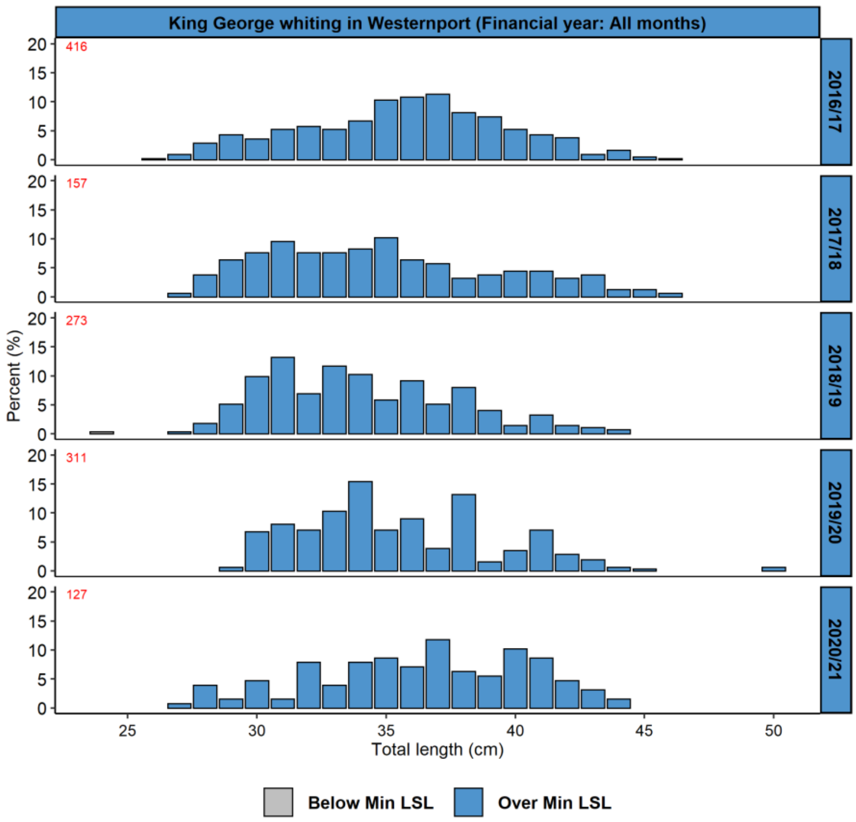


Figure 22 Frequency histograms of recreational King George whiting from creel survey length composition (a) Port Phillip (b) Western Port fiscal years 2016/17–2020/21. Red numbers indicate numbers of fish measured. Grey bars are those fish equal to or larger that the Legal Size Limit (LSL) and white bars are sub-legal sized fish less than the LSL.

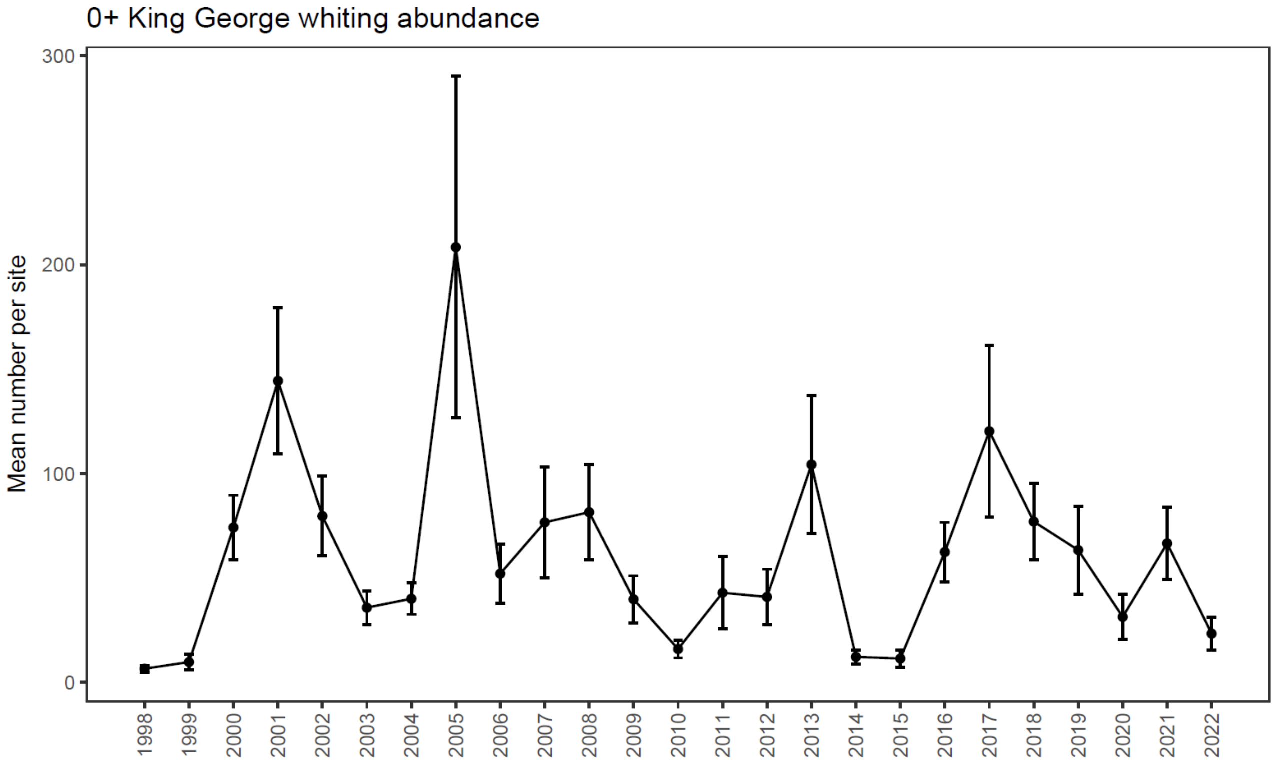


Figure 23 Port Phillip Bay King George whiting pre-recruit (0+ age) trawl survey catch rates (±SE) 1998–2022

Southern Sand Flathead (*Platycephalus bassensis*)

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 (for historic context)
- 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
- Relative abundance from fishery independent trawl surveys in Port Phillip Bay
- 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 five years (Figure 24). Catches in Bass Strait have been increasing in recent years but remain around, or below, 5 t. 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 25 and Figure 26).
- *Biomass* – Standardised CPUE from the creel surveys has remained relatively low (compared to historical levels) since the mid-2000s and n PPB was approximately midway between the reference period minimum (i.e. 2013/14) and reference period average in 2018/19 (Figure 27). In WPB values were mostly below the limit

reference point, with an anomalously high value at the target reference point in 2020 only, but had greater overall variability (Figure 28). Angler diarist CPUE for PPB showed relatively higher values during the past 5– 6 years among both under and legal sized fish, although values for the latter have decreased somewhat recently (Figure 29). The creel CPUE data indicates that the availability of legal sized sand flathead has stabilised since 2008 and shown signs of an increase from the lowest point in 2013 until 2020/21 (Figure 27). However, the 2021/22 financial year shows a drop to the lowest level on record, to below that of the minimum reference period. Creel surveys in Corner Inlet have only recently been introduced and therefore has limited data, nevertheless CPUE has been steadily declining over the last four years, but is must be noted sand flathead are a byproduct in this fishery (Figure 30). Consistent with creel CPUE, diary angler targeted CPUE showed a decline from the mid-2000s to the late 2000s, but since 2011 its positive 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 sand flathead below the LML since 2011 (Figure 31) that do not contribute to the creel survey catch rates. Long-line CPUE (Figure 32) 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 33). The ongoing small beam trawl CPUE indicates a drop in legal sized biomass from 2004 to 2006 similar to that in long-line and trawl biomass, and shows a stable, or slightly increasing, trend since 2012 consistent with the diary angler data (Figure 27). This fishery independent survey suggest sub-legal size classes are all increasing in abundance. 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. Preliminary observations suggest that sand flathead in Port Phillip Bay are now maturing at smaller sizes (J. Bell Personal observation), which may explain why few individuals appear to be reaching the LML and fishery dependent CPUE indices are not detecting an increase in the abundance of legal sized fish.

- *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 34) (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 stabilised 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. Elevated recruitment 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.

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, and in particular increases in sub-legal size classes, however, due to lack of recent strong recruitment events, any ongoing recovery in stock biomass is expected to remain slow.

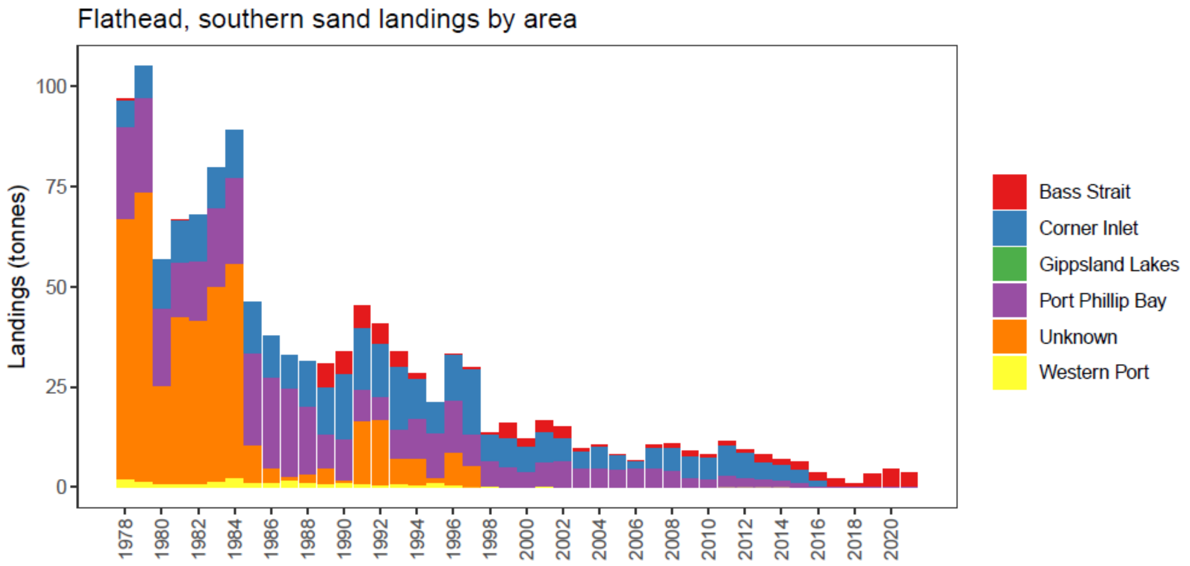
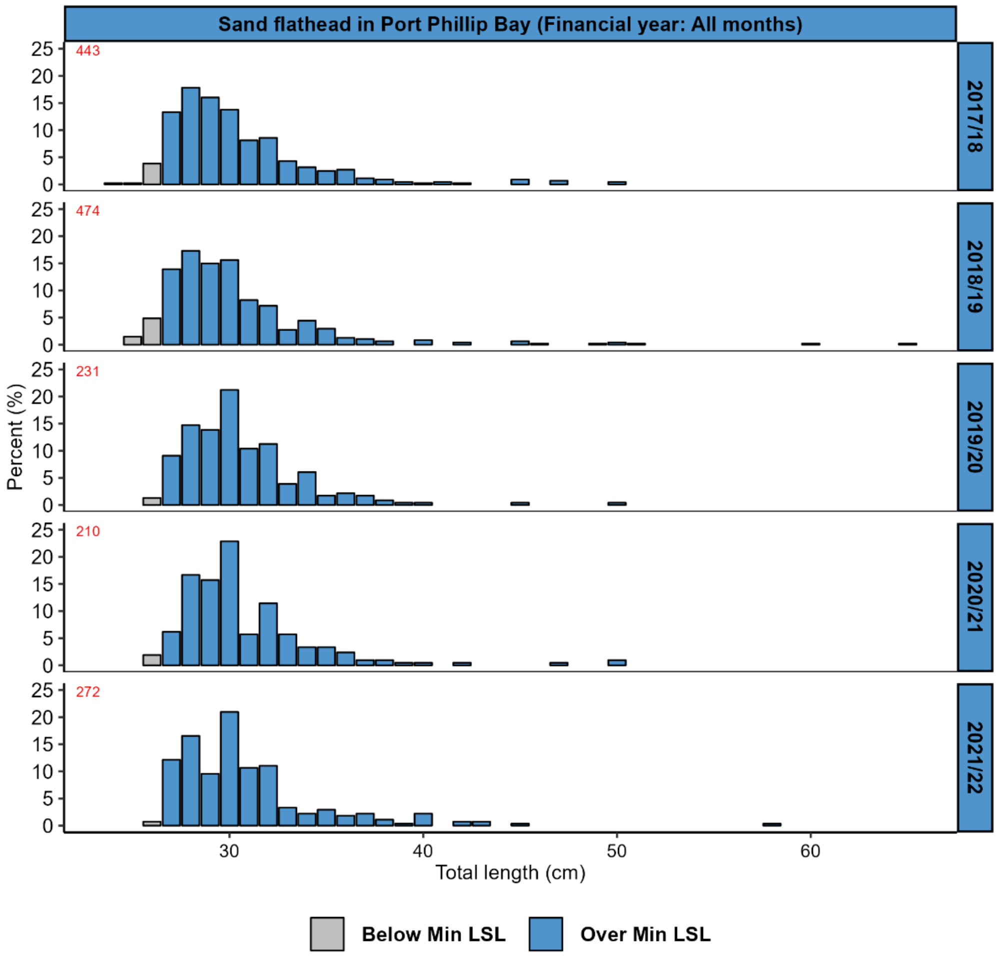


Figure 24 Victorian southern sand flathead commercial catches, financial year 1978–2021. Note: most of the catch classified as “unknown” is from Danish seine or trawl fishing in Bass Strait waters prior to the Danish seine/trawl fishery coming under Commonwealth management in 1998. Recent Commonwealth harvests are not included.

(a)



(b)

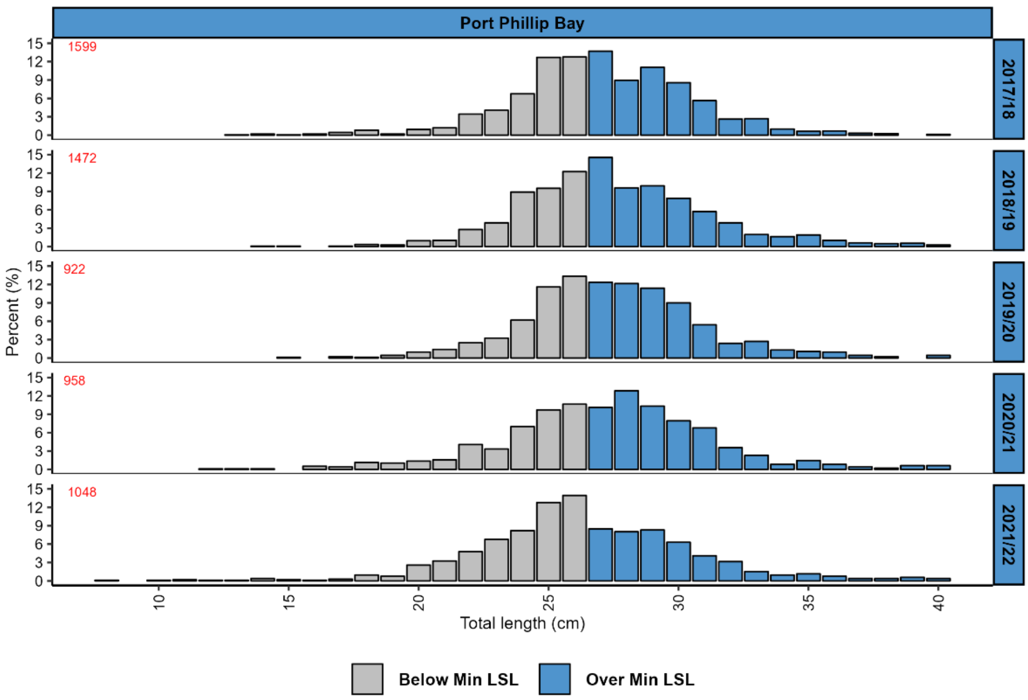


Figure 25 Frequency histograms of Port Phillip Bay recreational sand flathead length composition (a) creel surveys, (b) angler diary, fiscal years 2017/18–2021/22. Red numbers indicate numbers of fish measured. LSL = legal size limit.

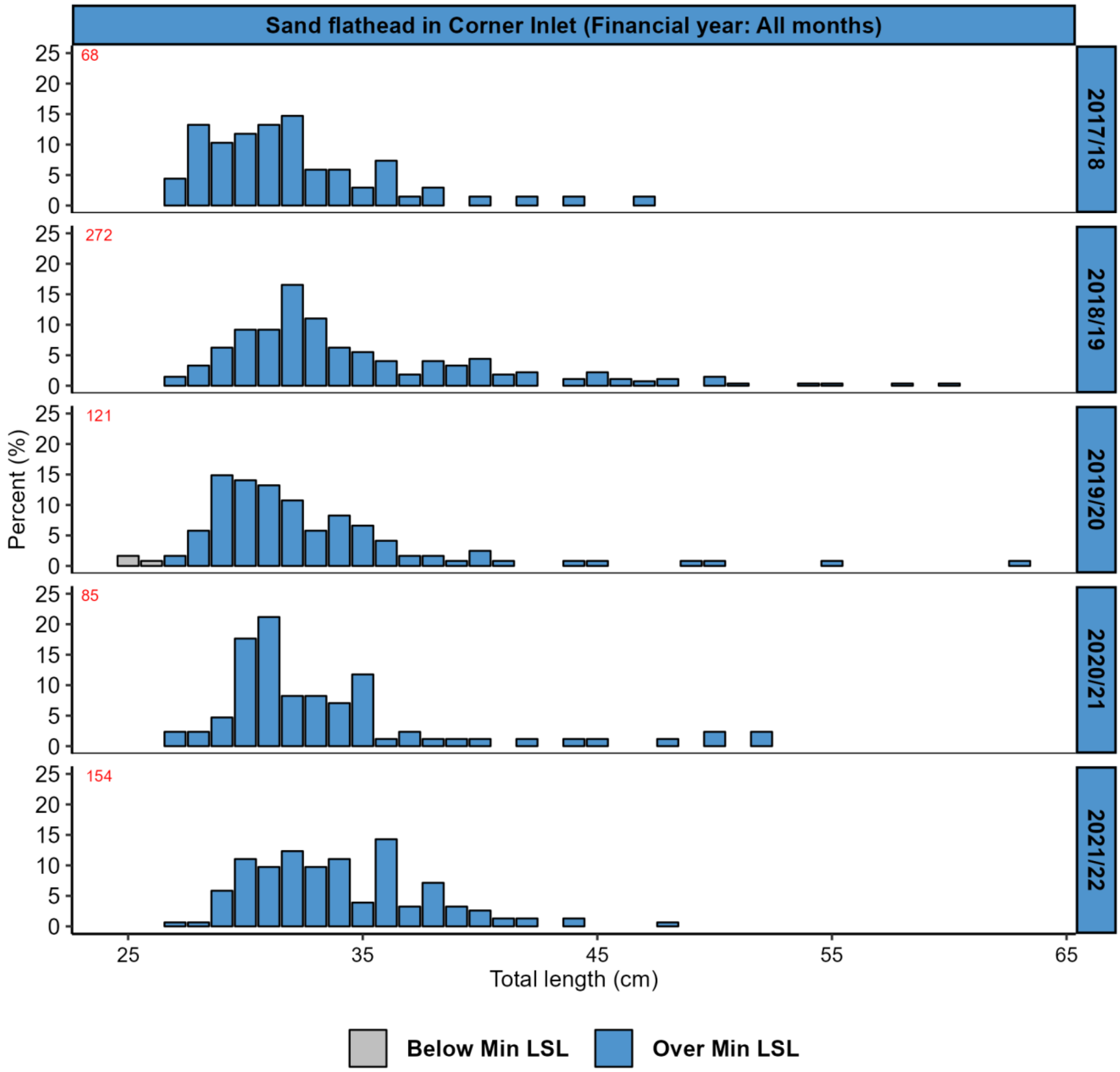


Figure 26 Frequency histogram of Corner Inlet recreational sand flathead length composition from creel surveys, fiscal years 2017/18–2021/22. Red numbers indicate numbers of fish measured. LSL = legal size limit.

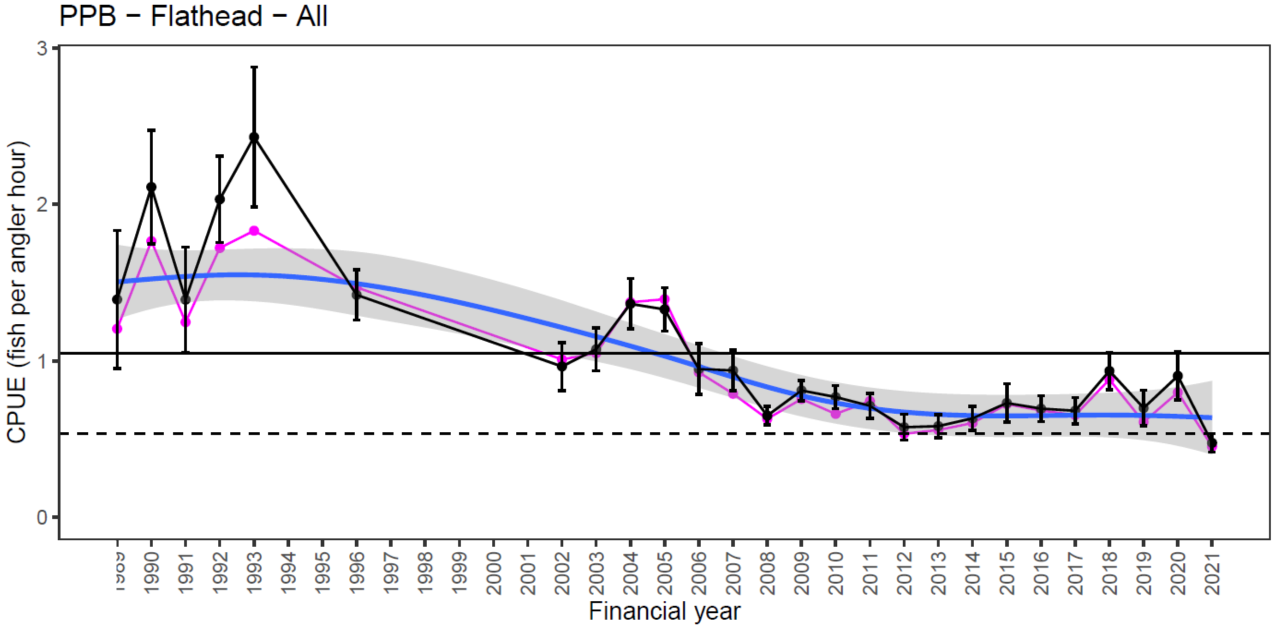


Figure 27 Catch-per-unit-effort (CPUE) of southern sand flathead by recreational anglers interviewed in creel surveys undertaken in Port Phillip Bay (PPB) during 1988/89–2021/22 financial years. Black line is nominal CPUE (±SE), magenta line is standardised CPUE, blue line is a generalised additive model (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.

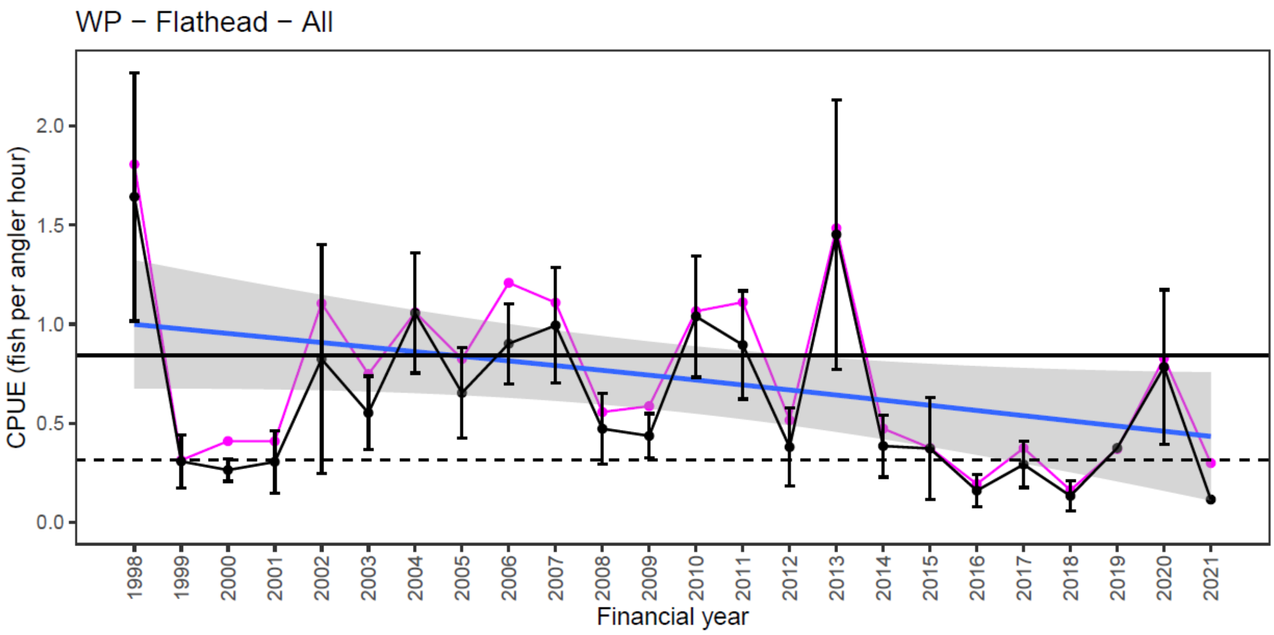


Figure 28 Catch-per-unit-effort (CPUE) of southern sand flathead by recreational anglers interviewed in creel surveys undertaken in Western Port Bay (WPB) during 1998/99–2021/22 financial years. Black line is nominal CPUE (±SE), magenta line is standardised CPUE, blue line is a generalised additive model (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.

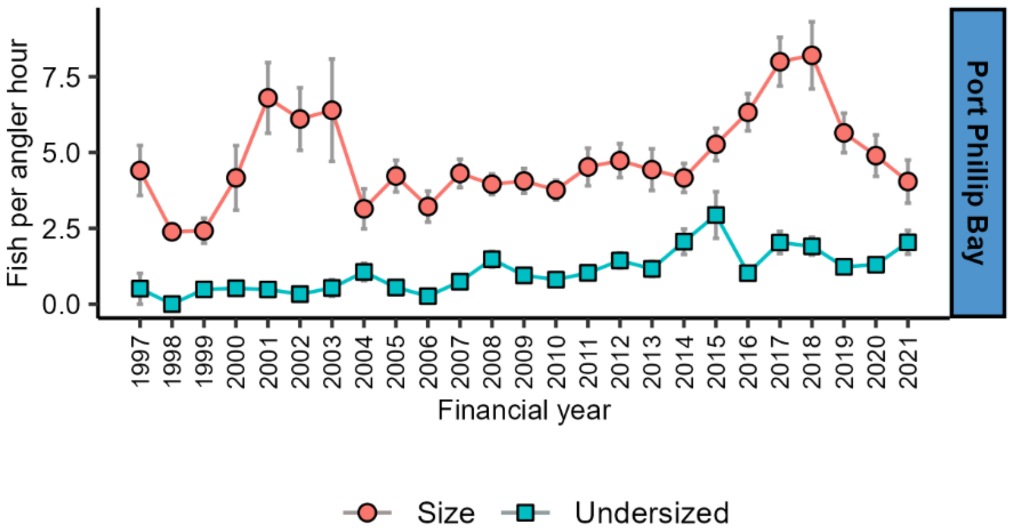


Figure 29 Catch-per-unit-effort (CPUE) of under- and over-legal minimum length southern sand flathead by recreational angler diarists in Port Phillip Bay (PPB) during 1997/98–2021/22 financial years.

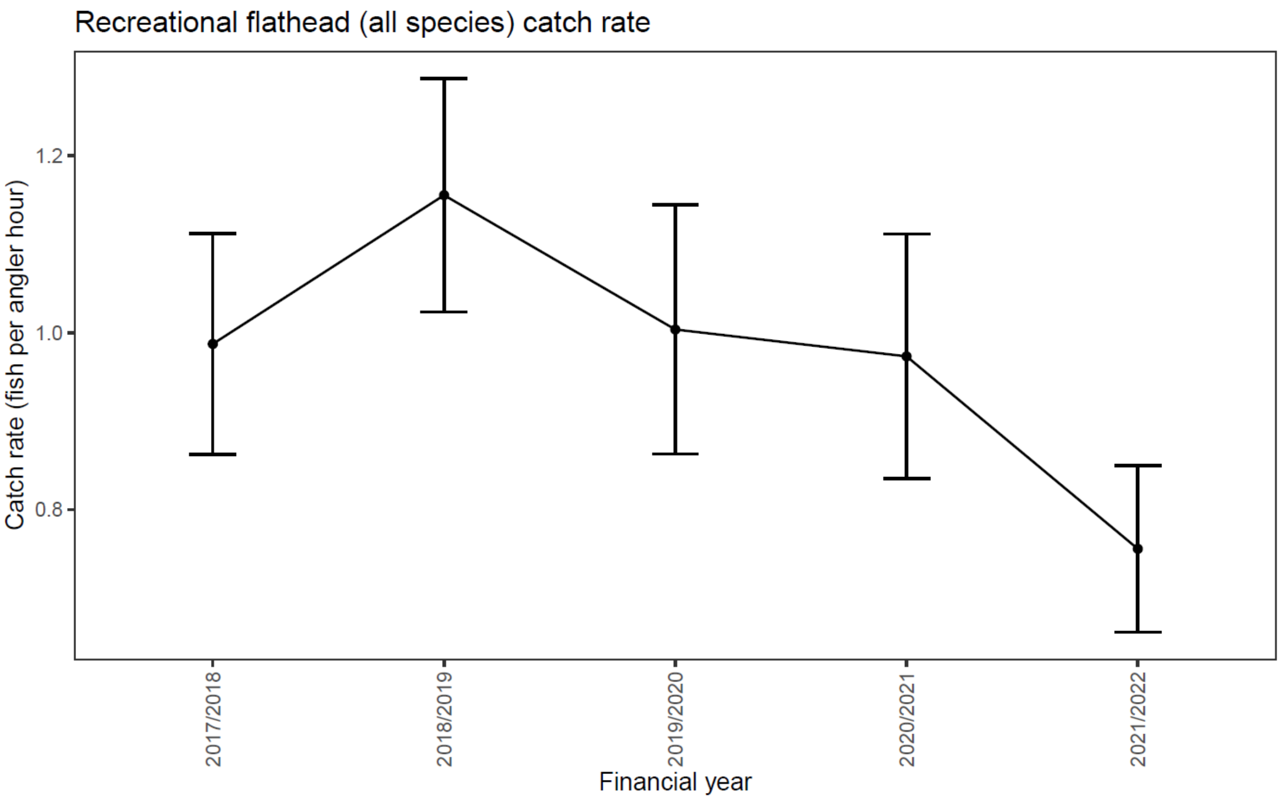


Figure 30 Catch-per-unit-effort (CPUE) of all flathead species by recreational anglers interviewed in creel surveys undertaken in Corner Inlet (CI) during 2017/18-2021/22 financial years.

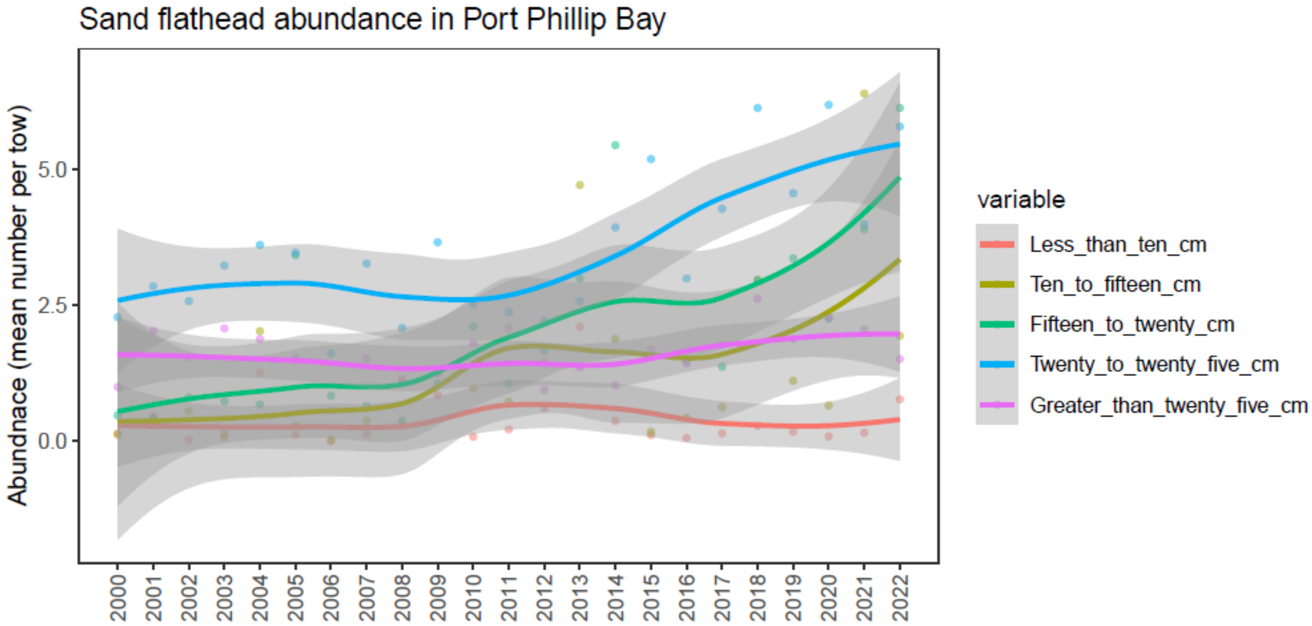


Figure 31 Abundance of sand flathead by size category from research net tows in Port Phillip Bay during 2000–2022. Trendlines are fitted using a GAM.

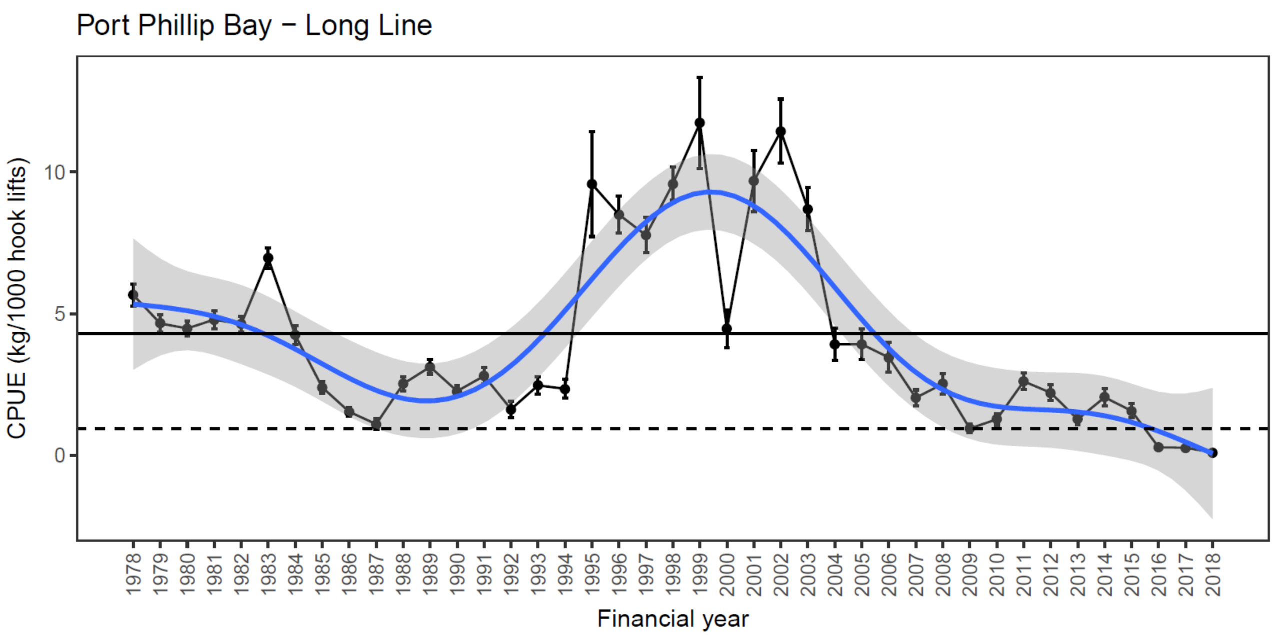


Figure 32 Nominal catch-per-unit-effort (CPUE) (±SE) (black line) for sand flathead by commercial long-line in Port Phillip Bay (PPB) during 1978–2018. Blue line is a generalised additive model (GAM) of the CPUE trend with the shaded grey area representing the 95% confidence interval of the GAM. Horizontal 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.

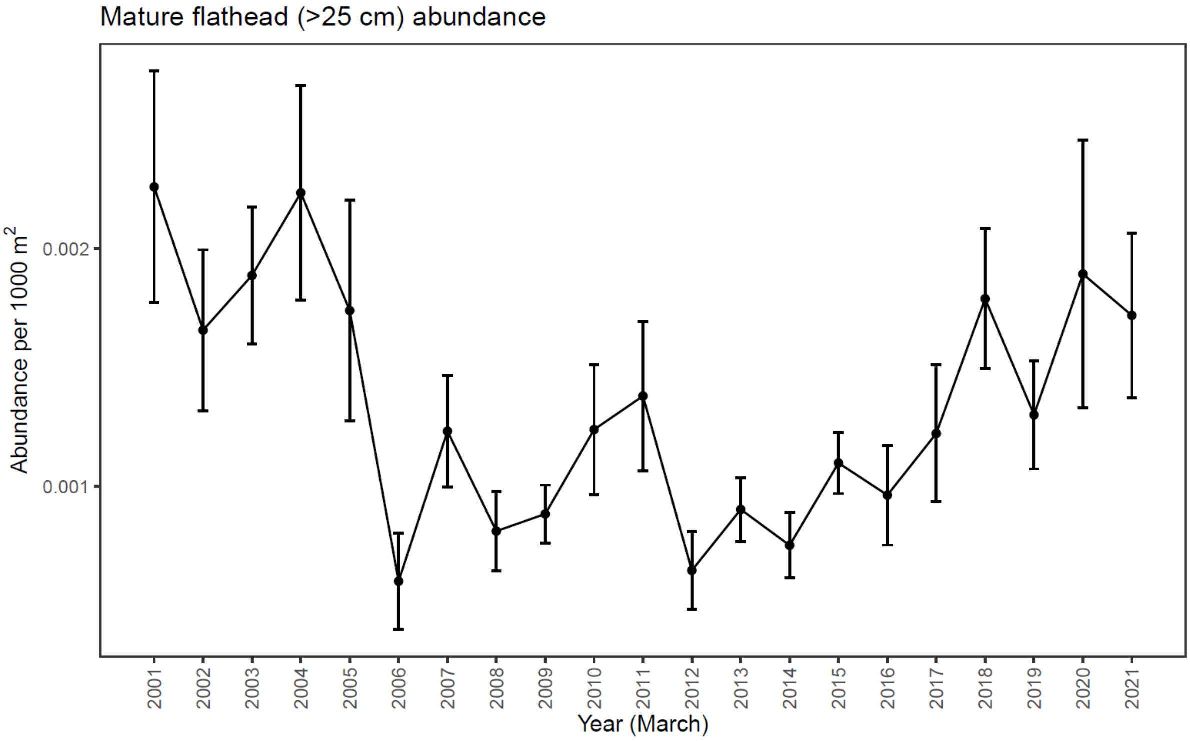


Figure 33 Port Phillip Bay mature (> 25cm) sand flathead abundance (mean ± SE) from 2001 – 2021.

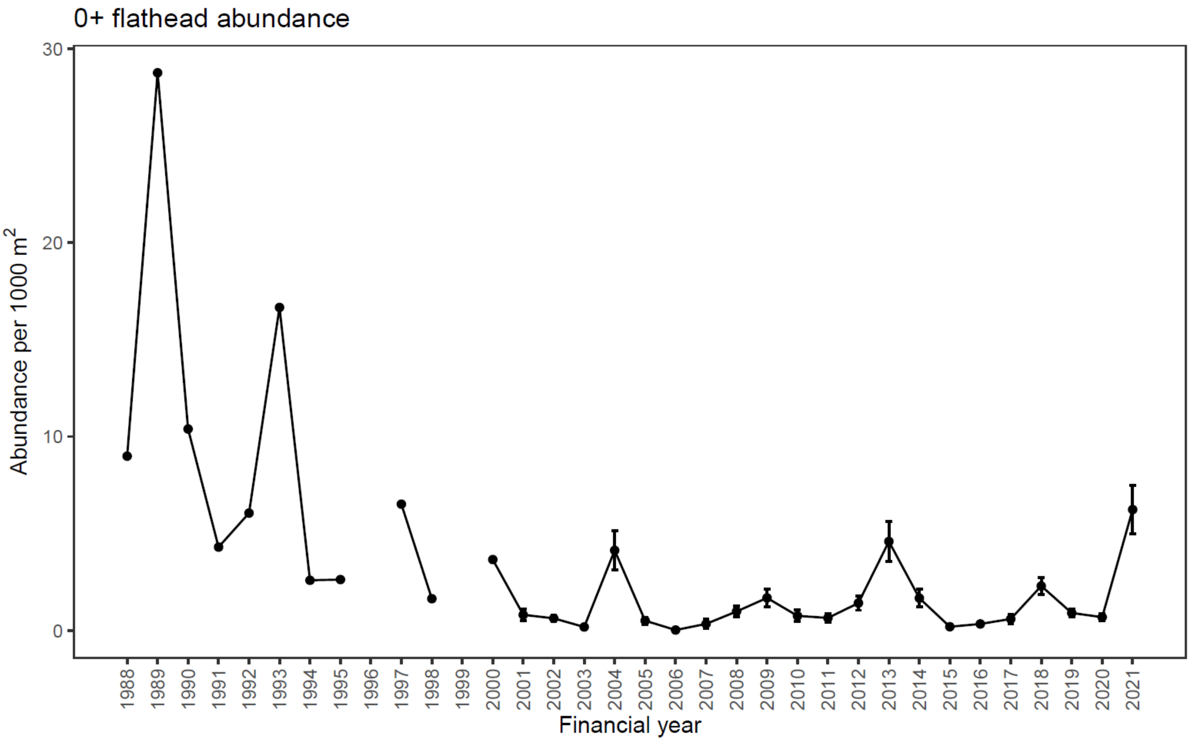


Figure 34 Port Phillip Bay sand flathead pre-recruit (0+ age) beam trawl survey catch rates (±SE) 1988–2021. Note: SE can only be calculated from 2000 onwards, data prior is based on extrapolation of beam trawl to earlier otter trawl data using a regression relationship from 11 years when the otter trawl 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 discrete self-replenishing stocks, with limited mixing among adjacent estuaries.

This species lives for at least 29 years and typically grows to more than 60 cm TL. Size at 50% maturity occurs 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 occurs in estuaries during October to February, often associated with a salt-wedge.

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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 the recreational fishery estimated from annual creel surveys (1979–2022, reference period 1979-–2015)
- CPUE (nominal) for diary angler catches
- Length composition of diary angler catches
- Length composition of recreational fishery creel survey catches
- Pre-recruit (post-larval) abundance from fishery independent netting surveys (2010–2022).

Management measures have been implemented through the Gippsland Lakes Recovery Plan including the buy-out of all commercial netting licences by April 2020 and the recent introduction of a black bream slot limit of 28–38 cm. The minimum size limit of 28 cm remained unchanged and was enhanced by a new maximum size limit of 38cm to provide added protection for larger bream. Large black bream are more prolific breeders, producing more eggs and thereby contributing more stock to future generations. The modified slot limit is evidence-based and underpinned by science with modelling indicating that 12 per cent more breeding biomass will remain in the population with the slot limit in place. The removal of the commercial fishery has resulted in CPUE (standardised and nominal) for commercial mesh net no longer being suitable as a primary performance measure for black bream stock status in the Gippsland Lakes.

This assessment found:

- *Fishing pressure* – Commercial harvests have dropped considerably since the 1980s (Figure 35), and more recently have declined substantially in response to declining netting effort due to commercial licence reductions since 2010 up until the fishery ceased in March 2020 (Appendix 2). The estimated fishing mortality rate experienced by the stock from 2015–2019 was in the order of 0.2 (95% CLs = 0.1–0.3) which is not overly high within the bounds of a species with the life history characteristics of Black Bream (Kailola et al. 1993). There is no recent information on recreational harvest or effort.
- *Biomass* – 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 above the reference period lowest point from 2016–2018 (Figure 36). 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

(Figure 37). Since 2018, recreational CPUE has increased, but remains well below historic levels. In 2022 was just below the reference period average. Diary angler targeted CPUE, which includes catches of fish above and below the LML, shows peaks in 2006 and 2012–2013, similar to the timing of peaks in the mesh net and creel survey CPUE (Figure 38). Diary angler CPUE declined from 2013 to 2016, similar to mesh net and creel survey CPUE, however has increased in the most recent year to be well above the reference period average in 2022.

- *Recruitment* – Recruitment of 0+ age black bream has been relatively stronger (c.f. 2010–2016) from 2017 to 2020, lower in 2021, and the highest since the monitoring period started in 2022 (Figure 39). These cohorts will grow to legal size over the next 5-6 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.
- *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 2022 (Figure 40). 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 40).

Stock status summary: Overall, the above evidence indicates that the biomass of this stock is unlikely to be depleted or recruitment impaired. Furthermore, the above evidence indicates that the current level of fishing mortality attributable to the fishery has reduced commensurate with cessation of the commercial fishery and introduction of further recreational size limit restrictions. Due to the creel survey CPUE increasing from the lowest point recorded in 2004 to just below the reference point average in recent years; the increase in angler diary CPUE over the last 5 years to 2022 to be well above the reference period average; in 2022 and the relatively stronger recruitment of 0+ age black bream from 2017–2022 (c.f. 2010–2016) the Gippsland Lakes Black Bream stock has been assessed as recovering.

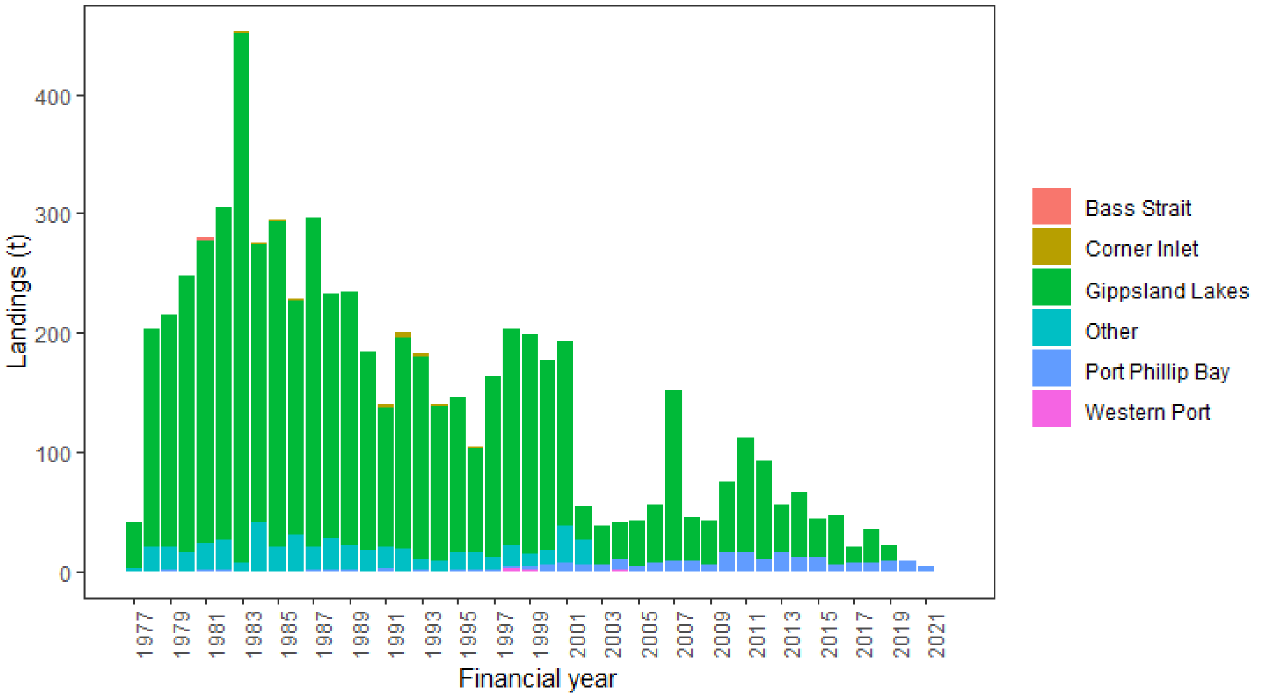


Figure 35 Commercial harvests of black bream from Victorian waters by area during fiscal years 1978—2021.

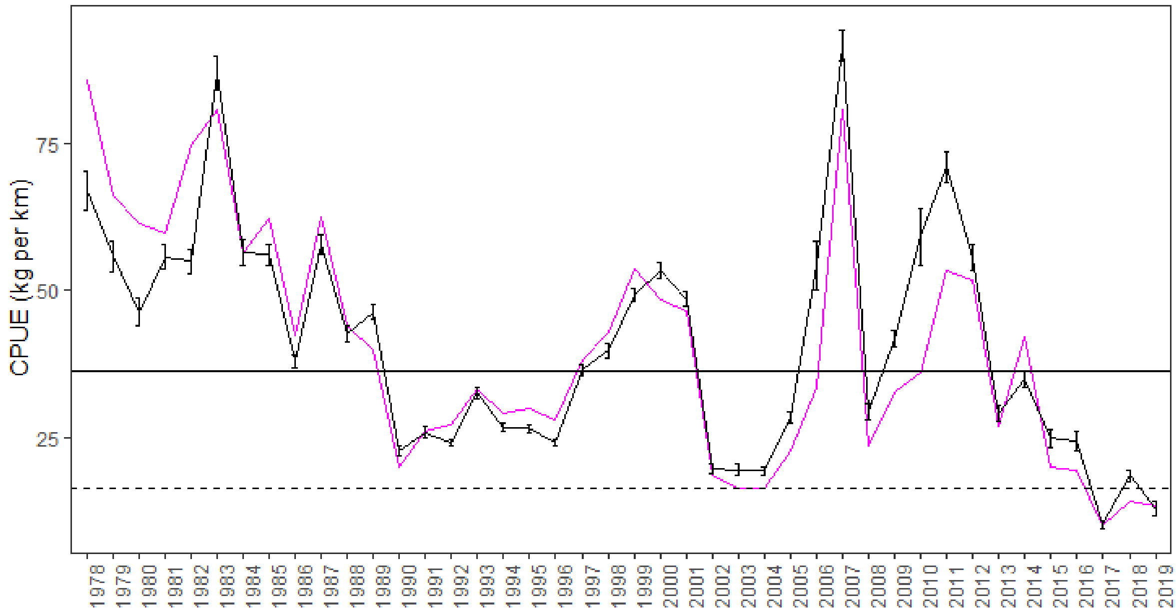


Figure 36 Catch-per-unit-effort **(**CPUE) of black bream by commercial mesh net fishers in the Gippsland Lakes during 1978 – 2019 financial years. Black line is nominal CPUE (±SE), magenta line is standardised CPUE, blue line is a generalised additive model (GAM) of the standardised CPUE trend with 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.

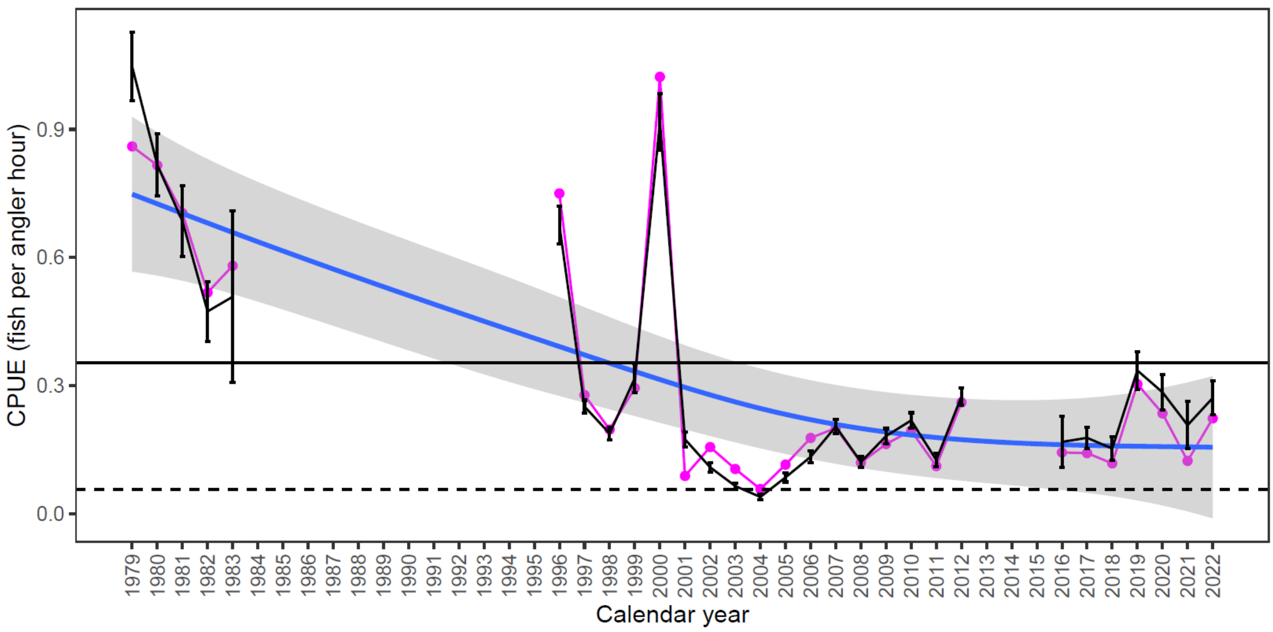


Figure 37 Catch-per-unit-effort (CPUE) of black bream by recreational anglers interviewed in creel surveys undertaken in the Gippsland Lakes during 1979–2022. Black line is nominal CPUE (±SE), magenta line is standardised CPUE, blue line is a generalised additive model (GAM) of the standardised CPUE 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.

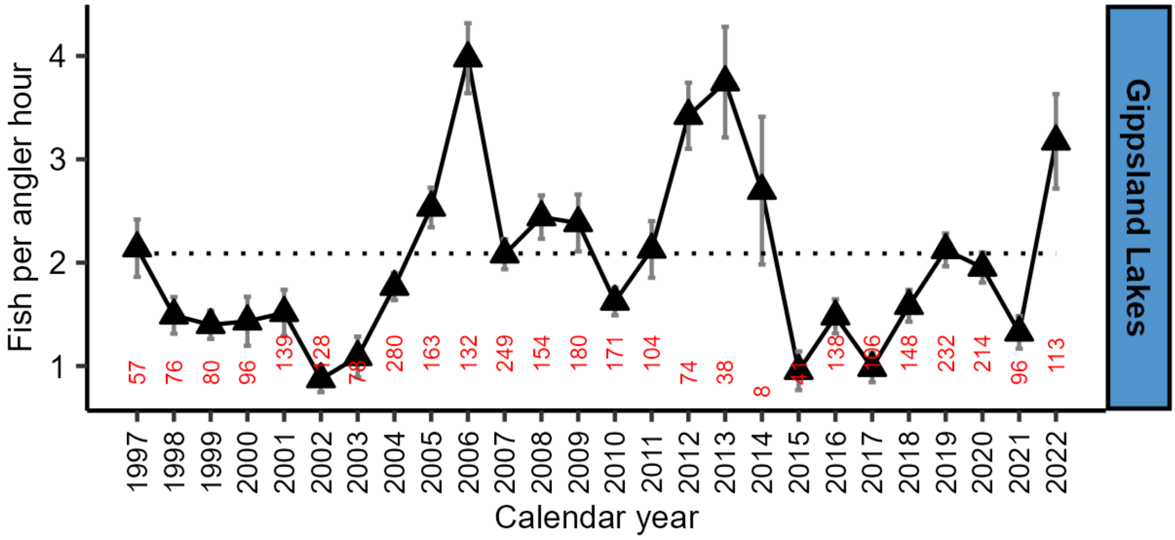


Figure 38 Diary angler mean nominal (±SE) catch-per-unit-effort (CPUE) of black bream from the Gippsland Lakes, 1997-2022 calendar years. Horizontal black line is the mean CPUE during the reference period (1997 - 2015) and the dashed black line is the minimum CPUE within the reference period. Red numbers along x-axis are numbers of diary angler trips.

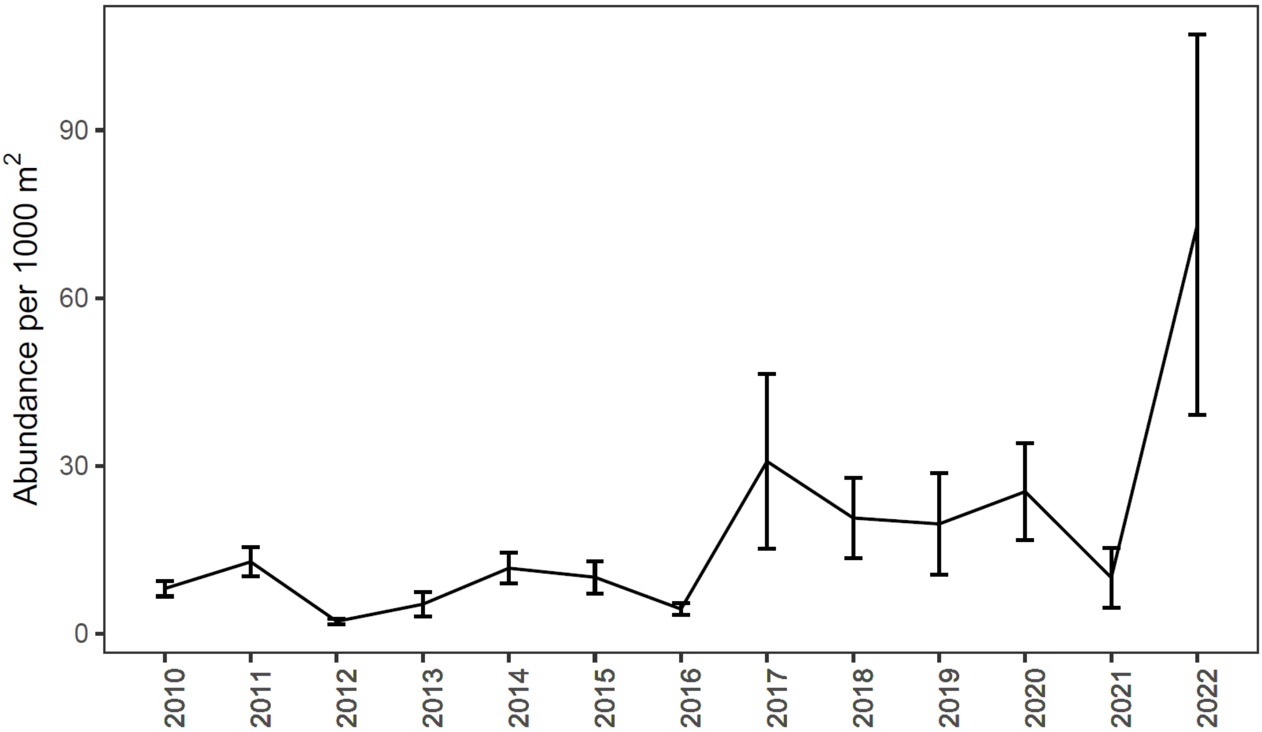
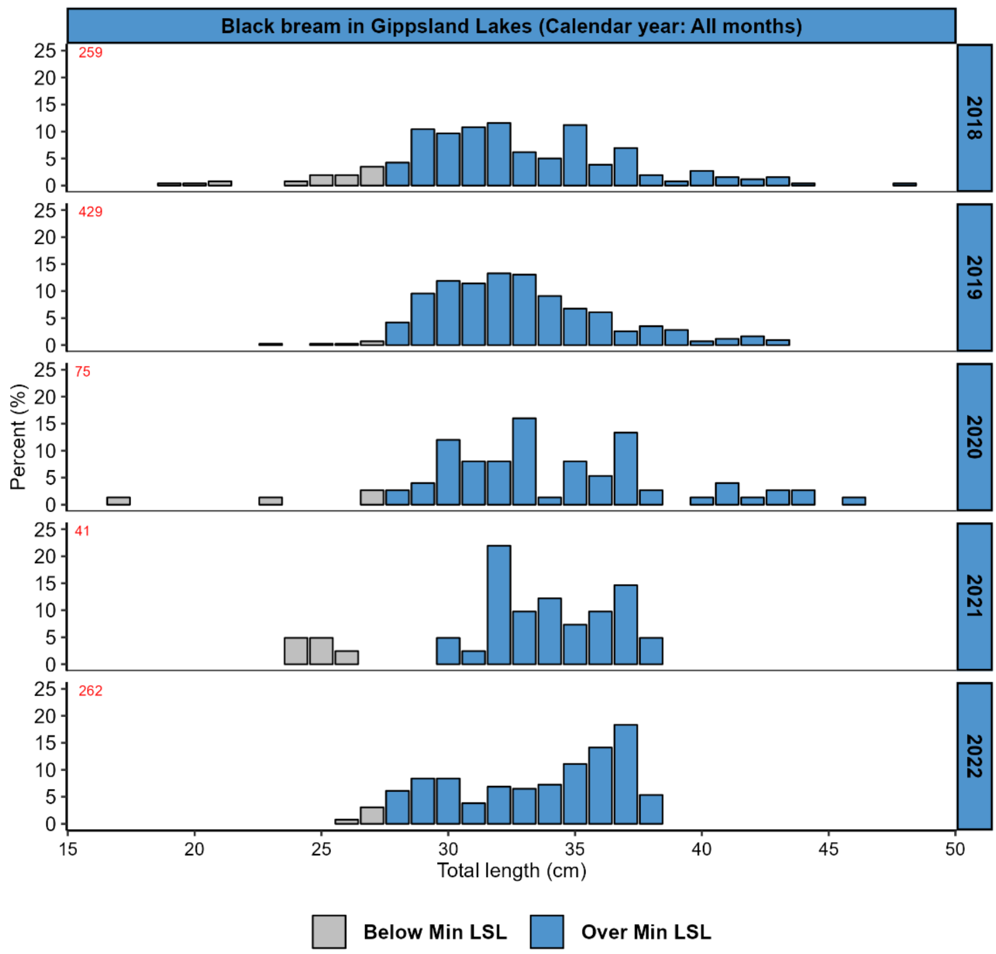


Figure 39 Pre-recruit survey abundance of 0+ black bream in the Gippsland Lakes (mean ±SE) during 2010–2022. Pre-recruit surveys comprise ~50 demersal trawl shots throughout the rivers and lakes of the system.

(a)



(b)

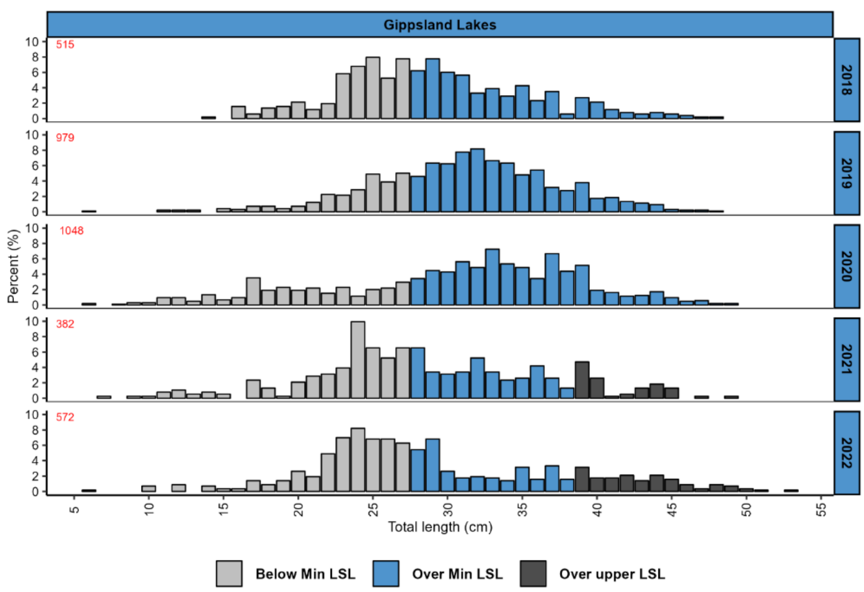


Figure 40 (a) Frequency histograms of Gippsland Lakes black bream length composition for recreational creel survey for calendar years 1997–2021, red numbers on x-axis indicate numbers of fish measured, blue line median length, red line is the legal minimum length (LML). (b) Frequency histograms of Gippsland Lakes black bream length composition from diary anglers for calendar years 2018–2022. Red numbers indicate numbers of fish measured.

Western Victorian Estuaries

Glenelg River
This review found:

- *Biomass* – Diary angler targeted CPUE was well below the reference period average in 2022 (Figure 47). For the last five years CPUE has had a stable trend at about or just below the reference period average with the exception 2022.
- *Fishing pressure* – There is no direct information on the amount of fishing pressure on the black bream population in the Glenelg River. Size composition data shows that larger fish (>35 cm) are consistently recorded in the catches in recent years suggesting fishing mortality is likely to be relatively low. A lower number of sampling trips has been recorded in recent years due to less diary anglers and CPUE and length frequency data is become unreliable.

Hopkins River
This review found:

- A lower number of sampling trips has been recorded in recent years due to less diary anglers and CPUE (and length) frequency data has become unreliable.

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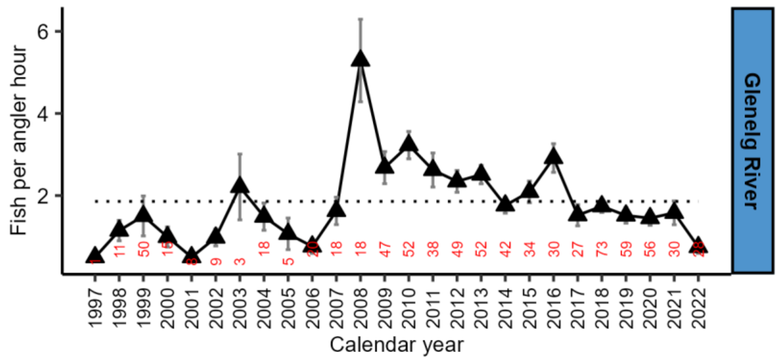


Figure 41 Diary angler mean nominal (±SE) catch-per-unit-effort (CPUE) of black bream from the Glenelg River, 1997-2022 calendar years. Horizontal black line is the mean CPUE during the reference period (1997 - 2015) and the dashed black line is the minimum CPUE within the reference period. Red numbers along x-axis are numbers of diary angler trips.

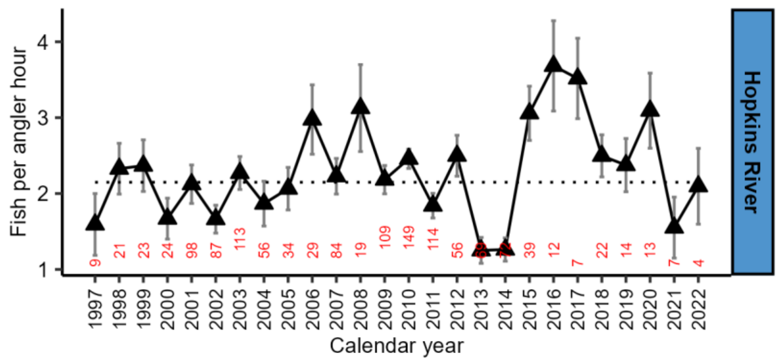


Figure 42 Diary angle mean nominal (±SE) catch-per-unit-effort (CPUE) of black bream from the Hopkins River, 1997-2022 calendar years. Horizontal black line is the mean CPUE during the reference period (1997 - 2015) and the dashed black line is the minimum CPUE within the reference period. Red numbers along x-axis are numbers of diary angler trips.

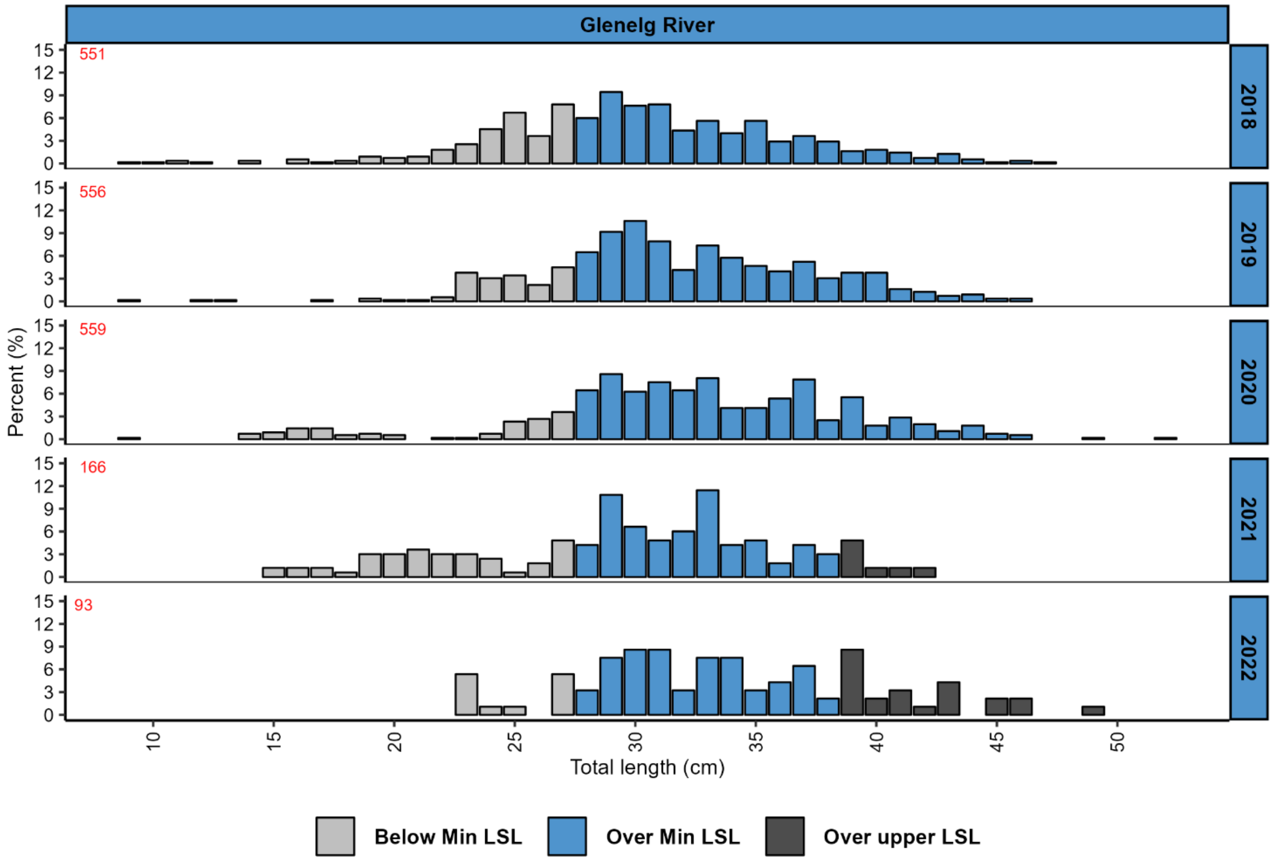


Figure 43 Frequency histograms of Glenelg River black bream length composition from diary anglers for calendar years 2018–2022. Red numbers indicate numbers of fish measured.

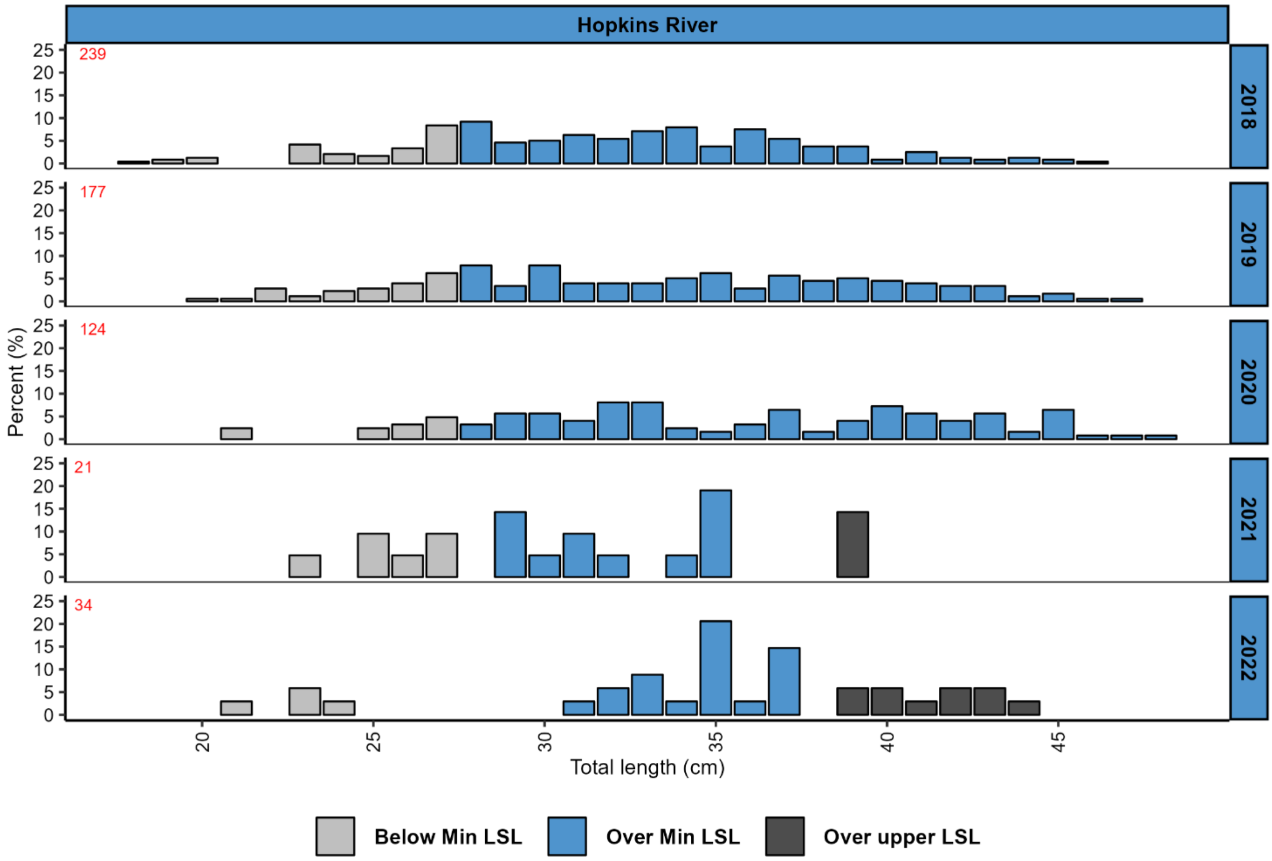


Figure 44 Frequency histograms of Hopkins River black bream length composition from diary anglers for calendar years 2018–2022. Red numbers indicate numbers of fish measured.

Eastern Victorian Estuaries

Lake Tyers
This review found:

- *Biomass* – Diary angler targeted CPUE was well below the reference period average in 2022. For the last five years CPUE has been below the reference period average.
- *Fishing pressure* – There is no direct information on the amount of fishing pressure on the black bream population in Lake Tyers. Size composition data shows that larger fish (>35 cm) are consistently recorded in the catches in recent years suggesting fishing mortality is likely to be relatively low. A lower number of sampling trips has been recorded in recent years due to less diary anglers and CPUE and length frequency data is become unreliable.

Mallacoota Inlet
This review found:

- *Biomass* – Diary angler targeted CPUE was well below the reference period average in 2022 (Figure 46). For the last five years CPUE has been below the reference period average.
- *Fishing pressure* – There is no direct information on the amount of fishing pressure on the black bream population in the Lake Tyers. Size composition data shows that larger fish (>35 cm) are consistently recorded in the catches in recent years suggesting fishing mortality is likely to be relatively low.

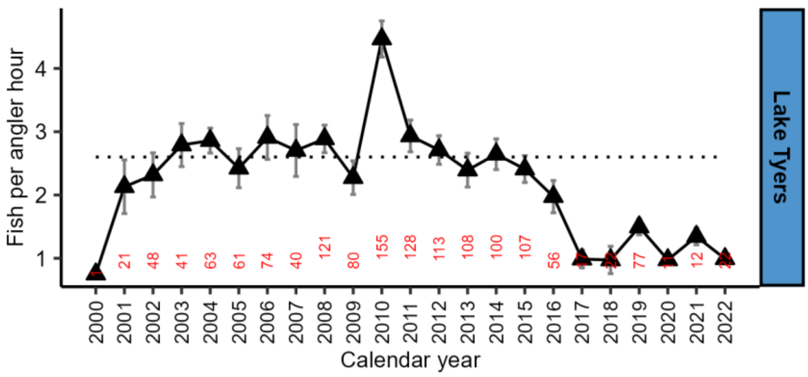


Figure 45. Diary angler mean nominal (±SE) catch-per-unit-effort (CPUE) of black bream from the Lake Tyers, 1997-2022 calendar years. Horizontal black line is the mean CPUE during the reference period (1997 - 2015) and the dashed black line is the minimum CPUE within the reference period. Red numbers along x-axis are numbers of diary angler trips.

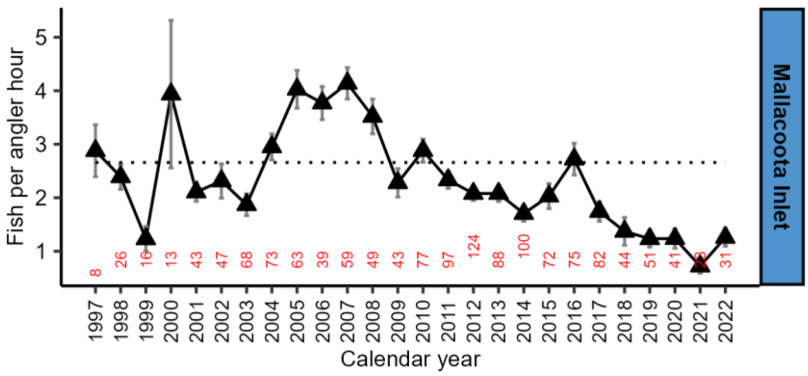


Figure 46. Diary angler mean nominal (±SE) catch-per-unit-effort (CPUE) of black bream from the Mallacoota Inlet, 1997-2022 calendar years. Horizontal black line is the mean CPUE during the reference period (1997 - 2015) and the dashed black line is the minimum CPUE within the reference period. Red numbers along x-axis are numbers of diary angler trips.

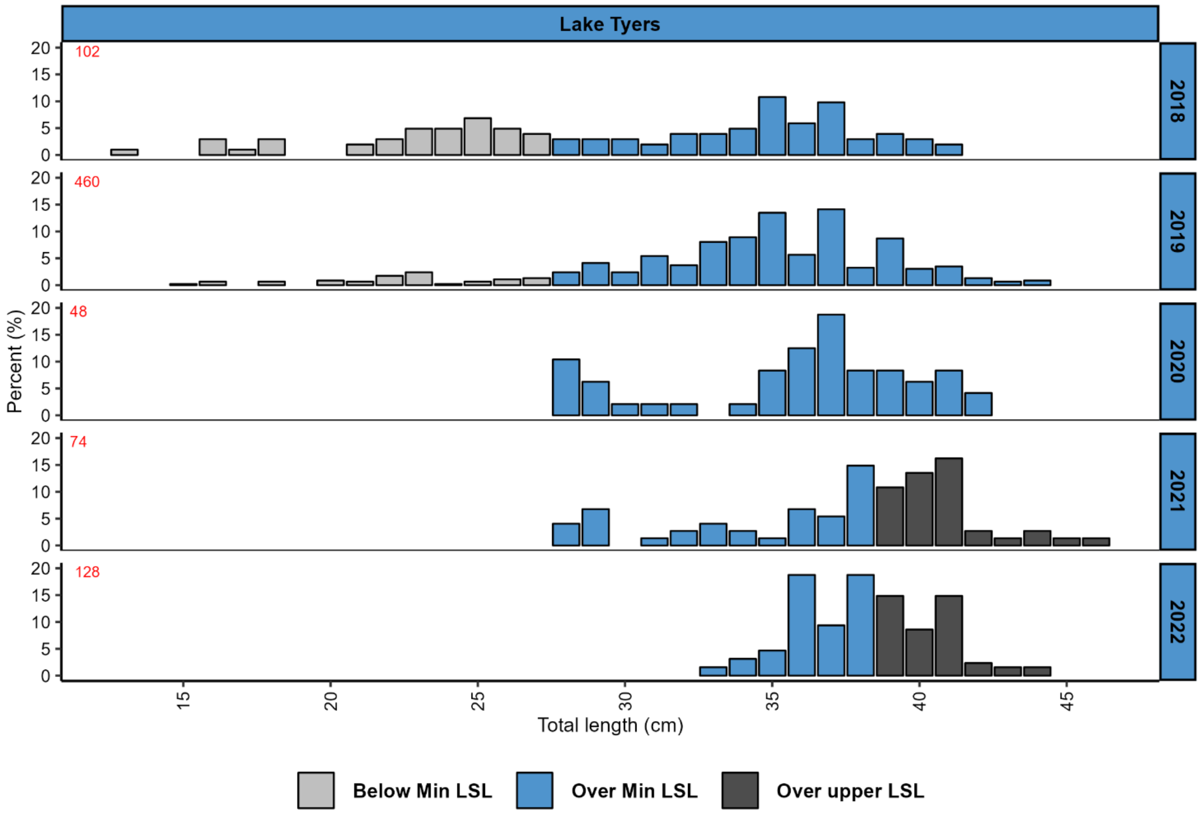


Figure 47 Frequency histograms of Lake Tyers black bream length composition from diary anglers for calendar years 2018–2022. Red numbers indicate numbers of fish measured.

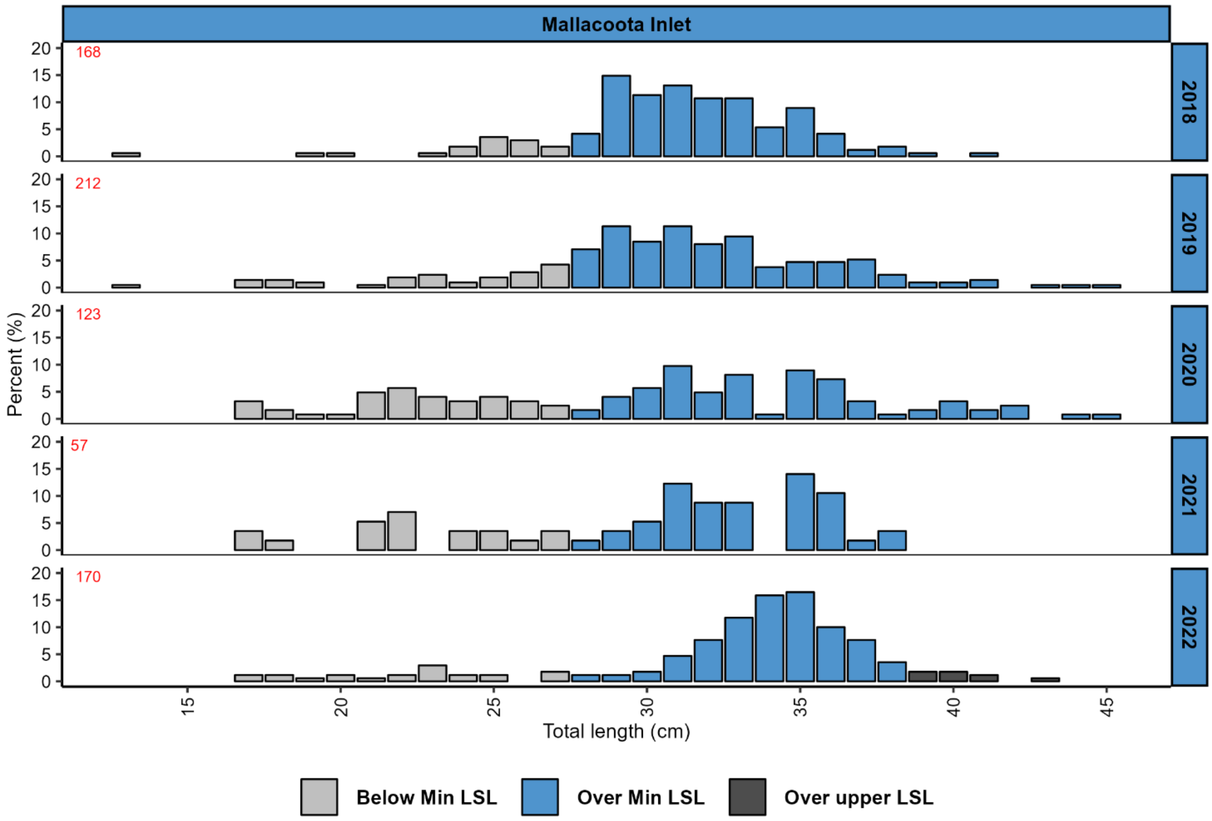


Figure 48 Frequency histograms of Mallacoota Inlet black bream length composition from diary anglers for calendar years 2018–2022. Red numbers indicate numbers of fish measured.

Southern Garfish (*Hyporhamphus melanochir*)

Stock Structure and Biology

The Victorian southern sea garfish population is considered to comprise a single stock that is genetically like 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 occur in Western Port (recreational) and the Gippsland Lakes (recreational and previously commercial) (Figure 49). 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 noting that mixed-species quotas in Port Phillip Bay may have resulted in discarding and compromised catch rates. 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).
- Commercial catch and effort data.

There are insufficient recreational fishery data for a definitive 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 declined through time (Figure 49). Catches have, however, increased over the last few years in Corner Inlet-Nooramunga, due to increased seining effort (Figure 49 and Figure 50).
- *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 2021/22 (Figure 50).

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. The CPUE trend is stable and currently well above the reference period in Corner Inlet-Nooramunga. Although some previous years have been below the reference period average, they remain within the bounds of historical cycling. Based on the above summary southern sea garfish in Victoria is assessed as sustainable.

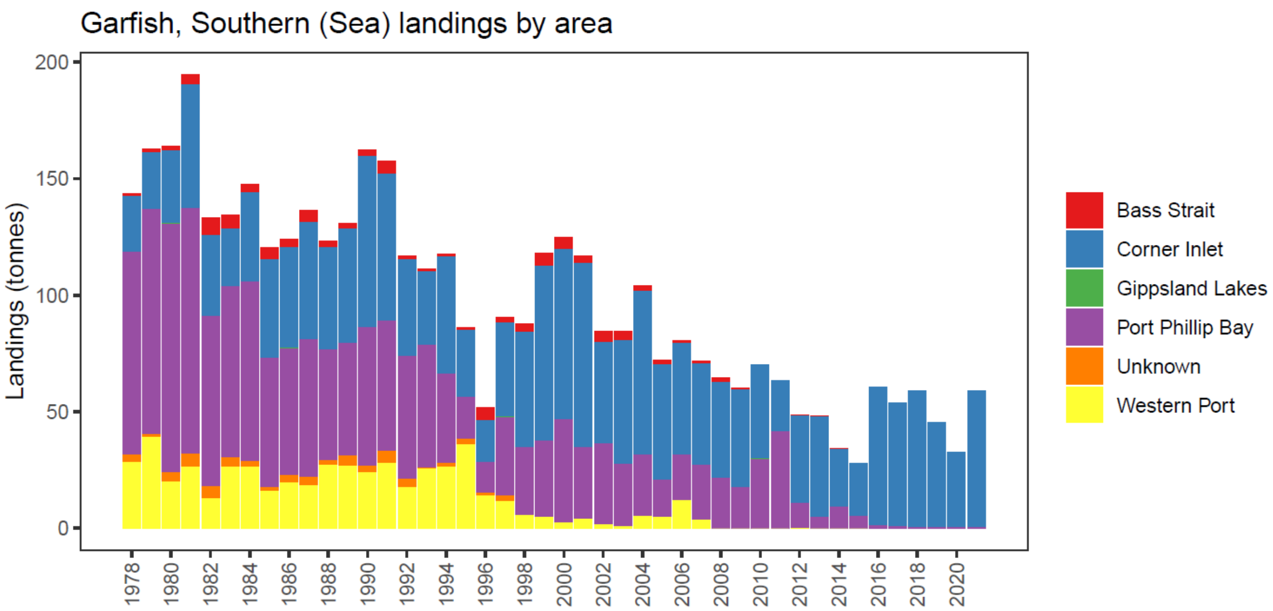


Figure 49 Total commercial harvests of southern sea garfish from Victorian waters, financial years 1978–2021.

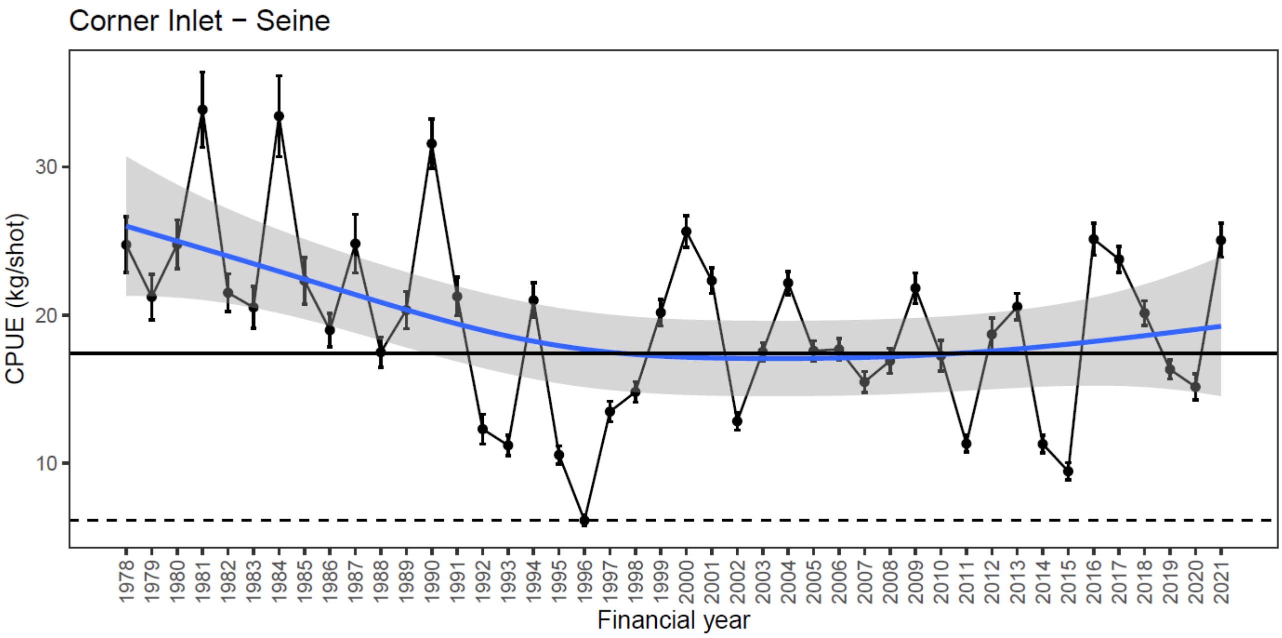


Figure 50 Southern sea garfish nominal catch-per-unit-effort (CPUE) (±SE) for the Corner Inlet haul seine fishery (1978–2021 financial years. Horizontal black line is the mean CPUE during the reference period (1985-2015) and the dashed black line is the minimum CPUE within the reference period. Blue 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.

Pipi (*Donax deltoides*)

Stock Structure and Biology

Genetically, the Victorian pipi population comprises of at least two biological stocks at either end of Bass Strait, centred around Discovery Bay in the west and Venus Bay in the east. There is no biological population parameter information available for Victorian pipi. Locally the biological stock delineation of Pipi remains unclear, but recruits are likely to be self-seeded or to come from nearby, adjacent beaches (Murray-Jones and Ayre 1997). In South Australia, pipi can live to 3–5 years of age and grow to 61 mm SL (shell length) compared with New South Wales populations, where they live to 1–2 years of age and grow to 75 mm SL. In South Australia, maturity (50 percent) is reached at 10 months of age and 28 mm SL and in New South Wales maturity is reached at 1 year of age and 37 mm SL. Pipi are highly fecund and are widely dispersed in the larval stage.

Studies in NSW a decade ago reinforced that pipi populations are naturally dynamic and spatiotemporally patchy. This renders them challenging to assess in terms of their stock status and impacts from fishing (Gray 2016).

Management/Assessment Unit

Victorian Pipi stocks support recreational and commercial fisheries in several main areas along the Victorian coastline from west to east including Discovery Bay, Fairhaven, Venus Bay, and Ninety Mile Beach.
Commercial fisheries occur mainly in Discovery Bay (DB) which as one of five management zones is further divided into areas east and west of Sutton Rocks (DBW, DBE), with much smaller commercial catches in Venus Bay (VB). The other commercial fishery management zones include the Western Zone (WZ), and Eastern Zone (EZ) which straddles VB. Since 2020, DBW, DBE, and VB have each been allocated a total allowable commercial catch (TACC), set and maintained annually at 10, 40 and 2 tonnes respectively. A minimum size limit of 35 mm SL applies.

Recreational fisheries occur state-wide including coastal beaches, bays, and inlets, although the predominant recreational harvest areas are also at Venus and Discovery Bays. There is a recreational only area where commercial fishing is prohibited along the coast separating Anderson's Inlet from Bass Strait adjacent to the western boundary of VB.

As DB supports the bulk of the commercial fishery, this area was used to assess the state of stocks throughout Victoria.

Assessment Summary

State-wide stock

For this assessment the status of the pipi stock was evaluated using:

- Nominal CPUE trends for the commercial fishery based in the Discovery Bay East zone DBE. Exploratory data analysis revealed that CPUE was generally unreliable as a proxy for stock biomass until after 2016/17, mainly because of changes in how the fishery operated, accompanied by some variation in consistency of the way in which effort was recorded. Further exploration of the data by zone showed that one licence accounted for 86% of the DBW catch during 2017/18–2022/23 and that it was steadily but implausibly increasing on a steeply linear trajectory. This meant that only the DBE trend, in which approximately one third of the change in CPUE could be attributed to differences among years, was relied upon as a biomass indicator for the same period.

- Commercial catch and effort data.
- Recreational fishery data were unavailable.

This assessment found:

- *Fishing pressure* – The overwhelming majority of pipi are landed from Discovery Bay. Infrequent, small, catches of pipi have been reported since 1990, however it was not until 2011 that the fishery developed, and substantial quantities began to be landed (Figure 51). Pipi catch in the 2013/14 year was 93 tonnes, but after 2014/15 if decreased to around half to two-thirds of this amount. in 2016/17 and 2017/18. During 2022/13 it was slightly below the combined TACC of 52 t introduced in April 2020.
- *Biomass* – The CPUE trend for DBE between 2017/18 and 2022/23 followed a decreasing trajectory which slowed after 2020 when pipi came under quota management. From an initial rate of 75 kg/h in 2017 the fitted (GAM) curve reduced by approximately two-thirds to 25 kg/h in 2023 (Figure 52). The lowest CPUE, recorded over the past three years, coincided with a substantial drop in the number of pipi fishing events during the past two decades at only 15% of the number of events typically reported during 2009/10–2004/15 (Figure 52). Given its brief history as a dedicated standalone fishery, the default reference period is omitted as it is too brief to encompass enough of the expected natural variation over time. More recently, in November 2023, severe mortalities along the coastline straddling DB to The Coorong in South Australia from an unidentified cause prompted industry to voluntarily close the fishery. In the current context of the operation of the fishery, further years of data will be required to clearly reveal patterns and trends in biomass.

Stock status summary: There is a likelihood that past effort, and hence early CPUE, is unreliable as a biomass indicator due to temporal differences in catch and effort reporting meaning that there is a possibility that changing fishing practices (e.g., additional people catching pipis under the one license) could be masking past changes in biomass. Now that the number of fishers is accurately recorded it will be important to continue monitor CPUE into the future in conjunction with industry consultation to ascertain whether fishing practices are changing through time. Additionally, a significant recreational fishery exists, particularly in Venus Bay and the landings from this fishery are currently unknown. Pipi population biology imbues the species with resilience to recover from depletion, but it does not follow that fishing has no impact on stock abundance and recruitment. The observed decline in DBE CPUE and unexplained mortalities in DB are of concern warranting careful monitoring as the stock is likely to have become depleted. Based on the available information the current overall status of the Victorian pipi stock remains uncertain.

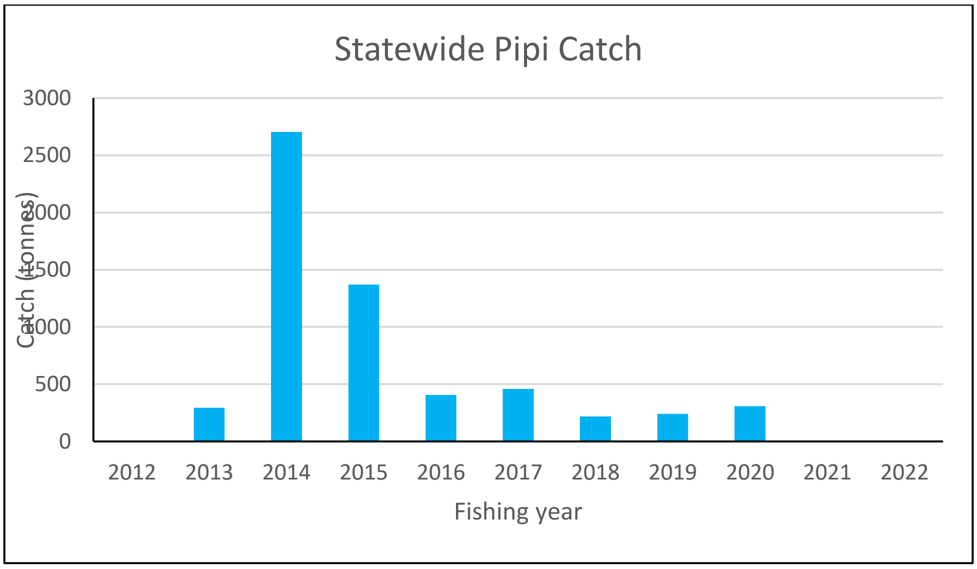


Figure 51 Statewide Victorian commercial catches of pipi from all records for the period of fishing years 2012/13–2022/23.

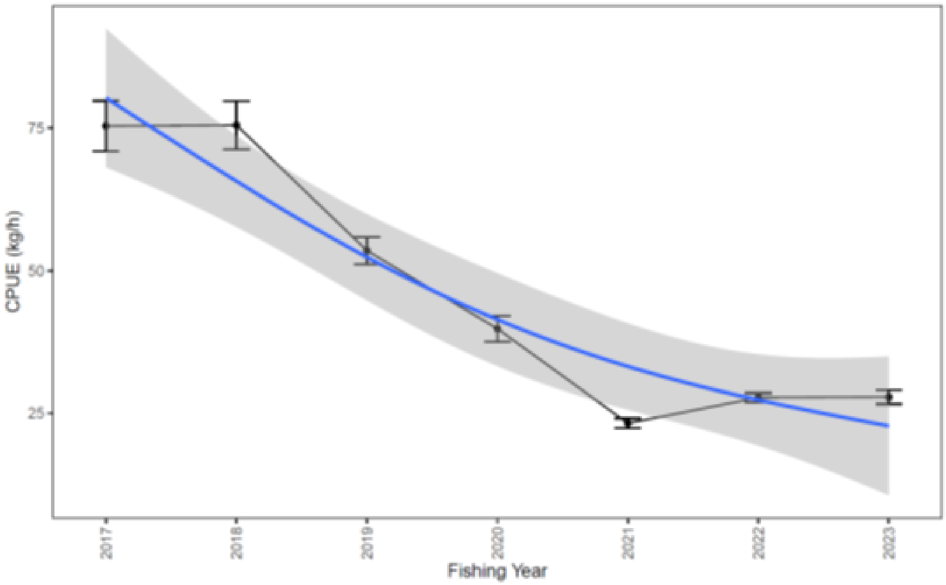


Figure 52 Catch-per-unit-effort (CPUE) in Discovery Bay East (DBE) from 2017–2022 fishing years for non-zero catch records from bait and pipi fishery logbooks only. Black line is nominal CPUE (±SE), blue line is a generalised additive model (GAM) of the CPUE trend with the shaded grey area representing the 95% confidence interval of the GAM.

Yellow-eye Mullet (*Aldrichetta forsteri*)

Stock Structure and Biology

Genetically, the Victorian yellow-eye mullet population is considered part of a broader eastern Australian stock. Yellow-eye mullet live to ten years and grow to 44 cm TL. Maturity (50 percent) is reached at 2 to 3 years of age and 20–26 cm TL. Yellow-eye mullet are highly fecund with fast growth. The main spawning period is summer/autumn in inshore coastal regions and the larval stages are widely dispersed.

Management/Assessment Unit

The Victorian component of the eastern Australian yellow-eye mullet stock supports recreational and commercial fisheries. Commercial fisheries occur mainly in Corner Inlet and the Gippsland Lakes. This report considers Victorian yellow-eye mullet as single stock.

Assessment Summary

State-wide stock

For this assessment the status of the yellow-eye stock biomass and fishing pressure were evaluated using:

- Nominal CPUE for commercial haul seine and mesh net fishing in Port Phillip Bay, Corner Inlet, and Gippsland Lakes (default reference period 1986–2015),
- Commercial catch and effort data.
- Incidental data and observations from surveys of juveniles of other species.

This assessment found:

- *Fishing pressure* – A total of 12.05 t of Yelloweye Mullet was caught in 2022 by commercial fishers operating in Port Phillip Bay and Corner Inlet (Figure 53). This follows a long-term declining catch trend since peaking at 245 t in 1988, driven largely by the progressive closures of bay and estuarine commercial fisheries along the Victorian coastline since the early 2000s, with the exceptions of commercial netting and longlining in Corner Inlet and longlining in PPB. Annual catches of 12–13 t during 2021 and 2022 contrast sharply with the preceding five years (2016–2020) when catches were consistently around 30 t. Historically, Yelloweye Mullet was once regularly targeted by commercial net fishers, but not in recent decades due to weak market demand and low prices, with other higher value species being preferred. Consequently, the recent low landings should not be interpreted as a reduction in biomass [Bell et al. 2023]. Yelloweye Mullet are caught incidentally by recreational anglers, and although recent catch quantities are unknown, they are seldom targeted as the species is rarely encountered during creel surveys.
- *Biomass* – Over recent decades, effort using mesh nets and haul seine, the predominant commercial gear deployed to target Yelloweye Mullet, has declined throughout all Victorian commercial fisheries, having now ceased in Gippsland Lakes and in Port Phillip Bay in 2022 following buy-outs of all commercial netting licences, implemented to improve recreational fishing access by hook and line methods.
  In Port Phillip Bay, the majority of Yelloweye Mullet previously caught commercially were taken using haul seine nets with the remainder taken using mesh nets (Hamer et al. 2016). Haul seine and mesh net CPUE peaked during the 1980s and then declined until the early 2000s (VFA 2017), after which haul seine CPUE became stable to increasing. In 2019 CPUE was slightly above the average for 1986–2015 (Figure 54). Mesh net CPUE

from Port Phillip Bay was not assessed beyond 2016 [VFA 2017] due to the paucity in suitable data available for analysis arising from the progressive phasing out of the commercial net fishery. Corner Inlet is now the mainstay of the commercial fishery, the majority of Yelloweye Mullet are caught using haul seine nets with the remainder taken using mesh nets. Mesh net CPUE (Figure 55) is considered less reliable as a proxy for biomass than haul seine CPUE as the former gear type isn't typically used to target Yelloweye Mullet. Overall, the CPUE time series are highly variable and have been influenced to an unknown degree by variation in the level of harvest retention and reporting. It is thought that in recent decades, due to their low value, Yelloweye Mullet have often been discarded and therefore the reported CPUE may have been under-estimating abundance, possibly also underestimating fishing mortality to the extent that there is some degree of post-release mortality. Notwithstanding these data uncertainty considerations, haul seine CPUE for Yelloweye Mullet in Corner Inlet has shown a shallow increasing trend over the past decade, rising close to the average for 1986–2015 (Figure 54).
Anecdotally, Yelloweye Mullet are found in abundance in Victorian waters despite not being targeted, and there is no evidence indicating that the spawning stock biomass is depleted.

- *Recruitment* – During annual surveys of juvenile King George Whiting at eight locations in Port Phillip Bay, juvenile Yelloweye Mullet are commonly encountered in samples, but not enumerated. They are also found and counted during pre-recruit surveys of Black Bream in Gippsland Lakes where in 2022 the number sampled was almost double the average since 2008 (Figure 56). Although the available data cast uncertainty about the status of Yelloweye Mullet in Corner Inlet, there are no signs of ongoing recruitment impairment.

Stock status summary: The status of yellow-eye mullet in Victoria has been problematic to assess due to uncertainty in the interpretation of CPUE, reduced targeting, and the fact that yellow-eye mullet in Victoria are part of a broader eastern Australian stock. Yellow-eye mullet were classified as 'recovering' for Victoria in recent SAFS assessments whereas for Western Australia, South Australia and Tasmania, these fisheries were deemed 'sustainable'. Overall, this would suggest the stocks in southern and eastern Australia are in good condition, and that the Victorian classification was incongruous warranting closer attention. Recent more wholistic consideration of all available evidence, qualitative as well as quantitative, indicated that too much reliance had been placed on the declining trends in catch and CPUE since the 1980s without considering that reduced commercial catch and effort in Victoria reflected both weak market demand and accompanying low beach prices plus the progressive closure of commercial net fisheries in Victorian bays and inlets. nor that recruitment is impaired. Indeed, with catches from the commercial fishery having reduced by 95% since 1988, and recreational catches remaining relatively small, fishing mortality is unlikely to be adversely impacting biomass or spawning. This is supported by recent evidence of population recruitment in Port Phillip Bay and in Gippsland Lakes.

Overall, the above evidence indicates that the biomass of this stock is unlikely to have ever been stock depleted or recruitment impaired and that the fishery is sustainable.

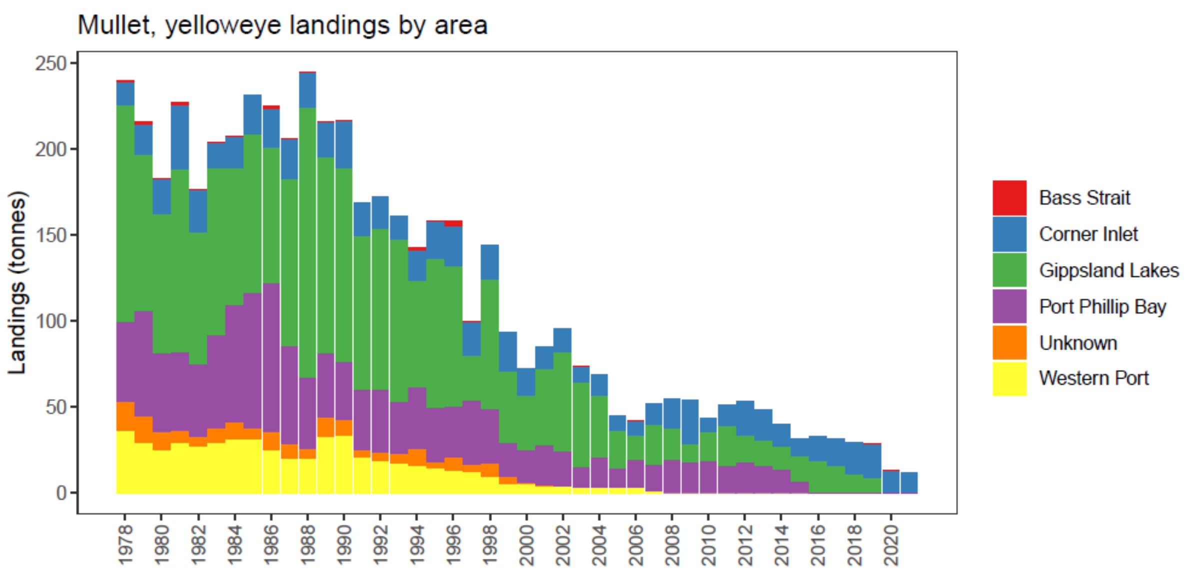
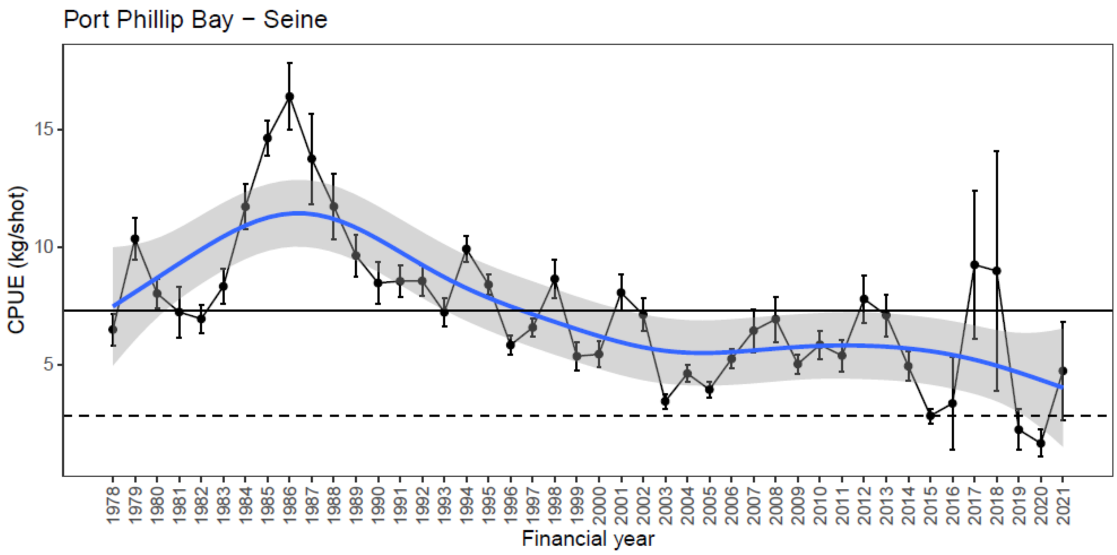
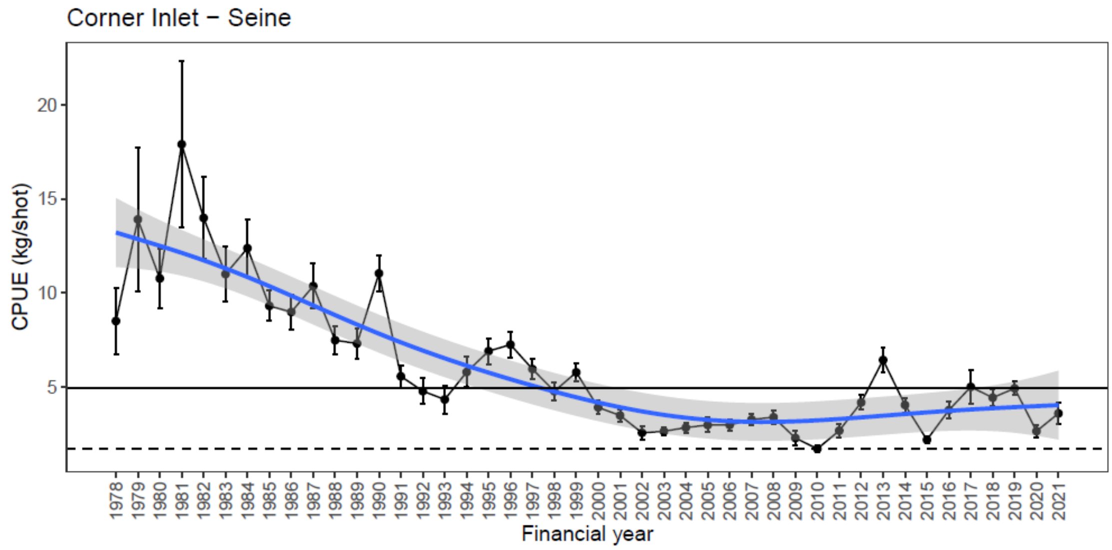


Figure 53 Total Victorian commercial catches of yellow-eye mullet by area, financial years 1978–2021.

(a)



(b)



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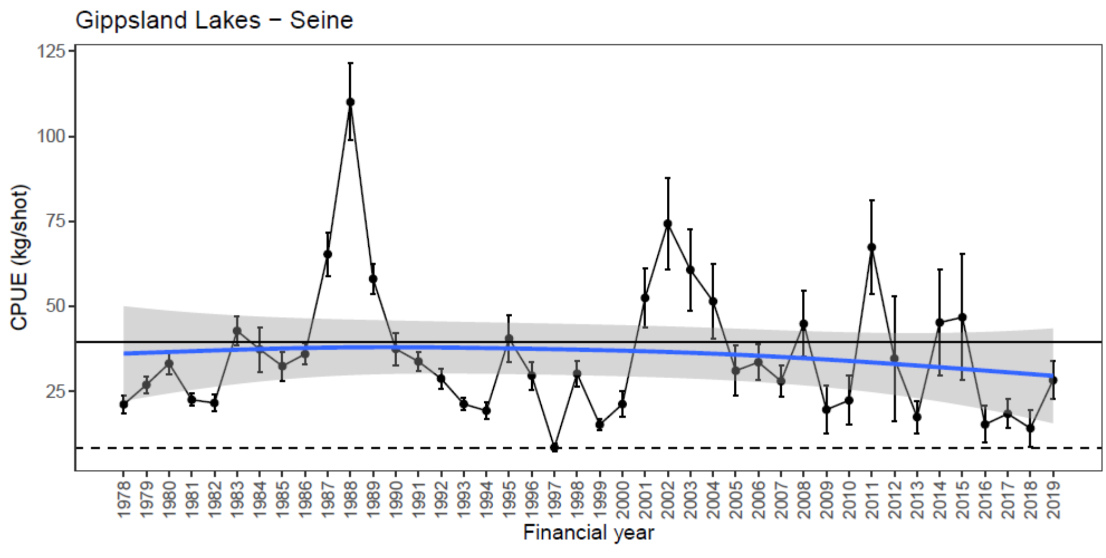
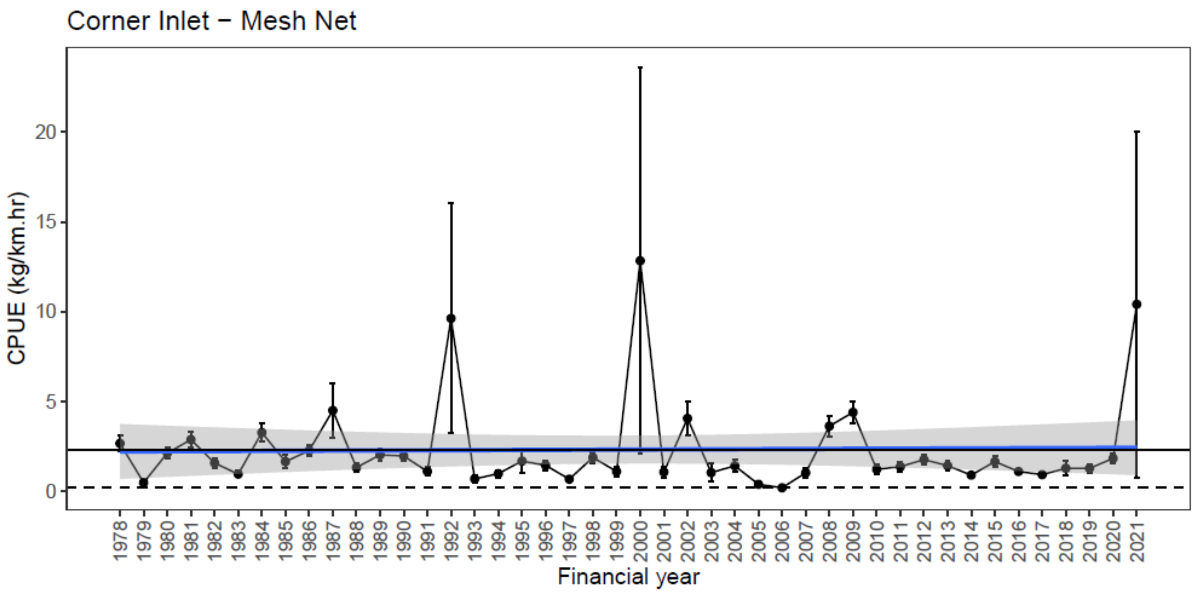


Figure 54 Yellow-eye mullet nominal catch-per-unit-effort (CPUE) (±SE) for; (a) Port Phillip Bay haul seine, (b) Corner Inlet haul seine, and (c) Gippsland Lakes haul seine (1978–2021 financial years). Horizontal black line is the mean CPUE during the reference period (1986–2015) and the dashed black 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.

(a)



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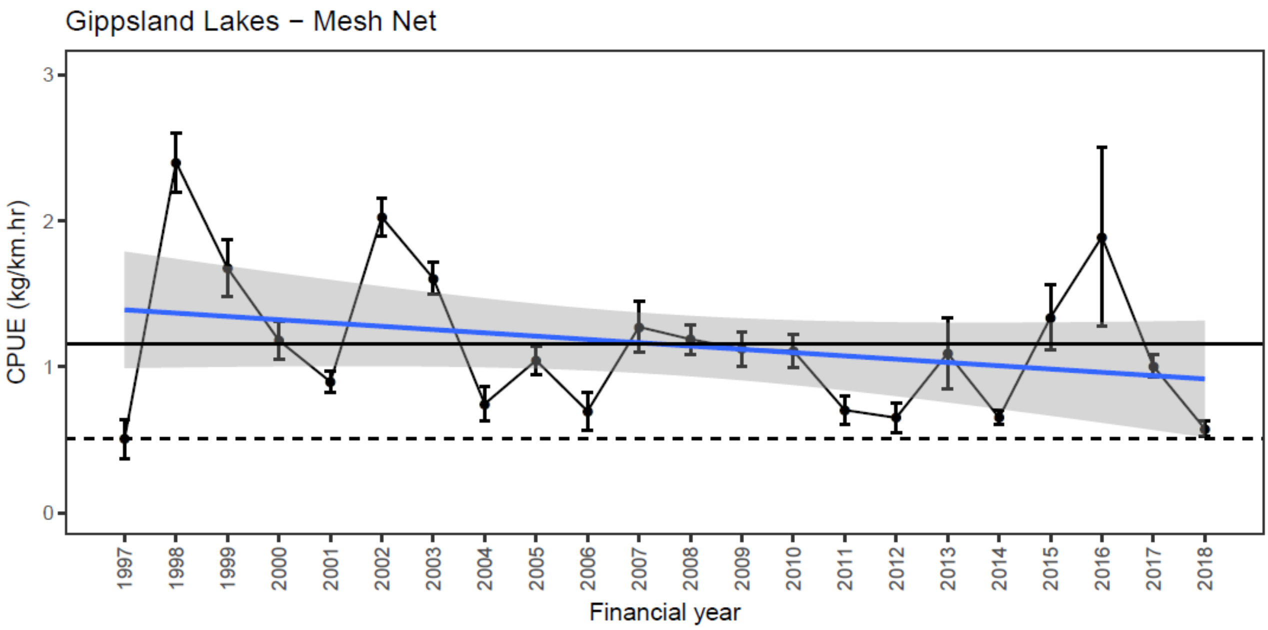


Figure 55 Yellow-eye mullet nominal catch-per-unit-effort (CPUE) (±SE) for; (a) Corner Inlet mesh net (1978–2021 financial years)., and (b) Gippsland Lakes mesh net (1978–2018 financial years i.e. pre-closure). Horizontal black line is the mean CPUE during the reference period (1986– 2015) and the dashed 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. There has been almost no yelloweye mullet landed in Port Phillip Bay during the last three years.

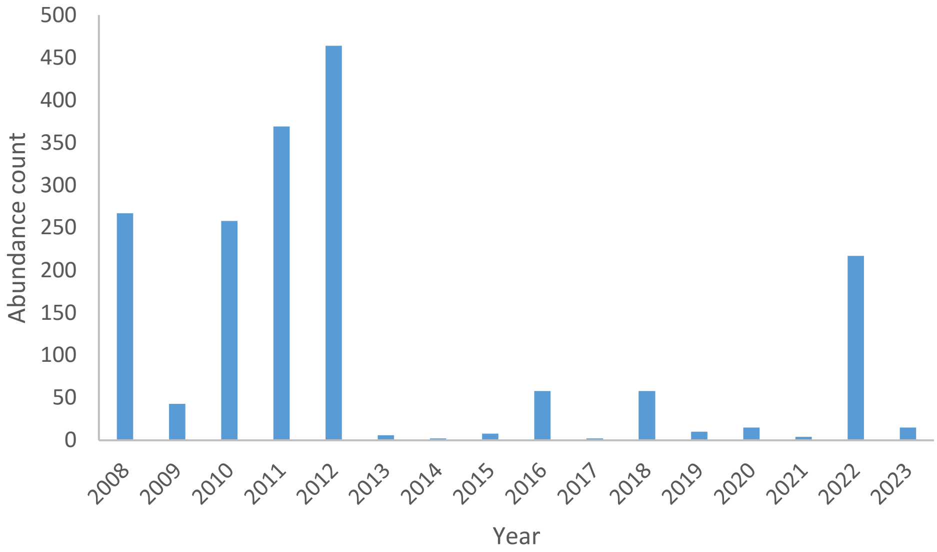


Figure 56 Abundance of Yellowtail Mullet in pre-recruit surveys in Gippsland Lakes.

Rock Flathead (*Platycephalus laevigatus*)

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 and has remained steady around 50t since 2015 (Figure 57). 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 57). While seine net effort has been relatively stable over the last 10 years, after declining to about from 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 2021/22 was close to historic high levels, though has declined in recent years (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 58, Figure 59 and Figure 60).
- *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 61 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 2020/21 (Figure 61a). 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 in 2020/21 has increased significantly, with record levels being observed in 2021/22 (Figure 61b).

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, particularly 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.

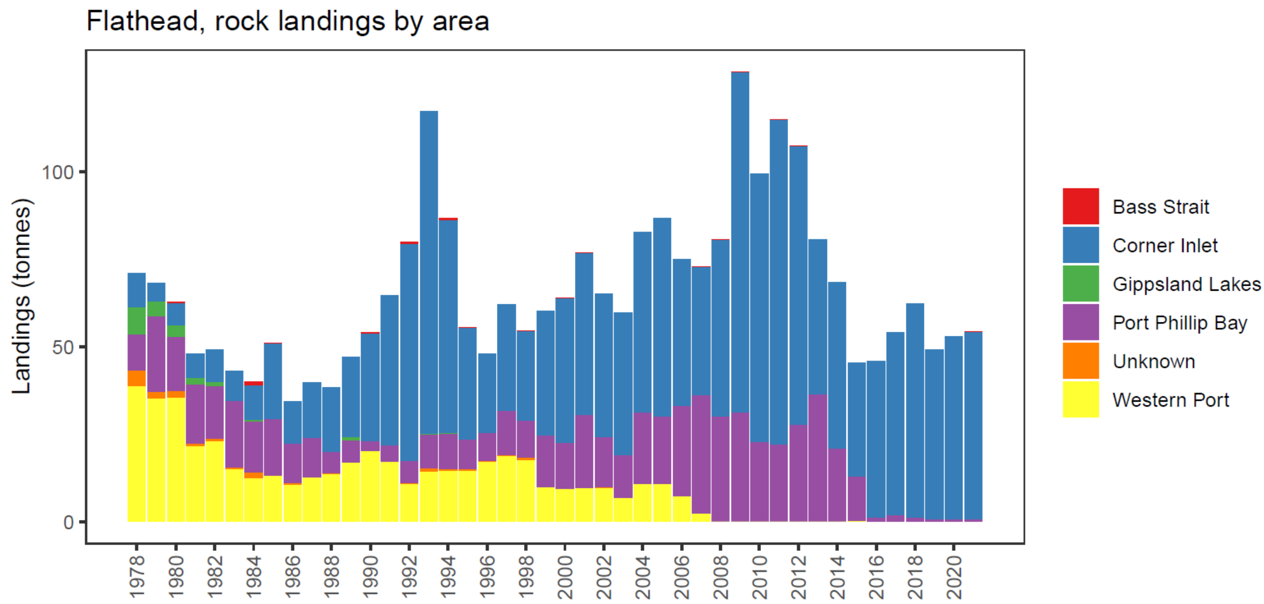


Figure 57 Total Victorian commercial catches of rock flathead by (a) area and (b) gear types, financial years 1978–2021.

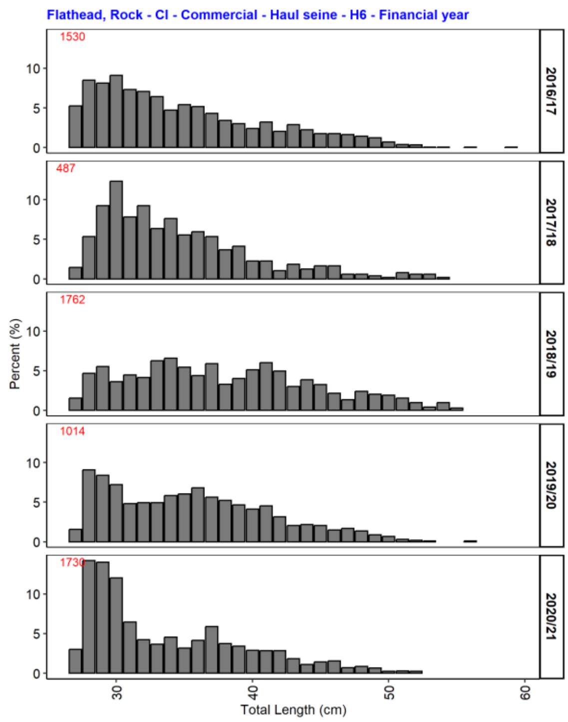


Figure 58 Frequency histograms of Corner Inlet length composition from haul seine catches financial years 2016/17–2020/21. Red numbers indicate numbers of fish measured scaled to catch sample weight.

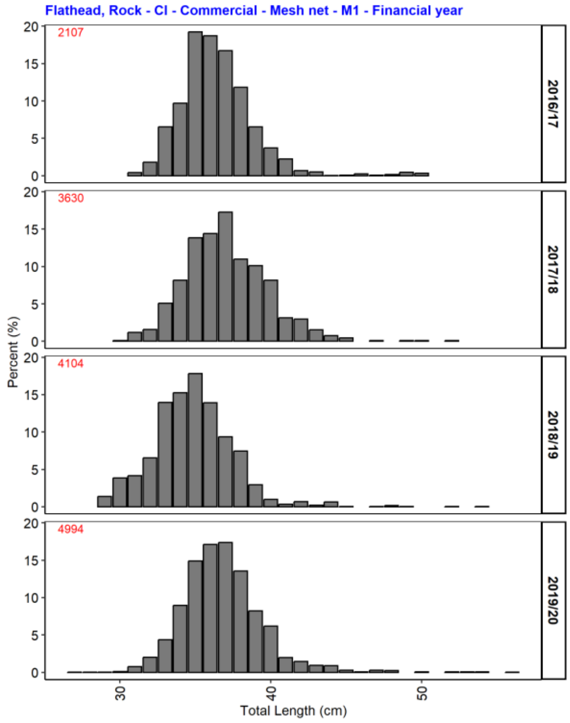


Figure 59 Frequency histograms of Corner Inlet length composition from mesh net (M1) catches financial years 2016/17–2019/20. Red numbers indicate numbers of fish measured scaled to catch sample weight.

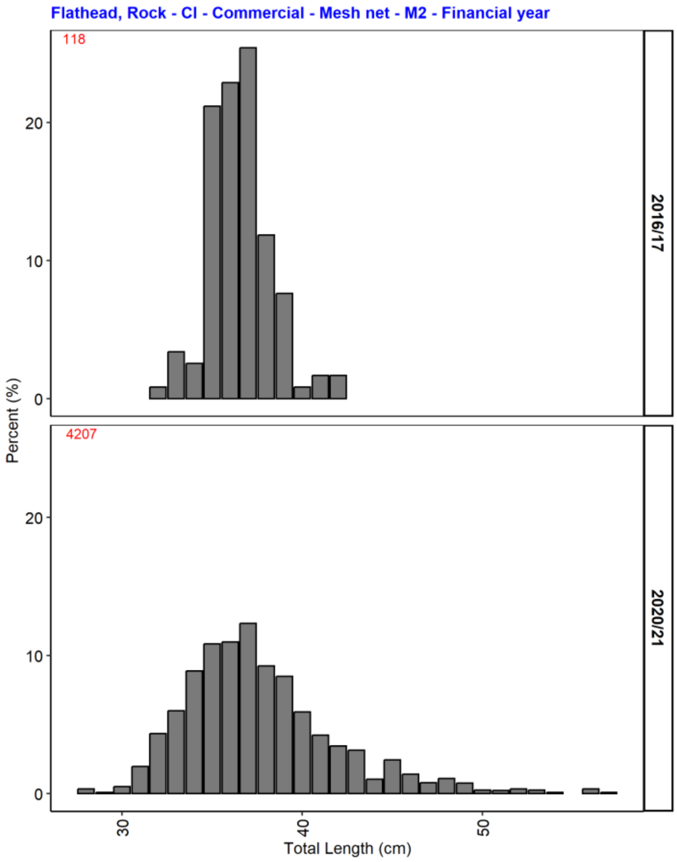


Figure 60 Frequency histograms of Corner Inlet length composition from mesh net (M2) catches financial years 2016/17 & 2020/21. Red numbers indicate numbers of fish measured scaled to catch sample weight.

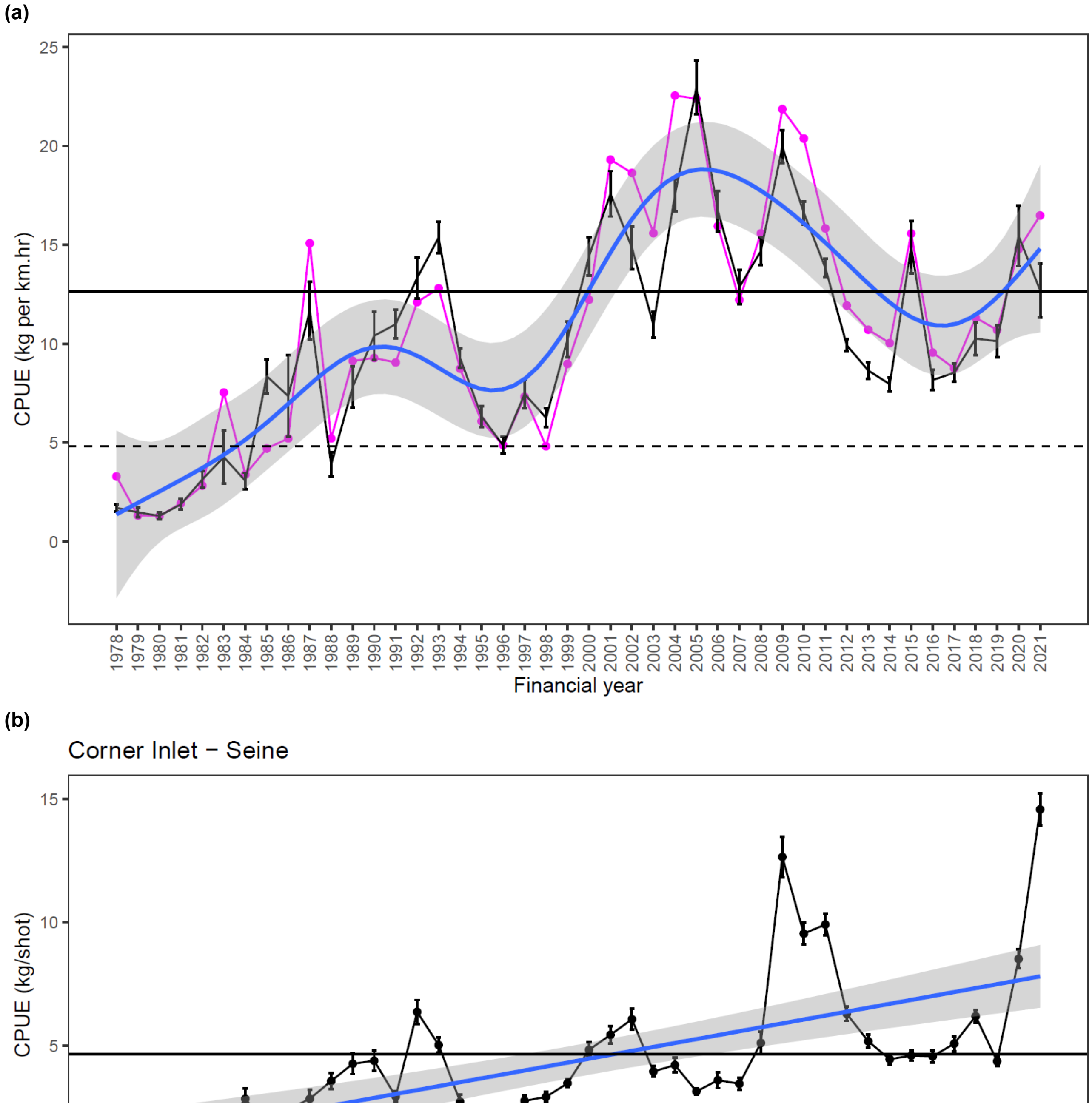


Figure 61 Catch-per-unit-effort (CPUE) of rock flathead by (a) commercial mesh net, and (b) seine net in the Corner Inlet during 1978–2021 financial years. Black line is nominal CPUE (±SE), magenta line is standardised CPUE, blue line is a generalised additive model (GAM) of the standardised CPUE trend 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*)

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. 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 nets with landings averaging ~45 t state-wide during the past 5 years, and slightly higher at 47 t in 2021/22. Prior to the 1990s squid jig was also important, but effort by squid jig has virtually ceased (see Appendix 2). There has been a decline in seine effort in all bays and inlets with Corner Inlet (CI) now accounting for most of the commercial catch and seine effort following the closure of the Western Port (WP) commercial fishery in 2009 and the Port Phillip Bay (PPB) commercial net fishery in 2022 [Bell et al. 2023]. As a result, state-wide commercial landings have declined by over 60 per cent from a peak period during the early 2000s [Bell et al. 2023]. Southern Calamari are targeted by recreational fishers in bays and inlets, and coastal waters, throughout the state, although there is no current information on landings.

- *Biomass* – Catch rates by commercial seine nets in Corner Inlet have been around, or above, historic highs since 2017/18 in Corner Inlet. Recreational catch rates from creel surveys have been relatively consistent since 2004, though declined in 2020/21 before returning to around average in 2021/22 (Figure 64).

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.

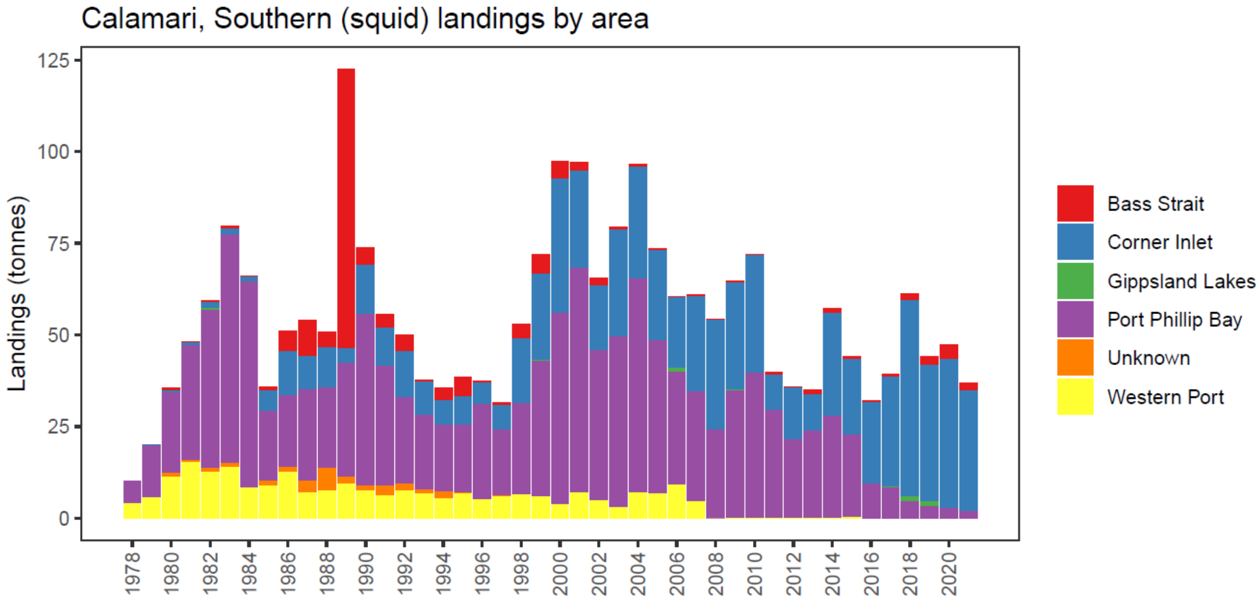


Figure 62 Total commercial catches of southern calamari by area in Victorian waters, 1978–2021/22 financial years.

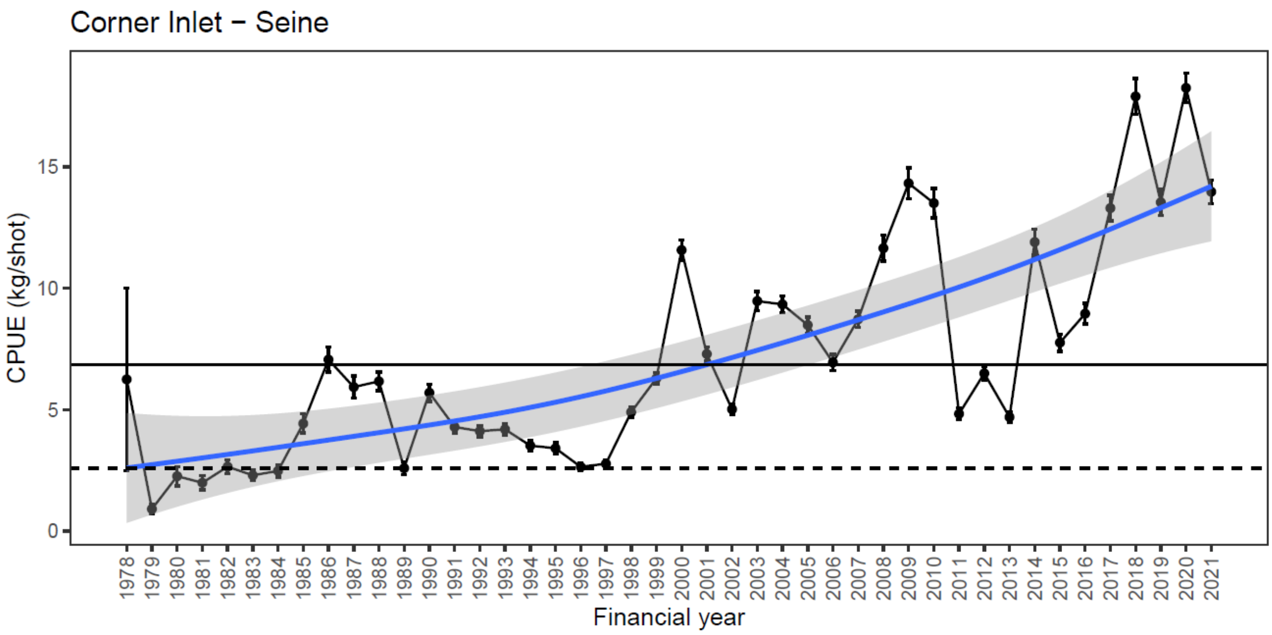


Figure 63 Southern calamari nominal catch-per-unit-effort (CPUE) (±SE) for (a) Port Phillip Bay haul seine, and (b) Corner Inlet haul seine (1978–2021 financial years). Horizontal black line is the mean CPUE during the reference period (1985–2015) and the dashed black line is the minimum CPUE within 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.

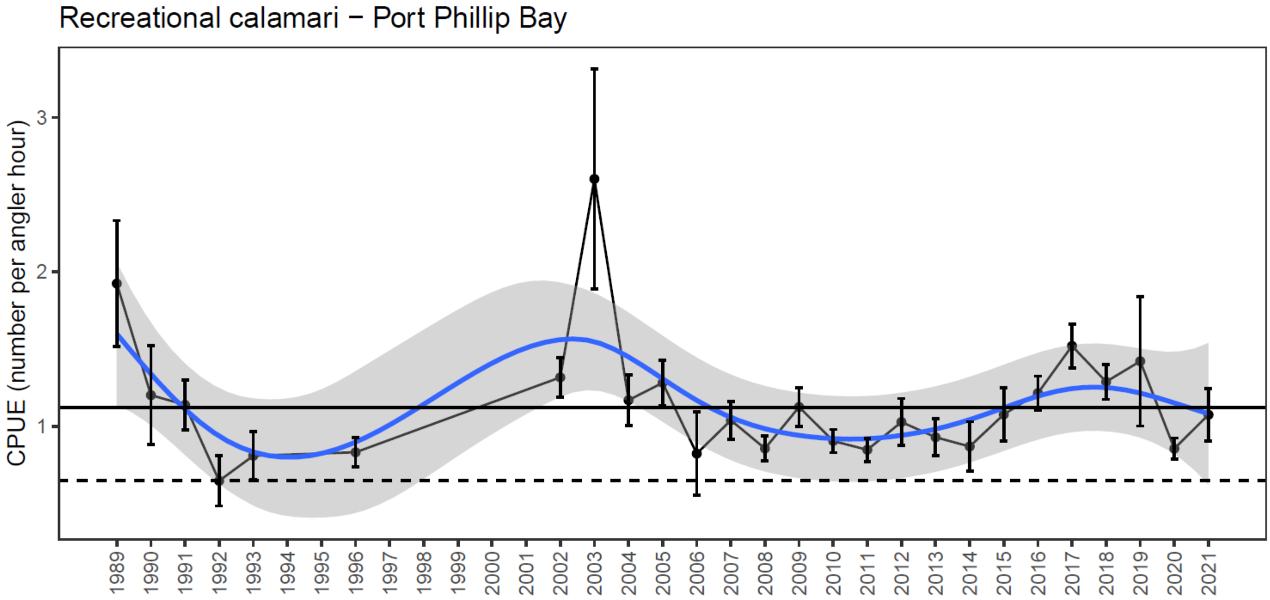


Figure 64 Southern calamari nominal catch-per-unit-effort (CPUE) (±SE) for the Port Phillip Bay recreational fishery from boat ramp creel surveys (financial years 2004–2016). Horizontal black line is the mean CPUE during the reference period (1989–2021) and the dashed black line is the minimum CPUE within 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.

Bluethroat and Purple Wrasse (*Notolabrus tetricus* and *N. fucicola*)

Bluethroat Wrasse

Purple Wrasse

Stock Structure and Biology

Wrasse are reef dwelling species with a single male dominating a “harem” of females. Aside from this aspect of biology where females of some species greatly outnumber males, stock structure of wrasse in Victorian waters is uncertain. Bluethroat Wrasse live to 23 years and males can grow to over 50 cm total length (TL). Purple Wrasse live for up to 24 years and grow to over 45 cm total length (TL). Maturity (50 percent) for blue throat wrasse is reached at four to eight years (20–30 cm TL), and for Purple Wrasse at three years (18 cm TL). Bluethroat wrasse can change sex (female to male) from 5 years of age in response to the loss of a dominate male. Purple wrasse do not change sex and males and female reach similar sizes. Wrasse are highly fecund and are fast growers. The main spawning period is spring. Wrasse are territorial inhabiting specific reefs.

Management/Assessment Unit

Victorian wrasse populations support mostly local port-based commercial fisheries (Figure 65). The Victorian fishery predominantly uses hook and line to harvest wrasse from in-shore waters (<30m depth) year-round for the live fish restaurant market. There is also a small recreational fishery. This report considers the Victorian wrasse fishery as west, central and east assessment zones, although the fishery is managed at a state-wide scale.

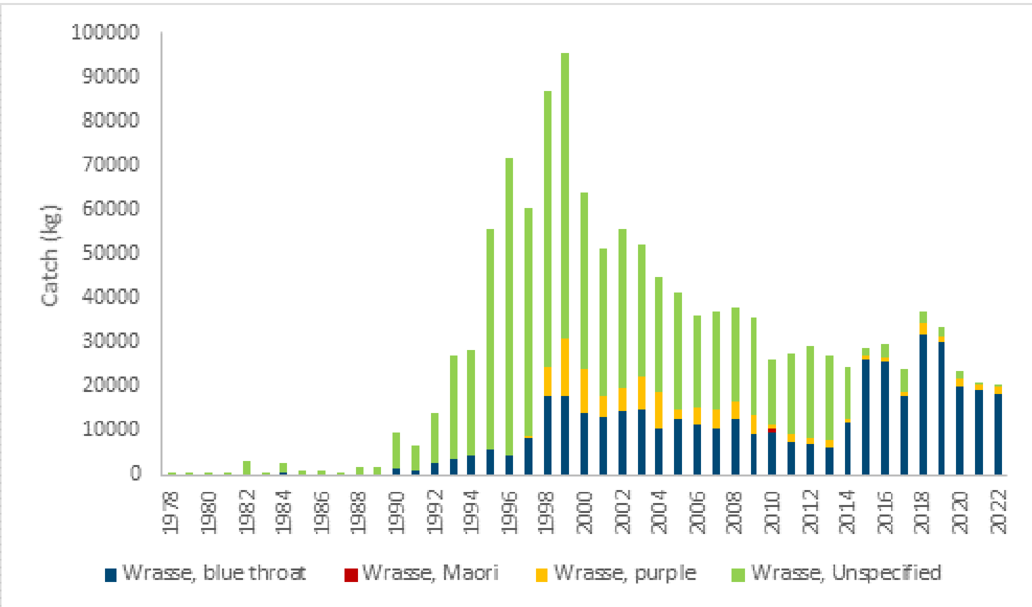


Figure 65 State-wide landings of wrasse by species from Victorian fisheries during 1978–2022 financial year. Note that most of the ‘Unspecified’ landings are likely to be Bluethroat wrasse.

Assessment Summary

For this assessment, the status of the Victorian wrasse commercial fishery (both blue throat and purple wrasse combined) was evaluated using:

- Nominal and standardised CPUE by handline for the commercial fishery separated into western, central and eastern zones.

  NOTE: CPUE is based on catches combined across species as reporting at the species level was unreliable during earlier years. Nevertheless, most of the catch (~90%) was Bluethroat Wrasse. The reference period used for wrasse is 1998–2015, avoiding the initial peak in harvests, much of which was marketed dead under 'Offshore Fishery Access Licences (OFAL)', and consequently does not reflect the current fishery operations and stand-alone 'Ocean Wrasse (OW)' licence arrangements.

- Commercial catch and effort data.

This assessment found:

- *Fishing pressure* – Harvests of wrasse increased rapidly to around 90 tonnes/year when a market for wrasse established in the early 1990s. However, the challenging nature of wrasse fishing, and the market preference for live fish, saw many OFAL fishers cease to target them (Figure 66). By 2010 state-wide harvest had declined to the current levels of 10–30 tonnes/year. The harvest in 2017/18, immediately after the 22 transferable 'Ocean Wrasse' licences were issued in April 2017, was the highest since 2009 (Figure 67a). The proportion of total catch by ocean wrasse fishery licence/permit in 2021/22 was >99%, increasing consistently each year from around 10% or less prior to 2007/08. The percentage of catch taken by rock lobster pots has been 8–9% for the past three years with around 90% taken by 'hook & line' (Figure 67). This is consistent with the objective of the harvest strategy to limit the targeted effort by rock lobster fishers who also participate in the ocean wrasse fishery to ensure that the fishery was predominantly 'hook & line'.
- *Biomass* – The standardised CPUE (3-y moving average) in all three assessment zones was below the target reference point and has been as low as the trigger reference point during the past four years (Figure 68). In the central and east zones (Figure 68a,b), CPUE is slightly below or remains relatively close to the trigger reference point, respectively, but in the western zone there has been three years of steady increase towards the target (Figure 68c). Overall, the CPUE is indicating that the stock biomass is not so low that recruitment impairment is likely. One caveat is that the relationship between CPUE and stock wide biomass is unclear, as CPUE for this fishery may be prone to hyper-stability due to the highly resident behaviour of wrasse on reef areas and fishers regularly move between different reef areas to maintain acceptable catch rates. The total catch taken in 2021/22 was similar to 2020/21, but down by about one third of 2019/20, with the biggest decrease in the central zone. It appears from monthly catch patterns during 2020 that the COVID-19 pandemic has led to reductions in catch that are aligned with public health safeguards which restricted public movement, disrupted interstate transport operations, and closed cafes and restaurants during the two waves of disease outbreak, primarily in Victoria but also in NSW (Ogier et al. 2023).

Stock status summary: The limited licences (22) and limited number of fishing days/year due to swell and weather impose constraints on harvest for most areas. However, substantial potential for increased effort and catch exists because most of the 22 licences are not yet fully utilised and the catch is unconstrained. The main risk for the fishery has been previously identified as a potential for localised depletion on individual reefs. Although the pandemic temporarily disrupted markets and catches were reduced, negatively impacting the fishery and associated business enterprises economically, it will not have adversely affected the wrasse stocks.

All three zones had stock biomass estimates (standardised CPUE) around or above the trigger reference point values specified in the harvest strategy, with east and west zones showing recent upturns and central zone a recent downturn, which has breached the harvest strategy trigger. In the West zone the standardised CPUE is at the target reference point value. This indicates that stock biomass is at an acceptable level across the breadth of the fishery. With no fishing taking place in the east zone in 2021/22 the performance of the fishery cannot be assessed in the most recent year; however, it was improving in 2020/21 and there is no reason to believe this won't continue given a reduction in fishing in 2021/22. In 2021/22 the central zone breached the trigger limit and therefore warrants close monitoring.

Patterns prior to licence transferability were consistent with stable to decreasing stock biomass, with decreases in CPUE between the reference period (2014/15) and transferability (2017/18), so the current situation in the West and East zones is an improvement since licences became transferable. The main concerns since transferability are the relatively high discarding rate for blue throat wrasse, particularly in the central zone, and spatial intensification of effort at Port Fairy and Port Phillip Heads, which, if it were to persist may cause localised depletion.

The proportion of wrasse caught in lobster pots across all licence classes has remained well below the 10 per cent allocation permitted under the Harvest Strategy. Ocean Wrasse licences now predominate taking >90% of the catch.

The current harvest and effort appear to present a low risk for the stock becoming recruitment impaired state-wide and based on this evidence the species is considered sustainable.

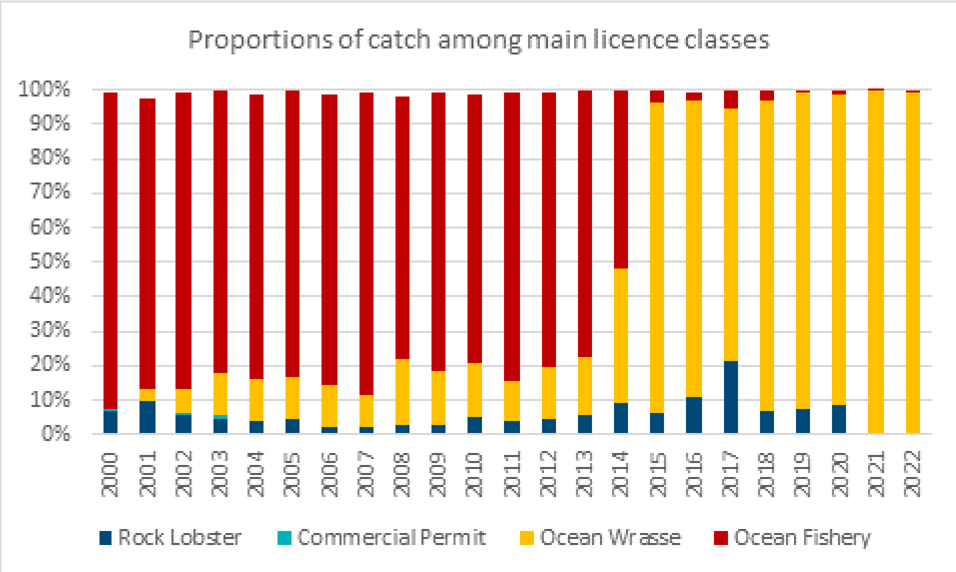


Figure 66 Distribution of catch among the main licence classes targeting wrasse during fiscal years 2000–2022.

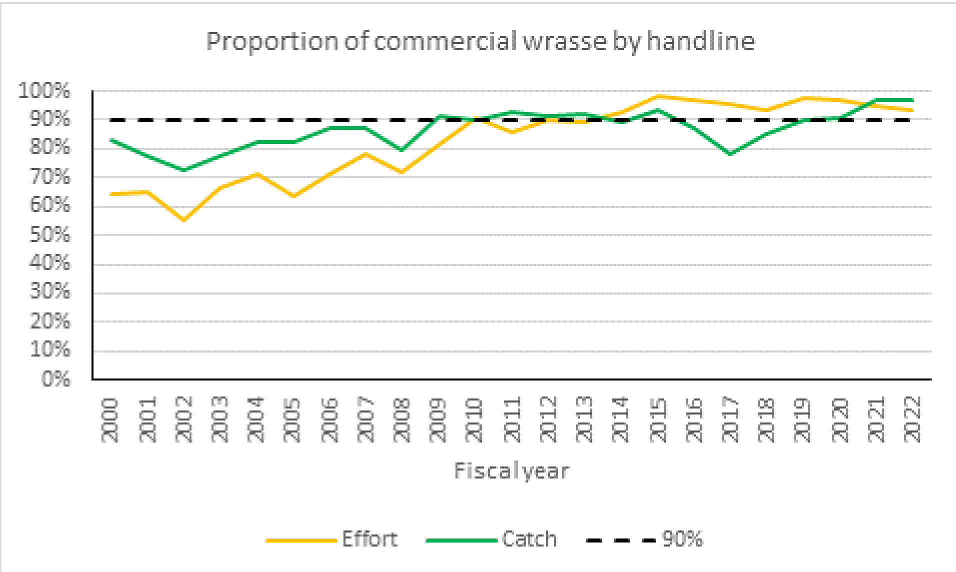
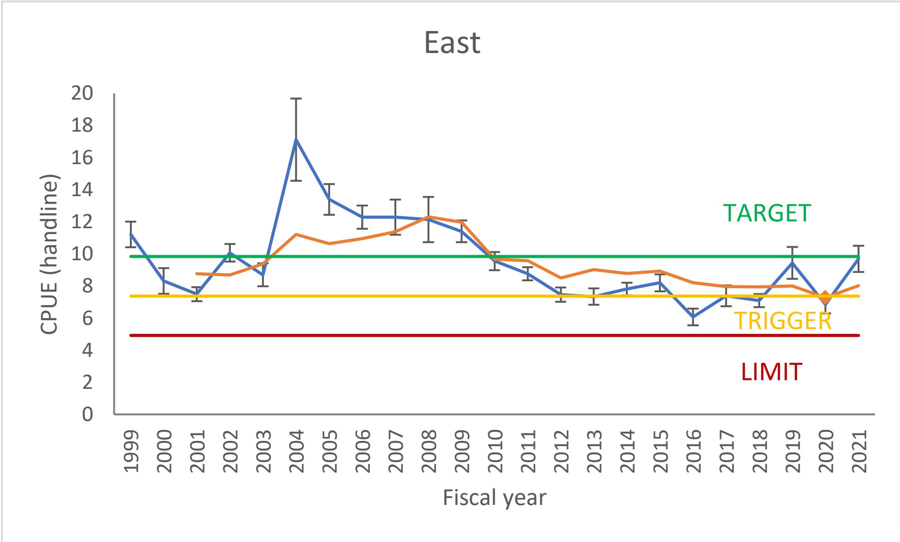


Figure 67 State-wide interannual change in total effort and catch during 2004–2022.

(a)



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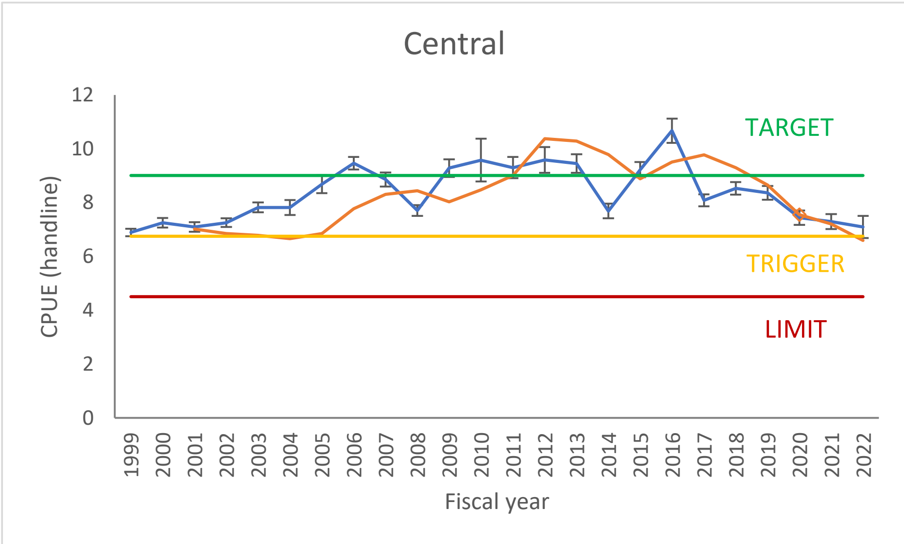

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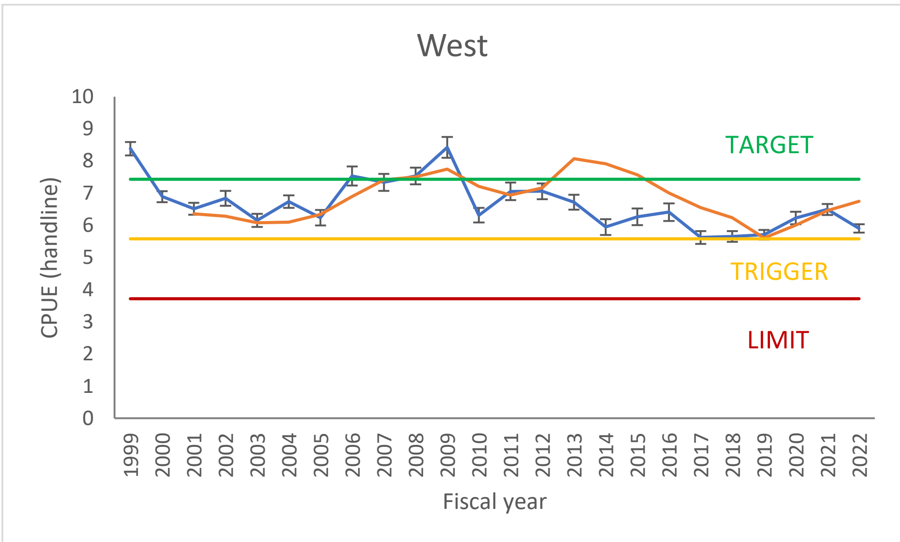


Figure 68 Catch-per-unit-effort (CPUE) of wrasse (all species) by commercial handline fishers in the (a) Eastern, (b) Central and (c) Western assessment zones during 1999–2022 financial years in accordance with the target, trigger and limit reference point specifications of the commercial wrasse harvest strategy. Blue line is nominal CPUE (mean kg/h ± SE) and orange line is 3 year moving average of CPUE standardised by GLMM.

Gummy Shark (*Mustelus antarcticus*)

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:

- Commonwealth assessment of total commercial gummy shark catch and modelled gummy shark pup production 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),
- Standardised 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 69). 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-Nooramunga mesh net) and decreased (Port Phillip Bay longline), with the latter a result of license buy-outs, but the former not necessarily related to targeting of Gummy Shark.

- *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 (Figure 70), potentially as a result of targeting this species due to the decreasing abundance of snapper (see snapper section). However, CPUE has declined somewhat in the last two years, which could be due to the introduction of a mixed species total allowable catch for the remaining fishers in Port Phillip Bay who may discard gummy shark in favour of the more valuable snapper. 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 71). It is difficult to determine whether this represents decreased gummy shark availability in the system as the same gear is used to target a range of species so CPUE can be unrelated to biomass. Recreational catch rates in Corner Inlet have been consistent over a five year period, with a slight decline in 2021/22 (Figure 72) Recreational catch rates in Western Port have been variable, showing no long term trend, throughout the time period analysed (Figure 73) and there has been a relatively consistent size composition of the catch (Figure 74) indicating that recruitment has been ongoing and fishing mortality is not high enough to decrease the proportion of larger fish in the population.

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 pup production of the Bass Strait stock was above the 48% of unfished levels (harvest strategy limit) and therefore sustainable at current catches. This assessment also projected future sustainable catches and the landings from the Commonwealth and state fisheries have remained below these projections. The information available in the 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-Nooramunga 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.

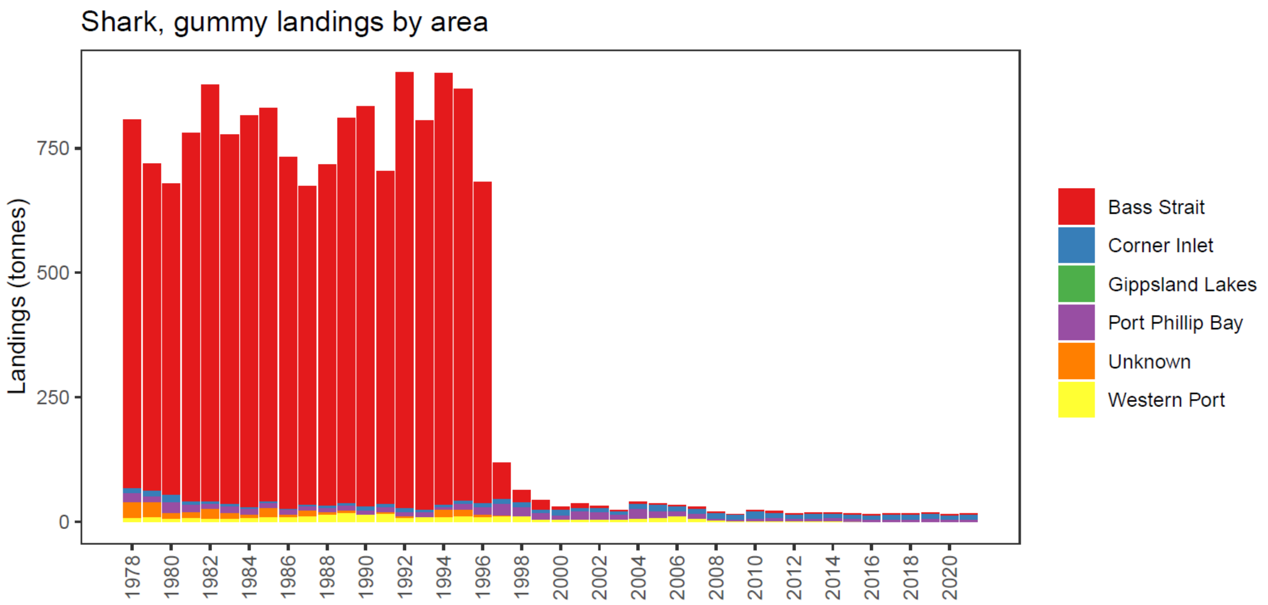


Figure 69 Total catch from the Victorian commercial Gummy Shark fishery by area by fiscal year during 1978–2020. Note from 1997 gummy shark in coastal waters transferred to Commonwealth management. Since 1997 most Gummy Shark harvested adjacent to Victoria were taken under Commonwealth issued licences and are not represented in this figure.

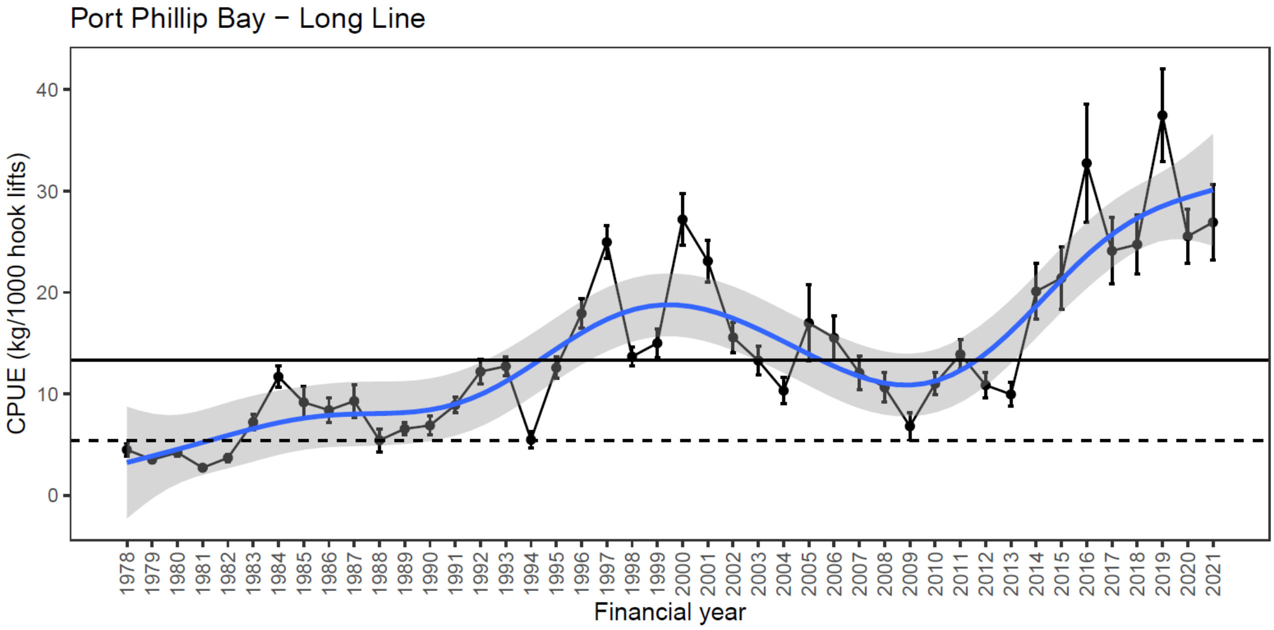


Figure 70 Nominal catch-per-unit-effort (CPUE) (±SE) of gummy shark by commercial longline fishers in Port Phillip Bay (1998–2021). Horizontal black line is the mean nominal CPUE during the reference period (1985–2015) and the dashed black line is the minimum standardised CPUE within the reference period. 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.

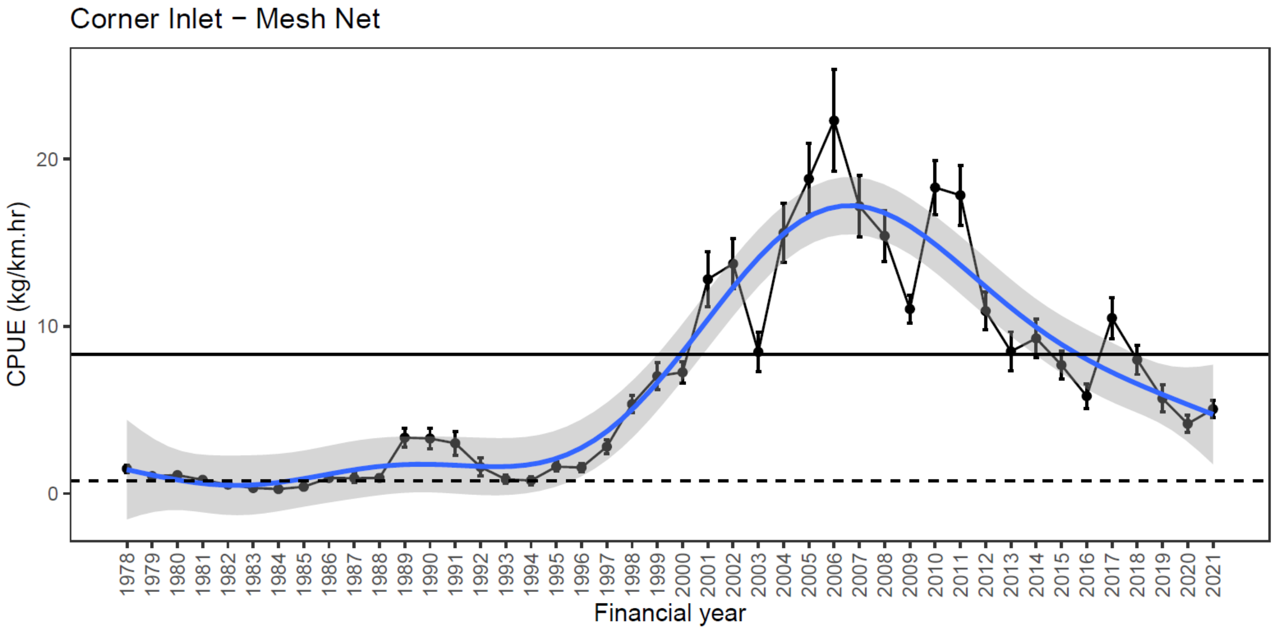


Figure 71 Nominal catch-per-unit-effort (CPUE) (±SE) of gummy shark by commercial mesh net for Corner Inlet (1998–2021). Horizontal black line is the mean nominal CPUE during the reference period (1985–2015) and the dashed black line is the minimum standardised CPUE within the reference period. Blue 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.

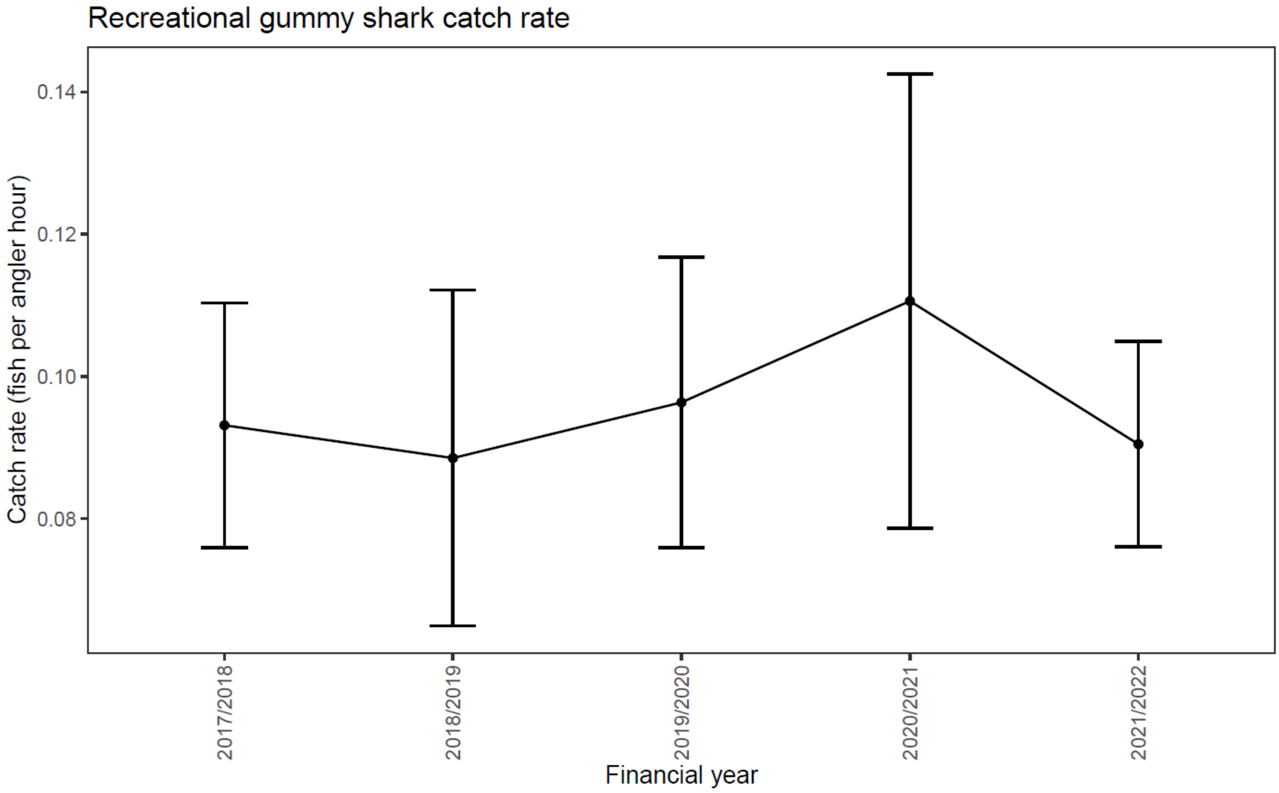


Figure 72 Catch-per-unit-effort (CPUE) of gummy shark by recreational anglers interviewed in creel surveys undertaken in Corner Inlet (CI) from 2017/18–2021/22 financial years.

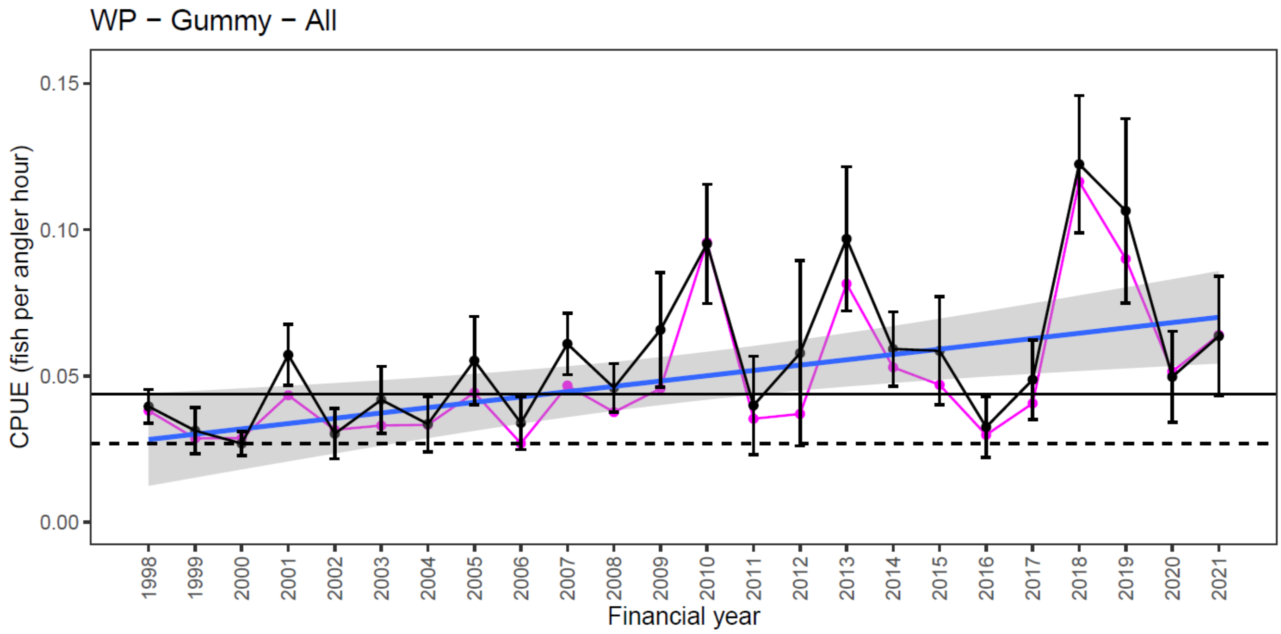


Figure 73 Catch-per-unit-effort (CPUE) of gummy shark by recreational anglers interviewed in creel surveys undertaken in Western Port (WP) from 1998–2021 financial years. Black line is nominal CPUE (±SE), magenta line is standardised CPUE, blue line is a generalised additive model (GAM) of the standardised 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.

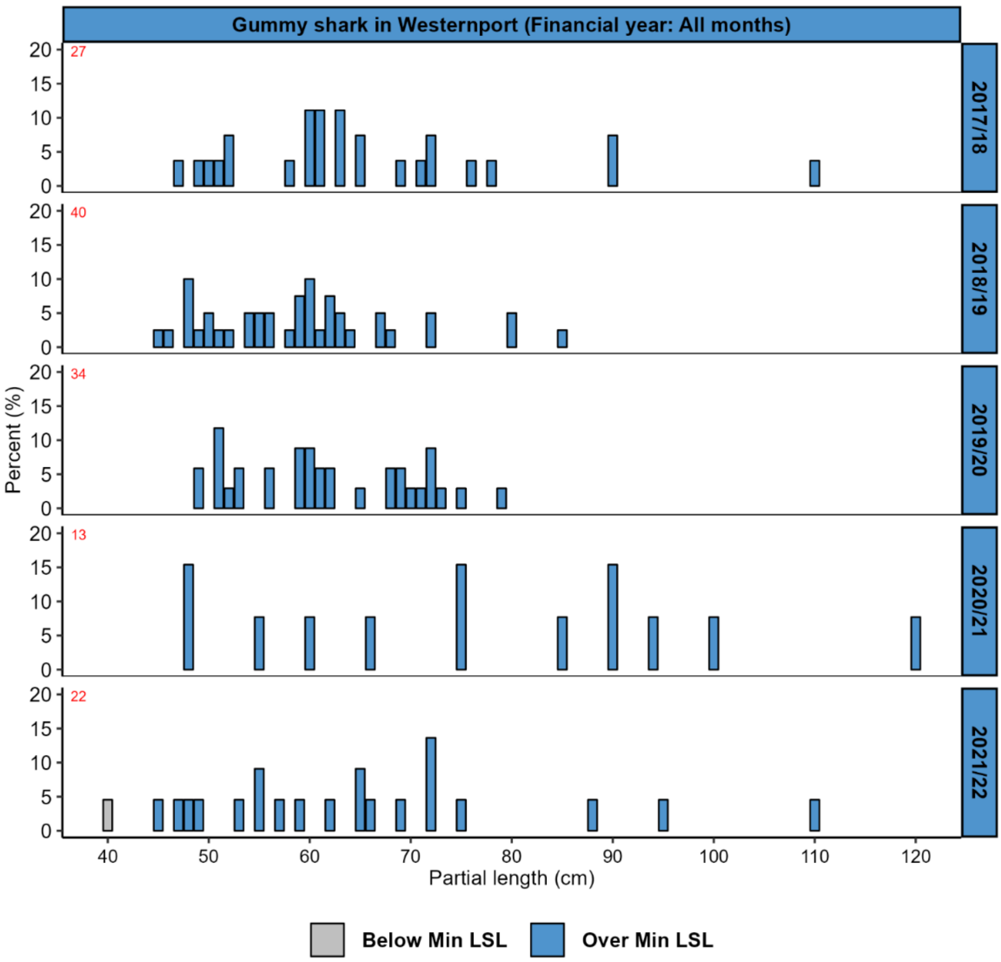


Figure 74 Frequency histograms of Corner Inlet length composition of gummy shark by fiscal years 2017/18 to 2021/22.

Silver Trevally (*Pseudocaranx georgianus, P. dentex, and P. wrighti*)

Stock Structure and Biology

The Victorian silver trevally population is part of a broader south-eastern Australian stock. The common name refers to three species from the genus *Pseudocaranx* which are not differentiated in catches, *P georgianus*, *P. dentex*, and *P. wrighti*. 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 (now closed to commercial fishing), 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 the reference period 1998–2015.
- The impact of fishing pressure was assessed using time series of commercial catch and effort.

This assessment found:

- *Fishing pressure* – In Victoria, 100–300 t were landed in Bass Strait using mesh nets between 1978/79 and 1991/92 (Figure 75), 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 Corner Inlet-Nooramunga, Gippsland Lakes, and Port Phillip Bay with a declining catch trend through time as effort with this gear has declined due largely to the latter two fisheries being closed. Landings have been around 50 t or less for the last ten years, being the lowest on record at 8.4 t in 2021/22. Silver Trevallies are targeted and caught as byproduct by recreational fisheries throughout the state but there is no current information on recreational landings.
- *Biomass* – There has been high variability in nominal CPUE from seine netting in Corner Inlet-Nooramunga. This is likely to reflect varying abundance in inshore waters as silver trevally enter the inlet use its seagrass beds in as nursery grounds and are mostly caught as a by-product while targeting other species. Catch rates, while variable, peaked between around 1998 to 2008, but have subsequently declined to approximate levels observed prior to 1998. However, the large interannual fluctuations in nominal CPUE indicate that the actual trend is uncertain (Figure 76).

-

Stock status summary: The low landings of in recent years arising from low seine netting effort in Victoria implies that fishing operations are unlikely to cause impaired recruitment under current practices, particularly due to the fact effort will remain low due to the closure of most bay and inlet fisheries. Given the high catch rates observed in Victorian waters during recent years and low levels of effort, it is unlikely that Silver Trevallies in Victoria are depleted or at risk of becoming recruitment impaired. The current level of fishing mortality in Victoria is unlikely to cause the stock to become recruitment impaired yet the available evidence indicates that the status of the stock is uncertain.

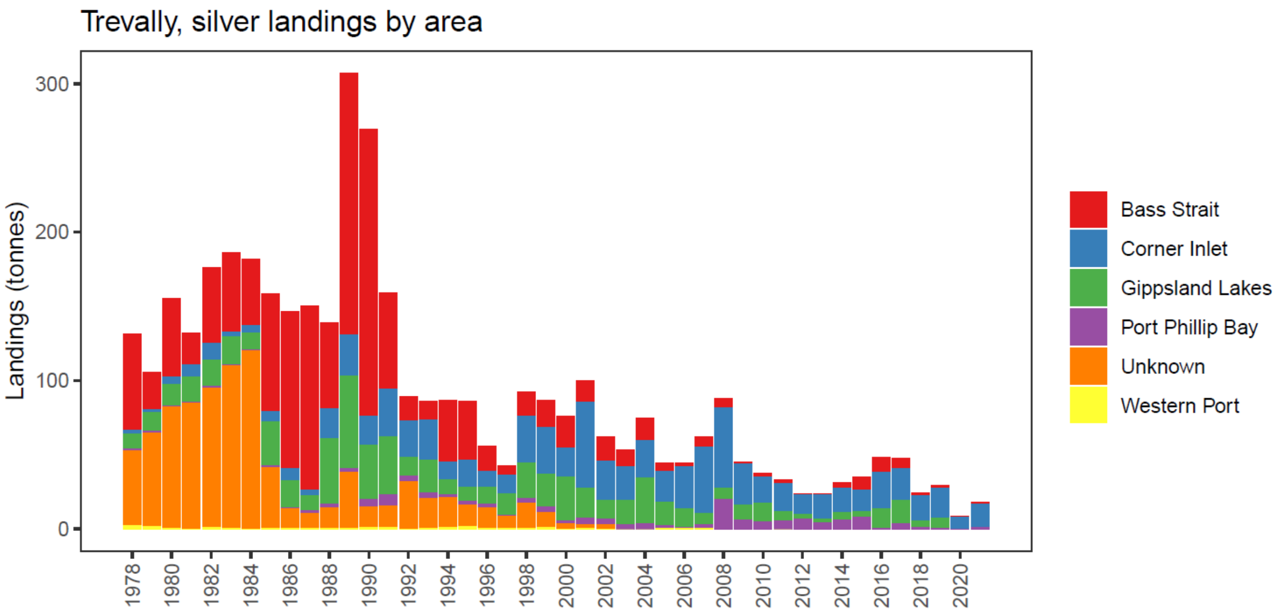


Figure 75 Total commercial catches of silver trevally by area in Victorian waters, 1978–2021 financial years.

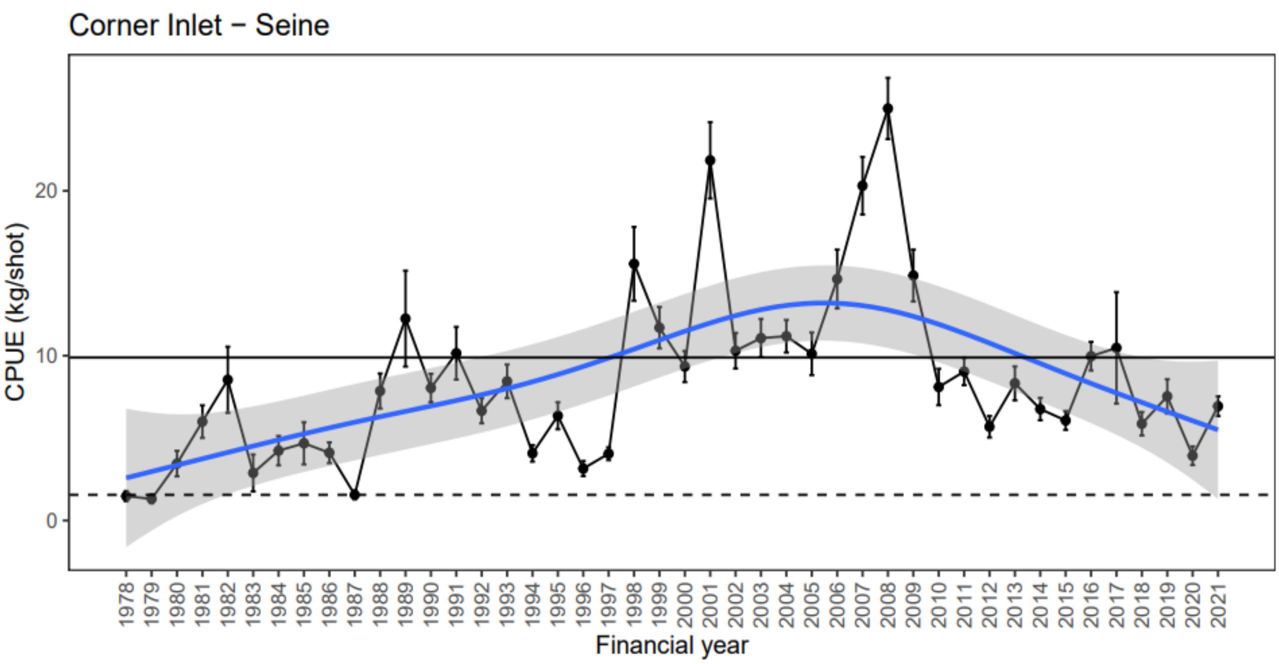


Figure 76 Nominal Catch-per-unit-effort (CPUE) (±95% CL) of catches of silver trevally taken by commercial seine from Corner Inlet (1978–2021 financial years). The blue line is a generalised additive model (GAM) of the CPUE trend with the shaded area representing 95% confidence intervals of the model. 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.

Southern Bluespotted Flathead (*Platycephalus speculator*)

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 77). 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 77) 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 77). The recent increase in harvest from Corner Inlet-Nooramunga represents a notable increase in fishing pressure.
- *Biomass* – Creel survey CPUE in PPB shows an overall declining trend since 2010 (Figure 78). 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 79a, 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.

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.

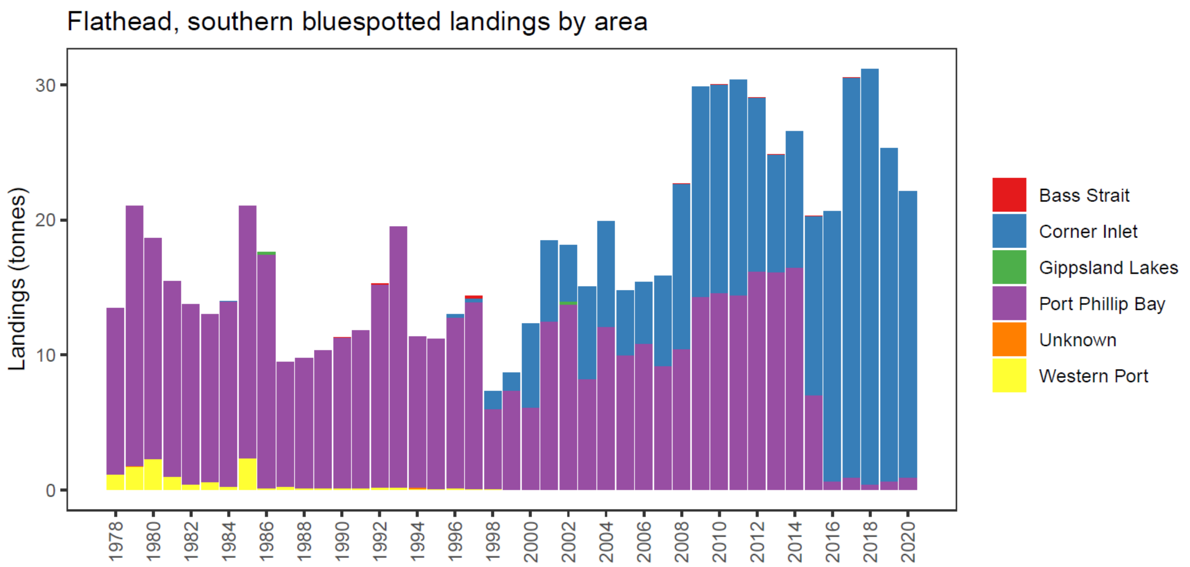


Figure 77 Total commercial catches of southern bluespotted flathead by area in Victorian waters, financial years 1978–2020.

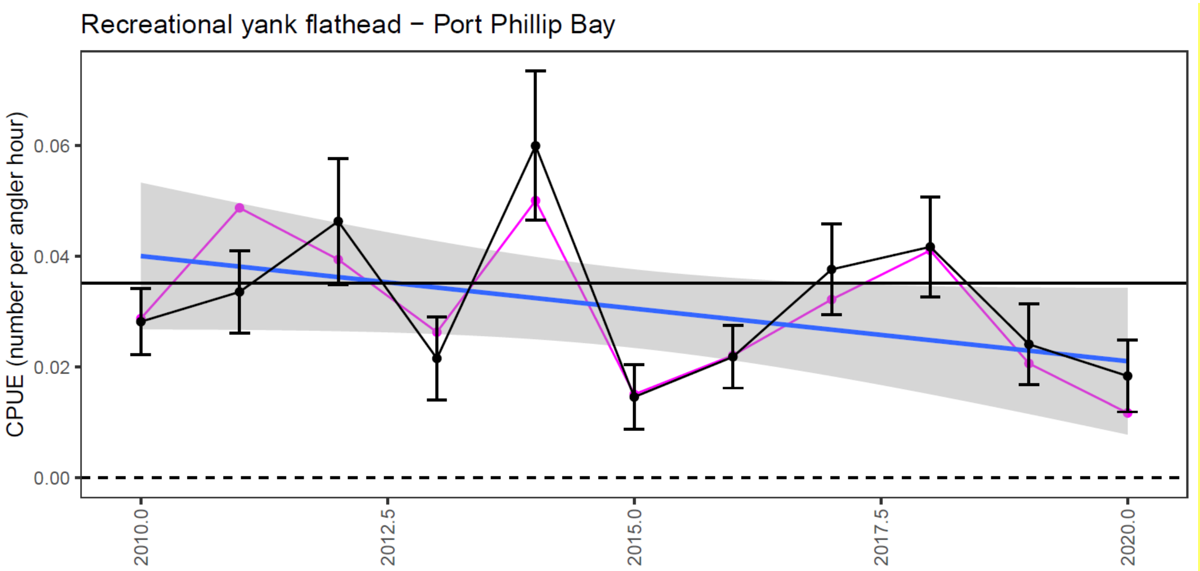
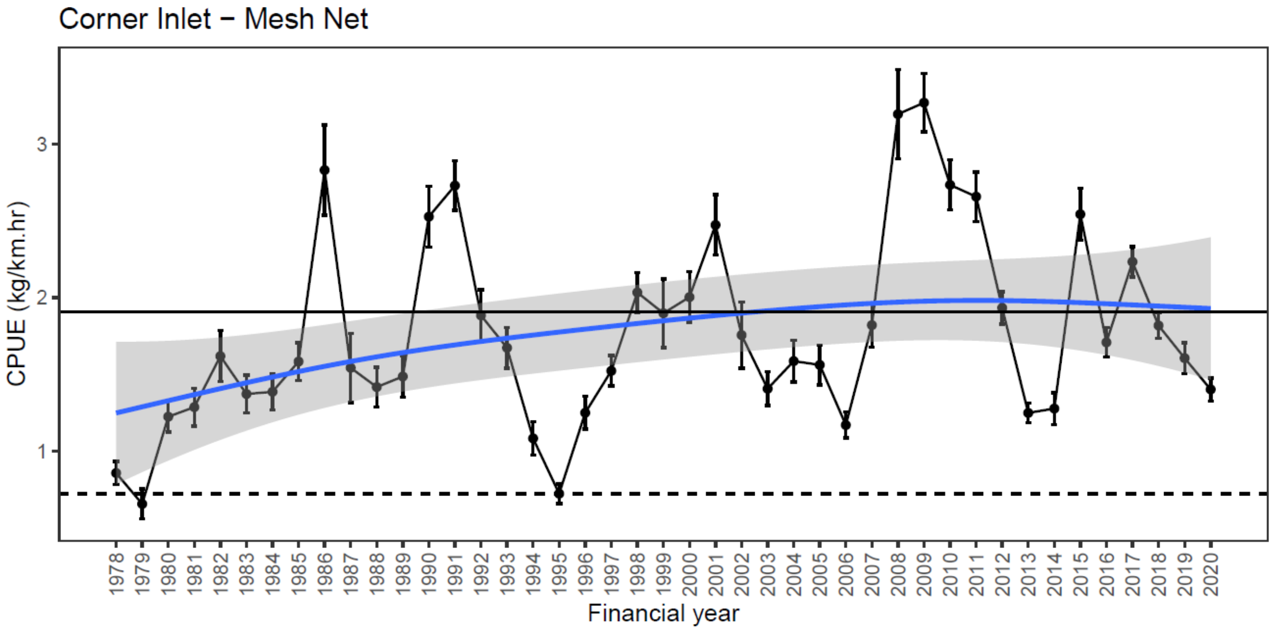


Figure 78 Creel southern bluespotted (yank) flathead CPUE during 2010-2020 standardised (GLMM) for geographic area, season and category of angler.

(a)



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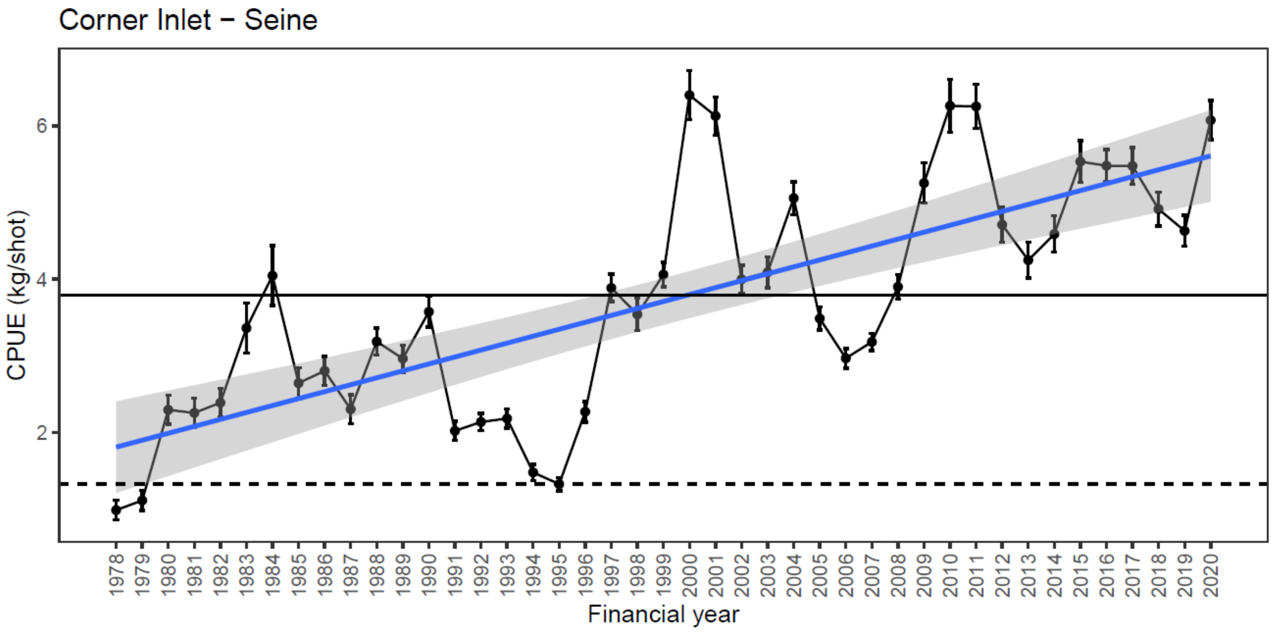


Figure 79 Catch-per-unit-effort (CPUE) (±SE) of southern blue spotted flathead (a) commercial mesh net and (b) commercial seine net Corner Inlet-Nooramunga (financial years 1978–2020). Blue line is a generalised additive model (GAM) of the standardised CPUE trend with the shaded grey area representing 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.

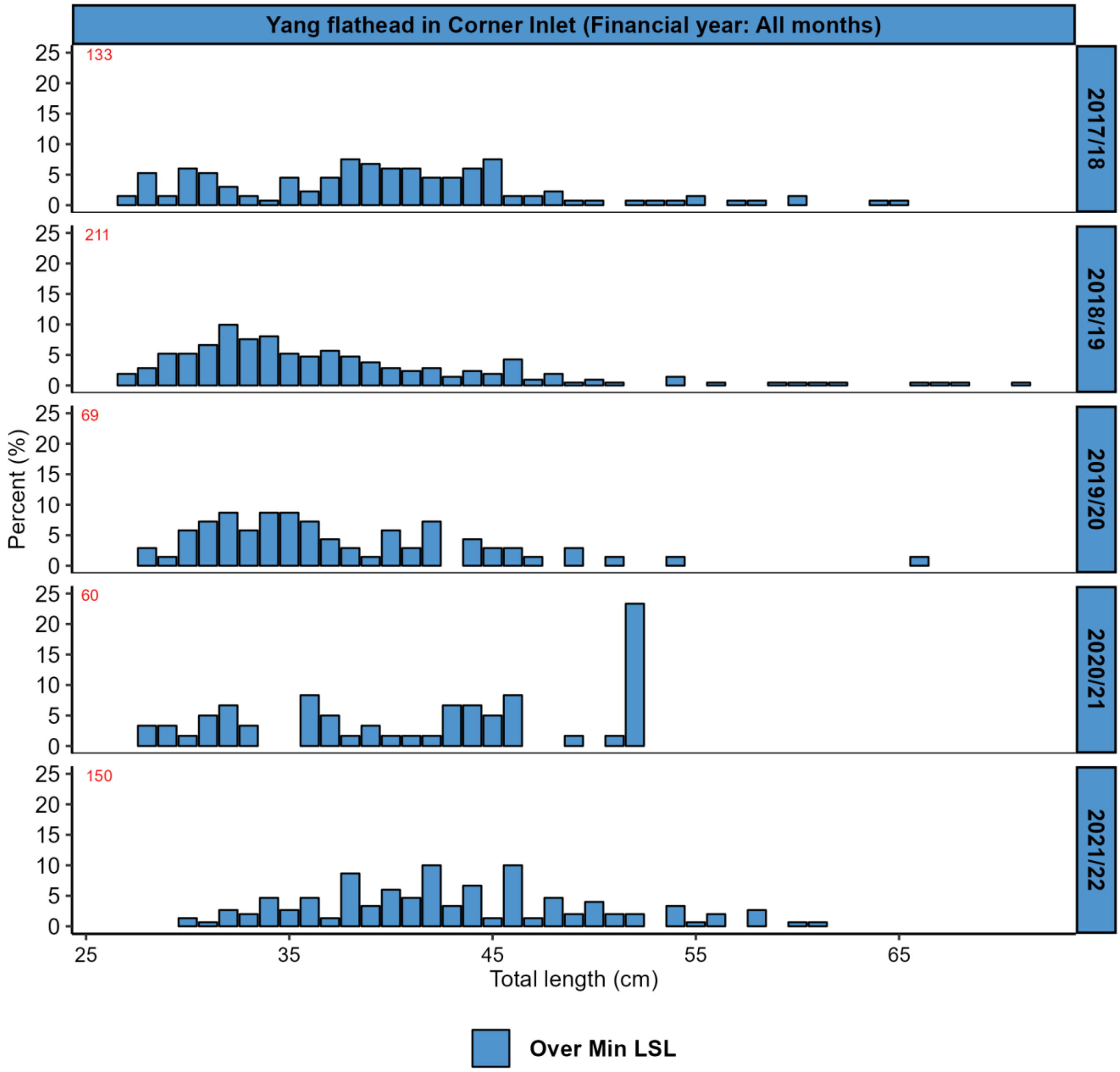


Figure 80 Frequency histograms of Corner Inlet recreational fishery southern bluespotted flathead creel survey length composition. Red numbers indicate numbers of fish measured. LSL = legal size limit.

Sand Crab (*Ovalipes australiensis*)

Stock Structure and Biology

The stock structure of sand crab in Victorian waters is unknown. Sand crab can grow to a carapace width (CW) of up to 20 cm.

Management/Assessment Unit

The Victorian sand crab populations support a commercial inshore trawl fishery in Bass Strait, mainly off Gippsland (Figure 81). The extent of the recreational fishery is unknown. This report considers the population of sand crab in Victorian waters as a state-wide management unit.

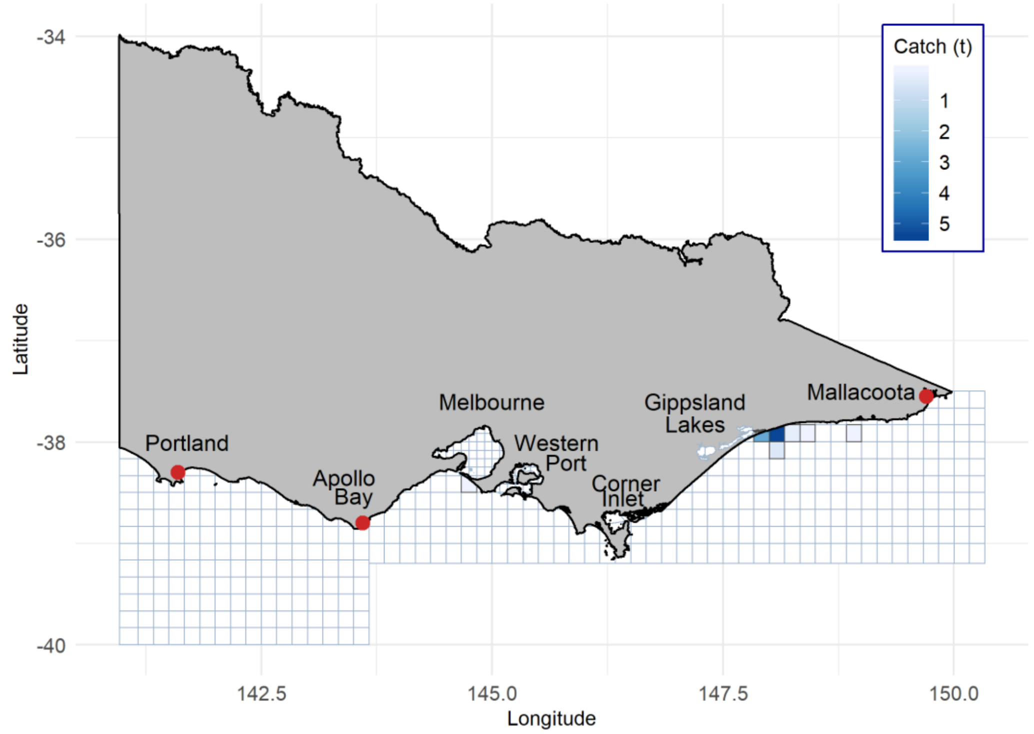


Figure 81 Spatial distribution of state-wide landings of sand crab from Victorian fisheries during the 2018/19 financial year. Most sand crab are taken by trawl method in the Victorian Inshore Trawl fishery.

Assessment Summary

For this assessment, the status of the sand crab biomass was evaluated using:

- CPUE trends for the commercial inshore trawl fishery. Due to changing discard practices, the data were filtered to only include trawl shots with a catch of >0 kg to ensure that fishers were retaining sand crabs when caught. The performance of the CPUE biomass proxy was assessed in relation the average and minimum values for the reference period of 1998–2015.
- The impact of fishing pressure was assessed using time series of commercial catch and effort.

This assessment found:

- *Fishing pressure* – Landings of sand crab peaked in the late 1990s to early 2000s and again in 2014-2016 with the earlier peak coinciding with peak fishing effort in the inshore trawl fishery (Figure 82) (see Appendix 2). The peak landings in recent years coincided with relatively stable fishing effort and are a result of greater proportion of targeting and retention of this species compared with other species.
- *Biomass* – CPUE of sand crabs has varied considerably with some years (1998, 2014) being more than double the mean CPUE of the reference period and others (2008, 2012) approaching the minimum observed in the reference period (Figure 83). However, there were occasions when sand crabs have been discarded due to low market value (e.g. mid-2000s to mid-2010s) rendering CPUE potentially unreliable as an indicator of biomass. Nevertheless, the relatively high landings in recent years are consistent with that a large proportion of those caught being landed and CPUE remains well above its historic low, although it is currently trending downward and is below the reference period average, warranting future monitoring.

Stock status summary: The inshore trawl fishery effort is about half of the historic level and CPUE remains relatively high, albeit slightly below the average during the reference period. Sand crabs are abundant throughout the state, including the bays and inlets, and while there is some possibility of local depletion in the relatively small area they are fished, there is minimal possibility that the current inshore trawl fishery represents a risk to the Victorian stock as a whole. Additionally, recreational catches are likely to be relatively small and localised. Based on the limitation posed by sporadic changes in retention rates there is uncertainty in interpreting stock status from the available evidence.

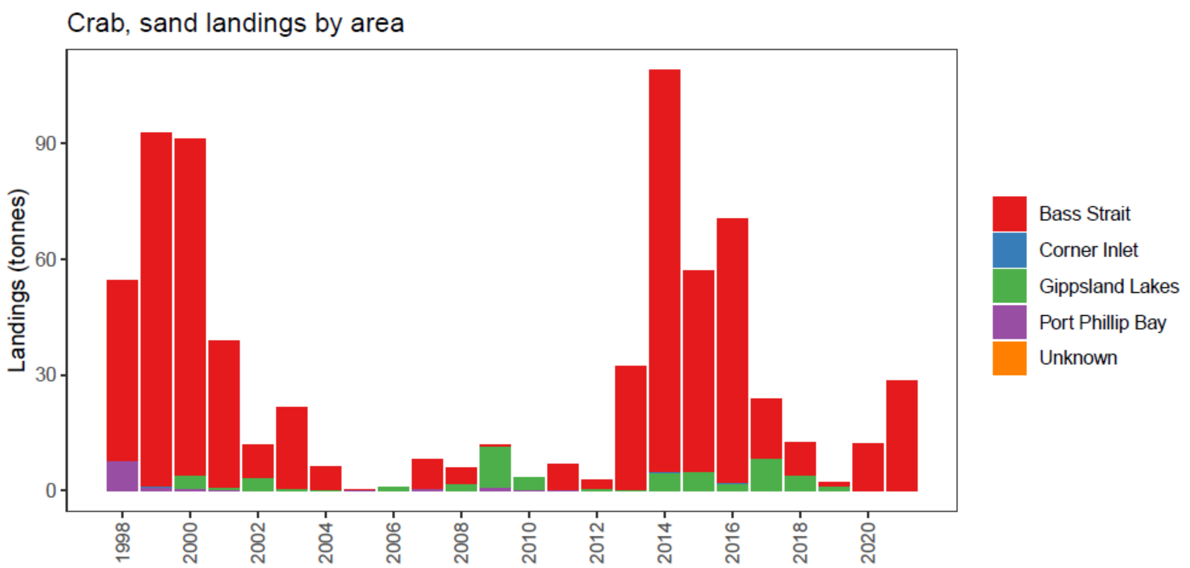


Figure 82 Total commercial catches of sand crab in Victoria by area, financial years 1998–2021 fiscal years.

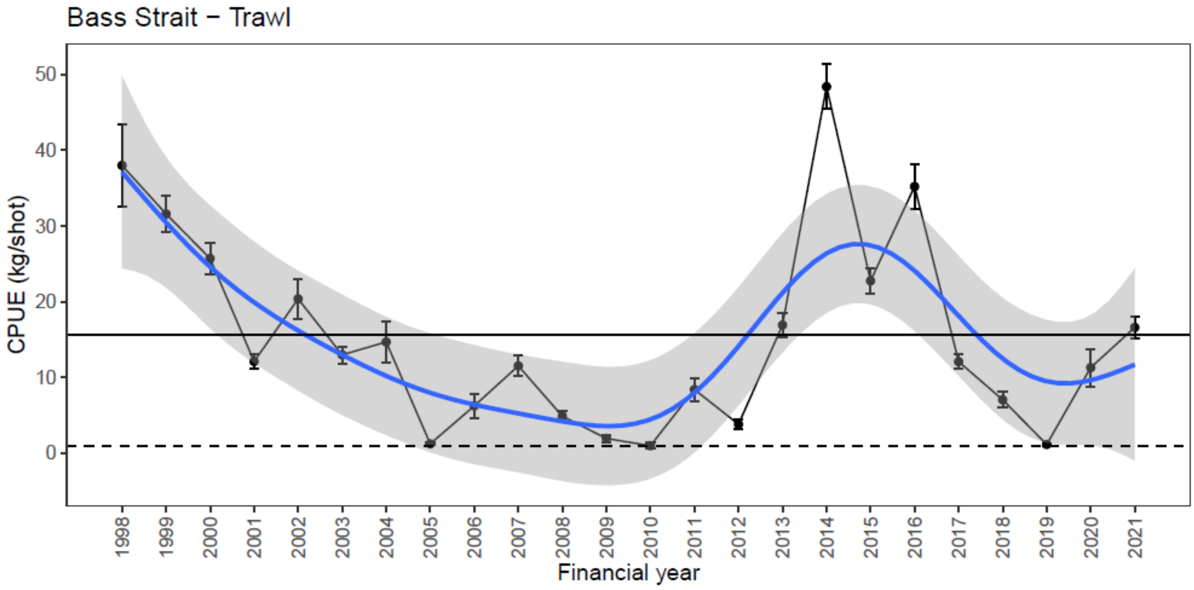


Figure 83 Catch-per-unit-effort (CPUE) (±95% SE) of sand crab for the commercial inshore trawl fishery from 1998–2021 fiscal years (black line). The blue line is a generalised additive model (GAM) of the CPUE trend with the shaded area representing 95% confidence intervals of the model. The black horizontal line is the average of the reference period (1998–2015) and the dashed line is the minimum observed value during the reference period. Note: prior to 1998 there was minimal inshore trawl effort and there was some inconsistent reporting meaning these data were deemed insufficiently accurate to derive biomass trends using CPUE so were thus omitted.

Eastern (*Arripis trutta*) and Western (*A. truttaceus*) Australian Salmon

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 and at their lowest in 2021/22 (Figure 84), 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 85). A very large downward spike was observed in 2021/22 which saw landings below reference levels for the first time in decades, this is thought to be partly due to a low number of shots and an inability for fisherman to land a large school (Figure 85). 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.

Stock status summary: 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.

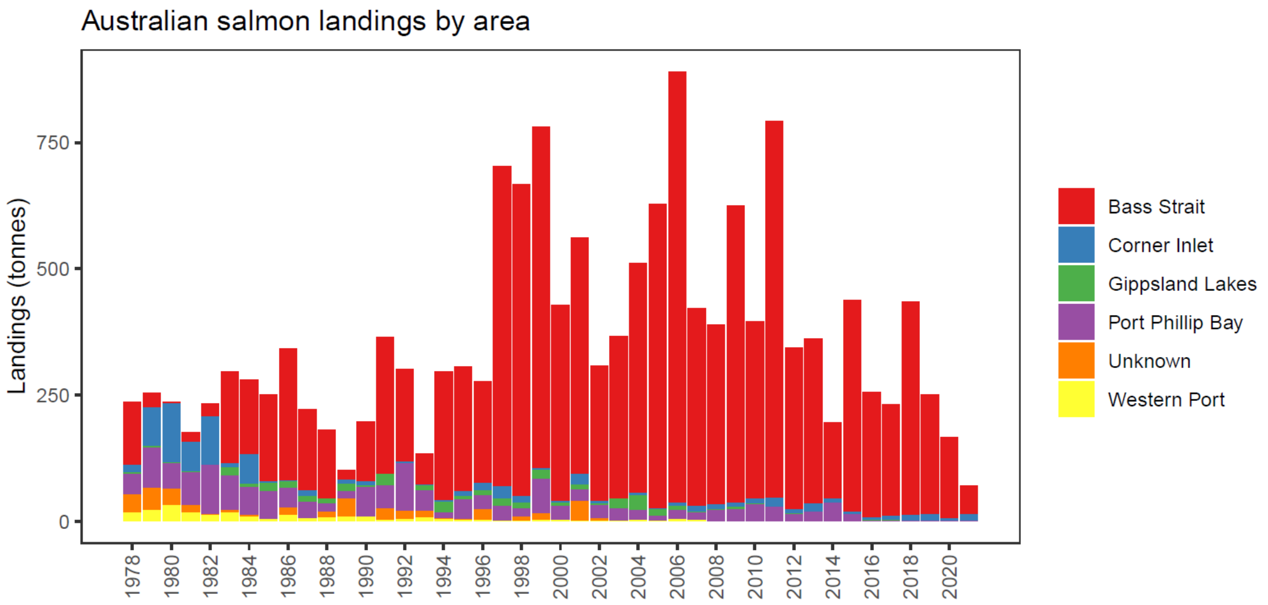


Figure 84 Total catch of Australian salmon in Victoria from the commercial fishery by area, financial years 1978–2021.

Western Australian salmon

Stock status summary: 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, nor is the species a common target of recreational fishers in the major Victorian 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 that 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 (Wise and Molony 2018). Based on the above, western Australian salmon in Victoria is considered to be sustainable.

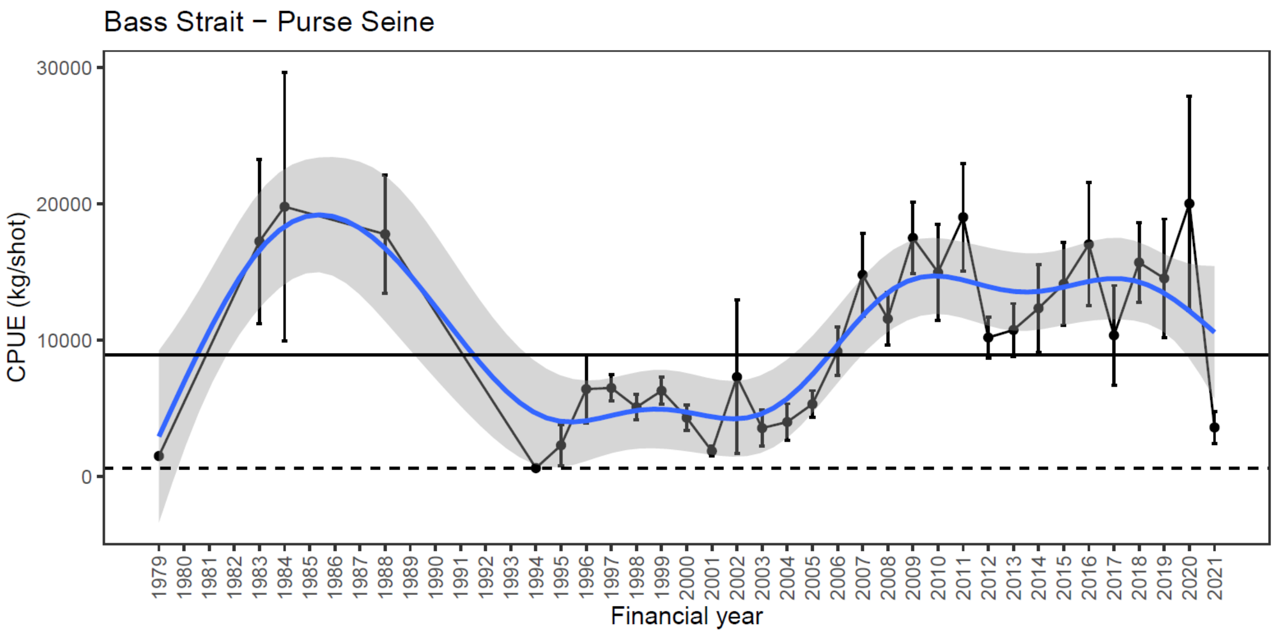


Figure 85 Nominal Catch-per-unit-effort (CPUE) (±95% CL) of catches of eastern Australian salmon for the commercial purse seine ocean fishery (1997–2021 financial years). The blue line is a generalised additive model (GAM) of the CPUE trend with the shaded area representing 95% confidence intervals of 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.

Tailor (*Pomatomus saltatrix*)

Stock Structure and Biology

Information about the stock structure of tailor populations is limited, although there is considerable genetic divergence between eastern and western Australian populations. This assessment focusses on Gippsland Lakes, where tailor is part of a straddling, south-eastern Australian stock shared with New South Wales and Queensland. Tailor can live to 11–13 years of age and reach 120 cm TL. Tailor will mature (50 percent) at 1–2 years of age (males 29 cm TL; females 31 cm TL) and are highly fecund and are fast growers. The main spawning period for the south-eastern Australian tailor stock occurs in winter/spring in coastal waters.

Management/Assessment Unit

The Victorian component of the south-eastern Australian stock supports a commercial fishery and a small recreational fishery in Gippsland Lakes. This report and previous editions only consider populations in Gippsland Lakes. It is important to note that past commercial catches of tailor from Gippsland Lakes, and throughout Victoria more generally, were an order of magnitude lower than in New South Wales and Queensland, and the impact of the Gippsland Lakes fishery was likely to have had negligible influence on overall stock status. Since closure of the commercial fishery there is only an unknown but presumed low level of recreational fishing mortality impacting the Gippsland Lakes stock.

Assessment Summary

The status of tailor stocks in Victoria was evaluated using:

- Nominal CPUE for the commercial mesh-net fisheries in the Gippsland Lakes. Tailor are also infrequently captured by fishers in Corner Inlet and by purse seine fishers offshore, however there were insufficient data available from these fisheries to inform temporal abundance trends.

This assessment found:

- *Fishing pressure* – State-wide commercial tailor harvest has been variable from <20 t to nearly 100 t representing changes in targeting, retention rates and availability of this highly mobile species (Figure 86). Landings in the last ten years have also been variable but well within the bounds of historical peaks observed during the 1980s to 2000s.

- *Biomass* – Prior to cessation of commercial fishing in Gippsland Lakes, nominal CPUE of tailor from the mesh net fishery was variable, likely because of variation in targeting, retention rates and availability. Although there was an overall slow decline in CPUE, very high spikes in 1998 and 2003 with large associated variance contrasted markedly with greater stability in the last decade of the fishery where in most years values were close to the average and variance in the data was small.

Stock status summary: There is no evidence that recruitment to the stock has ever been impaired by the Gippsland Lakes fishery and the available evidence suggests that the now exclusively recreational fishery in Gippsland Lakes should remain sustainable under current and future conditions.

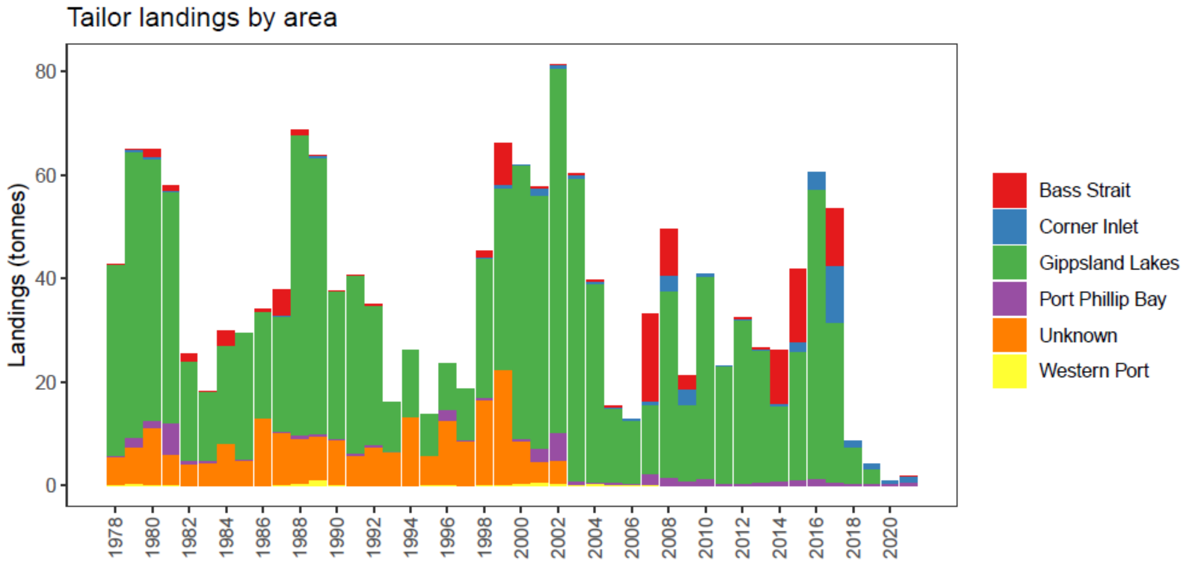


Figure 86 Total commercial catch of tailor in Victoria, financial years 1978–2021.

Elephant Fish (*Callorhinchus milii*)

Image source: Status of Australian Fish Stocks 2018

Stock Structure and Biology

Elephant fish populations in Victorian waters comprise a portion of a single biological stock for south-eastern Australia. Elephant fish live to ~20 years (Bell, 2012) and sexual maturity is attained at 59 and 54 mm fork length for females and males respectively (Bell, 2012). Based on the ovarian cycle, elephant fish lay 20–30 eggs per year from February – May, which are deposited on soft sediment habitats (Bell, 2012) and hatch after around 5–6 months. Known egg laying areas include Western Port, Port Phillip Bay, Corner Inlet, and the Barwon River (Bell, 2012) but elephant fish are also found in many other Victorian coastal areas, bays and estuaries during their reproductive season suggesting a proportion of the population lays eggs throughout much of the state. Western Port was the major known egg laying habitat for the species within Victoria with the species being so abundant that they once were the target of a relatively large recreational fishery.

Management/Assessment Unit

Elephant fish were historically landed in low to moderate quantities by commercial bay and inlet fisheries, particularly in Western Port. However, due to buy backs in Western Port and Port Phillip Bays, there have been no landings in recent years, and the landings from Corner Inlet are insufficient to support quantitative analyses. As a result, the status of the Victorian stock is estimated using catch and effort information from the recreational fishery in Western Port, supplemented by information from the Commonwealth Southern and Eastern Scalefish and Shark Fishery (SESSF).

Assessment Summary

The performance of the CPUE biomass proxies from creel surveys of the recreational fishery in Western Port Bay were assessed in relation to the average and minimum values for the reference period 1998–2015.

This assessment found:

- *Fishing pressure* – The buy-out of commercial fishing licences in Western Port and, to a lesser extent, Port Phillip Bay, has largely removed any commercial take of elephant fish from Victorian waters. Elephant fish were once a popular target of recreational fishers in Western Port, with ~45 t of elephant fish landed in 2008 by recreational fishers and ~70% of the recreational catch being comprised of mature females that had moved inshore to reproduce (Braccini et al. 2008). When combined with State (Figure 87) and Commonwealth landings this was unlikely to be sustainable, so daily bag limits were reduced to one elephant fish per angler (previously three) to reduce fishing mortality. In 2021/22, of >200 creel survey interviews, no anglers reported targeting elephant fish suggesting there is almost no targeted effort toward this species now.
- *Biomass* – Standardised recreational CPUE trends among recreational fishers in Western Port were relatively stable from 1998–2007 before declining markedly (Figure 88). It is believed that this reduction in CPUE resulted from declining availability of elephant fish in Western Port. Standardised CPUE from the Commonwealth shark gillnet fleet shows relatively stable, albeit slightly declining trends from 2008–2021, though there is some uncertainty surrounding the accuracy of gillnet CPUE for elephant fish as they are not targeted (the fishery targets gummy shark) and are often discarded, but at an unknown rate (Patterson et al. 2022; Sporcic, 2021).

Stock status summary: Standardised CPUE is now below the minimum observed during the reference period and the recreational fishery in Western Port is not performing adequately, with no targeted fishing observed in 2021/22 in >200 creel surveys. This could be caused by several reasons: 1) the reduction in daily bag limit has reduced fishing effort for elephant fish; 2) there may be fine scale population structuring and the stock that once supported the recreational fishery in Western Port is currently depleted to relatively low abundance but is not a major component of the SESSF meaning that this reduction is not reflected in analytical results based on data from the SESSF; 3) changes in discard rates within the SESSF fishery have masked the reduction in biomass of the stock. While all the above are plausible, it is most likely that the reduced abundance of elephant fish in Western Port is linked to changes in seagrass communities. Elephant fish were rare in Western Port prior to the 1980's (Figure 87), becoming more common from around that time, which corresponded with declining seagrass abundance that likely increased available suitable egg-laying habitat (Bell, 2012). In recent years, as seagrass communities have begun to increase in Western Port, there has been a reduction in the available egg-laying habitat, and general abundance, of elephant fish (Bell, 2012).

The above uncertainties, in both Western Port and offshore, create uncertainty about the current status of the stock.

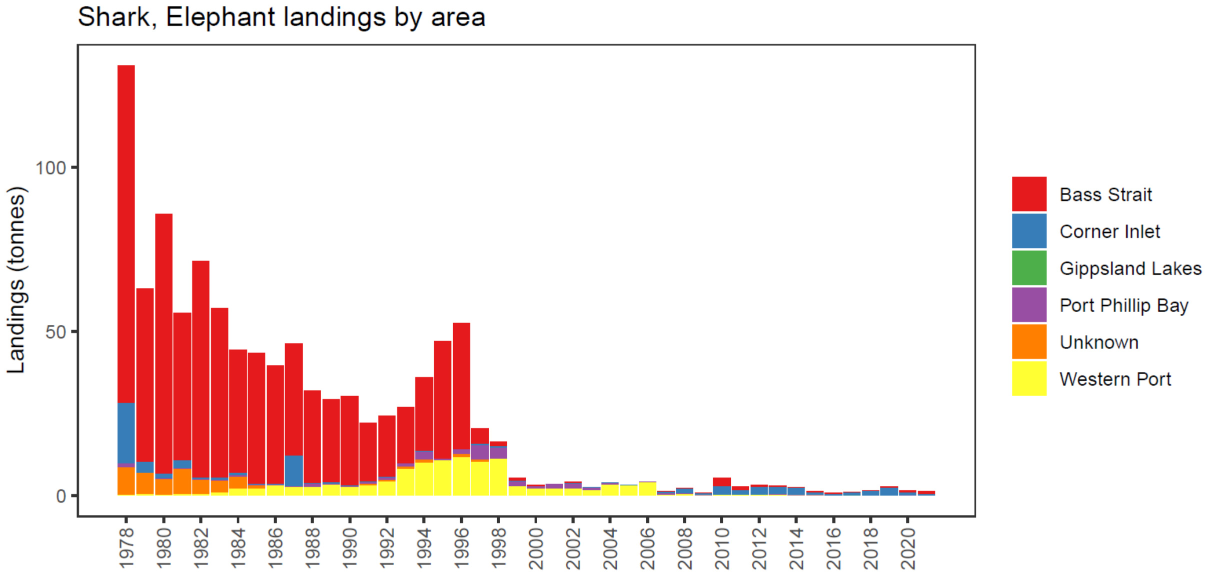


Figure 87 Total commercial catch of elephant fish in Victoria, financial years 1978–2021.

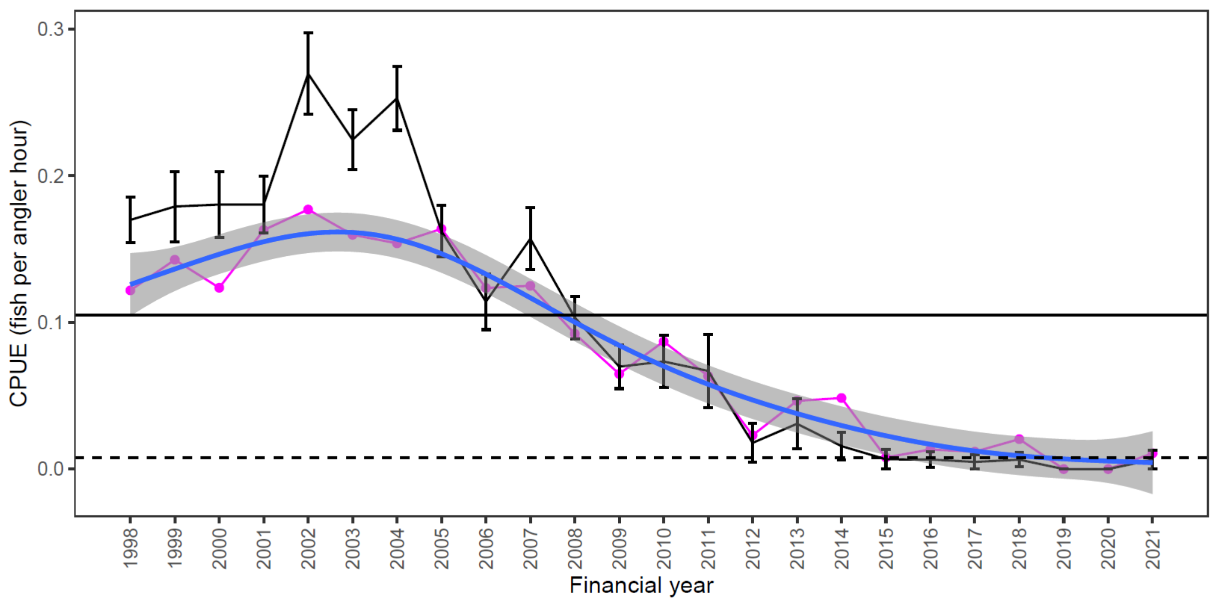


Figure 88 Catch-per-unit Effort (CPUE) of elephant fish by recreational anglers interviewed in creel surveys undertaken in Western Port Bay from 1998–2021 financial years. Black line is nominal CPUE (±SE), magenta line is standardised CPUE, blue line is a generalised additive model (GAM) of the standardised 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.

Estuary Perch (*Macquaria colonorum*)

Stock Structure and Biology

Estuary Perch inhabit estuaries throughout Victoria, although they are only highly abundant in several of these: the Glenelg, Hopkins, Tarwin and Bemm rivers. In these estuaries they support predominantly recreational fisheries, with only low commercial catches taken as by-product from the Gippsland Lakes (). Estuary Perch live for over 40 years, but their populations are often comprised of very few year classes (Walsh, 2010). This is thought to occur because the highly variable estuarine environments they inhabit are infrequently conducive to successful recruitment and their long lifespan ensures a proportion of the population survives for enough years to encounter suitable spawning conditions to perpetuate the population.

Management/Assessment Unit

Estuary perch, as their name suggests, inhabit estuarine systems and therefore it would be illogical to assess their status on a state-wide basis. As such, the status of estuary perch is assessed for individual estuaries for which sufficient data are available.

Assessment Summary

There are insufficient data from commercial fisheries to enable assessment of Estuary Perch populations. As such, recreational angler diary programs are used to derive the data required to calculate CPUE in the estuaries where the major estuary perch fisheries exist in western Victoria. This excludes the Tarwin and Bemm rivers and other small estuaries for which data were inadequate or unavailable.

The performance of the CPUE biomass proxies were assessed in relation to the specified reference period (2001–2015 and 1999–2015 for Glenelg and Hopkins rivers respectively).

Glenelg River

This assessment found:

- *Fishing pressure* – There is no direct information on the amount of fishing pressure on the estuary perch population in the Glenelg River. However, they are reaching very large sizes with more than half of the catch being >40 cm in 2017/18 (Figure 90a) suggesting fishing mortality is likely to be relatively low. Given the Glenelg River is relatively remote, and recreational anglers often release the estuary perch that they catch, the current level of fishing pressure is unlikely to be pose a risk to estuary perch populations in this system.
- *Biomass* – Catch rates of estuary perch in the Glenelg River have been well above the reference period average in recent years, and the interannual trend has been increasing, but the sample size is low prior to 2012 meaning there is minimal information upon which to benchmark current catch rates (Figure 91). The available evidence suggests that there has been poor recruitment of estuary perch in the Glenelg River in recent years because; 1) undersized (juvenile) estuary perch were prevalent in catches during 2013 and 2014 but then became scarce in 2015 and have been non-existent in the last two years (Figure 90 a, b), and 2) there has been a truncation in the size range of the catch at its lower end with most fish being 30 – 50 cm in length. However, the angler diarist responsible for providing most of the recent data in recent years predominantly fishes well upstream and targets large fish meaning the lack of juveniles may be a biased result which does not reflect of poor recruitment.

Stock status summary: Catch rates have been high in recent years in the Glenelg River and given the proportion of large fish in the system, fishing mortality is likely to be relatively low. However, a lack of juveniles in the data could mean poor recruitment in recent years. Estuary perch are a long-lived species, with this strategy thought to be required to bridge the gap between successful recruitment events, which are less prevalent in highly variable estuarine environments. A more targeted sampling regime is required to determine whether there has been a lack of recruitment, or the fisher's practices are responsible for the lack of juveniles in the sample. Ageing data would be very useful to estimate the number of successful recruitment events that the fishery is reliant upon. It would also enable the level of fishing mortality to be estimated more accurately. Given there is minimal historic information, and it is possible that there has been poor recruitment in recent years, there is some risk that the fishery could become depleted in the future. Based on the evidence available the status of the Glenelg River estuary perch stock remains uncertain.

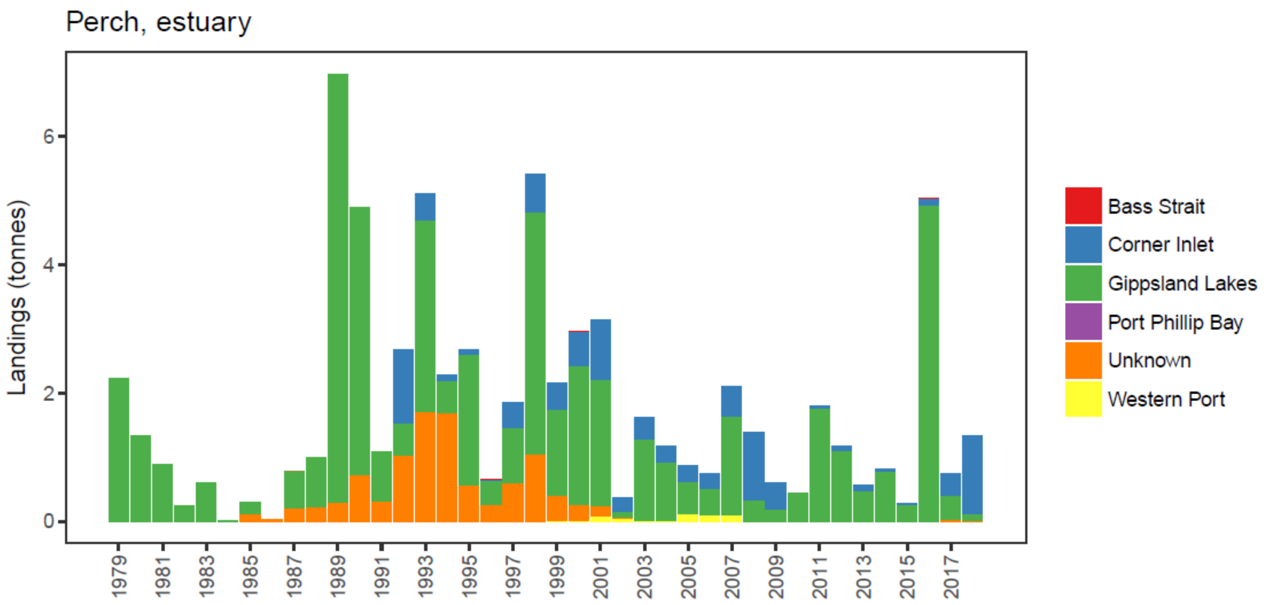
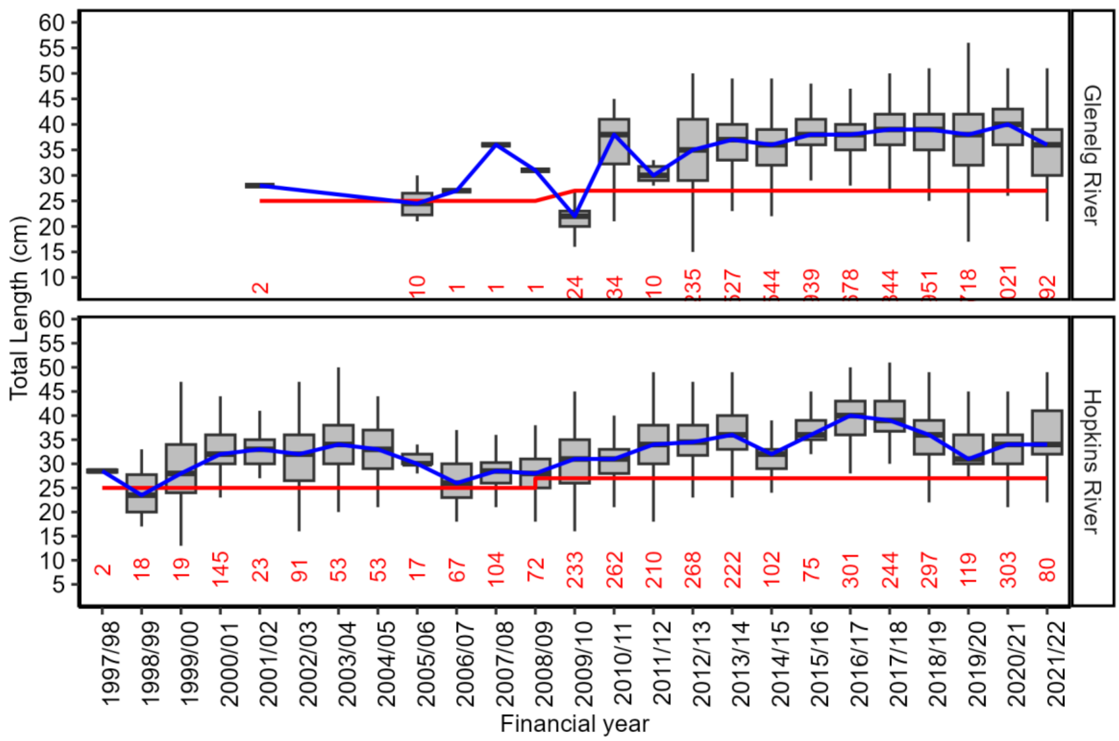


Figure 89 Total catch of estuary perch from the Victorian commercial fisheries, financial years 1978–2018.

(a)



(b)

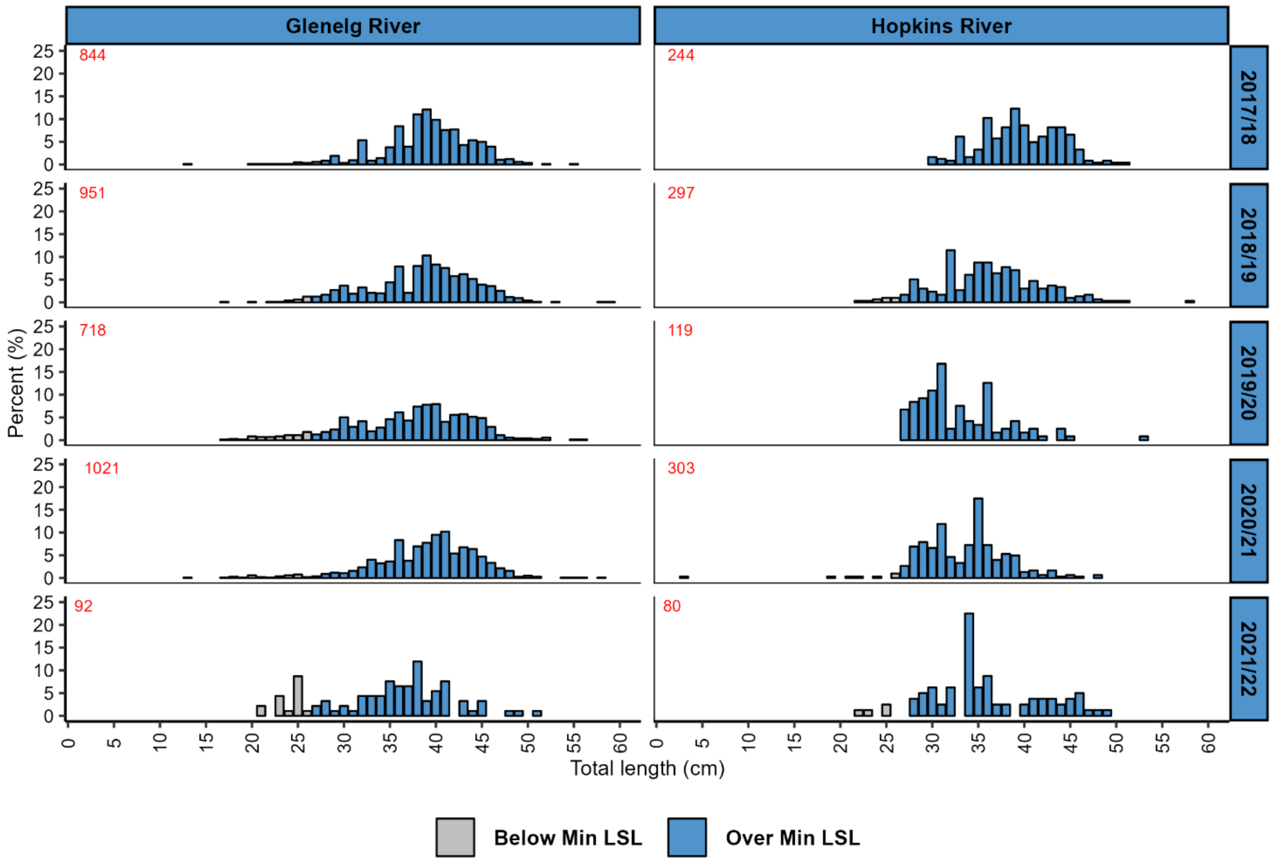


Figure 90 (a) Box-plots of Glenelg River and Hopkins River estuary perch length composition from diary anglers for fiscal years 1997/98–2021/22. Red numbers on x-axis indicate numbers of fish sampled. Blue line = median length, red line = LML. (b) Frequency histograms of Glenelg River and Hopkins River estuary perch length composition from diary anglers for fiscal years 2017/18–2021/22. Red numbers indicate numbers of fish measured.

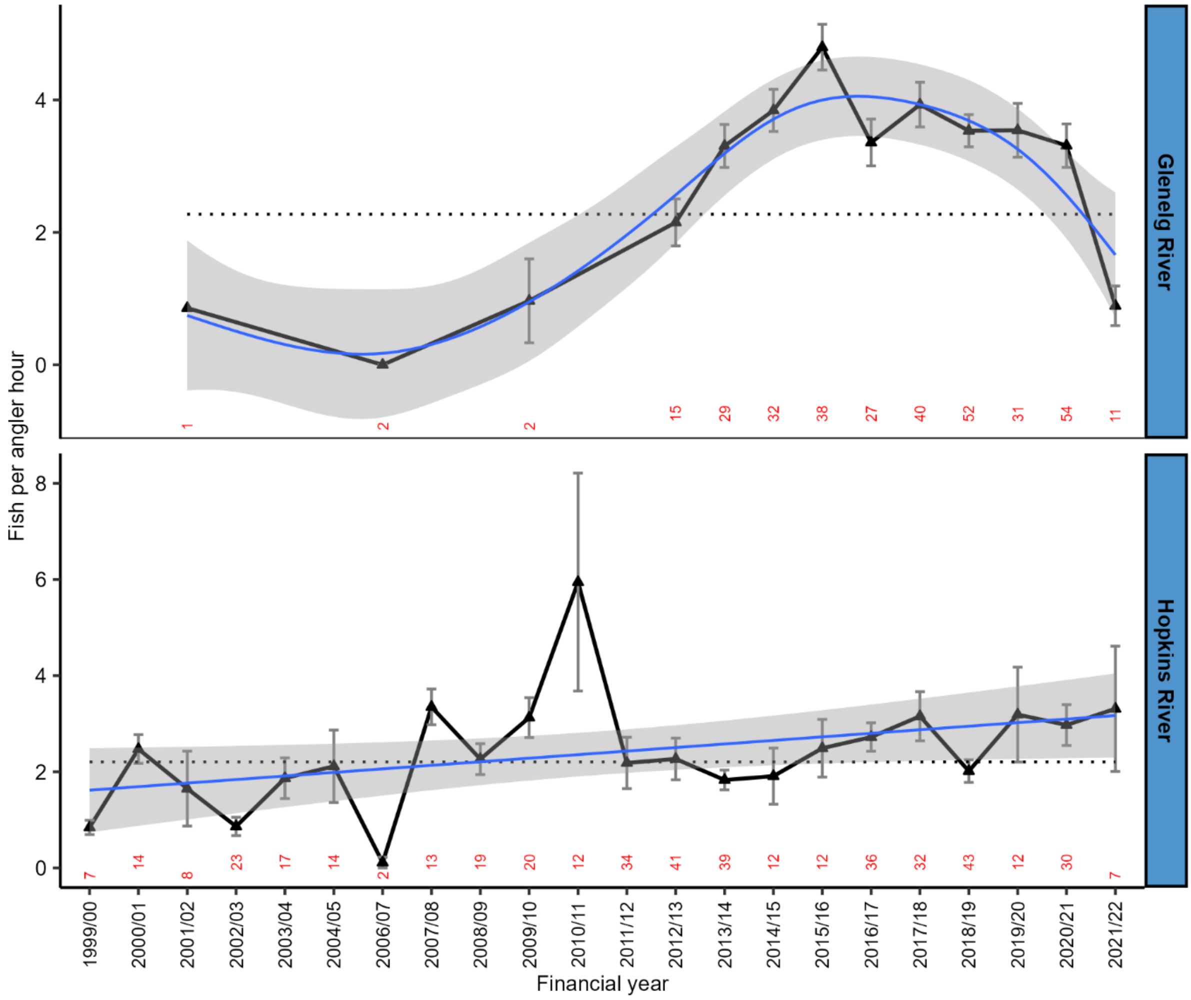


Figure 91 Nominal Catch-per-unit-effort (CPUE) (±SE) of estuary perch for diary anglers in Glenelg River and Hopkins River (1999/00-2021/22 fiscal years). Horizontal dotted black line is the mean CPUE during the reference period (2001–2015). Blue line is a generalised additive model (GAM) of the nominal CPUE trend with the shaded grey area representing the 95% confidence interval of the GAM. Red numbers along x-axis are numbers of diary angler trips.

Hopkins River

This assessment found:

- *Fishing pressure* – There is no direct information available on the amount of fishing pressure on estuary perch in the Hopkins River. The length frequency data provides a limited indication of the level of fishing mortality (Figure 90b). In this case, the size frequency of the catch is consistent with relatively low fishing mortality, although large perch represent a smaller proportion of the catch than they do in the Glenelg River. This perhaps reflects that the Hopkins is a far smaller estuary located at the much more populous provincial city of Warrnambool. Nevertheless, the prevalence of large fish in the catch indicates that perch are surviving well beyond maturation.
- *Biomass* – A relatively long angler diary CPUE time series is available to assess the biomass of estuary perch in the Hopkins River. Catch rates have, on average, increased throughout the time series and have remained relatively stable for the last three years at historic highs well above the reference period average (Figure 92). Interpretation of the long-term trend needs to be undertaken with the caveat that there have been some significant changes in angling behaviour during this time; particularly the development, and widespread uptake, of lure fishing, which greatly increases the catchability of estuary perch. Additionally, the angler diarist responsible for the last few years of data uses live bait and solely targets very large fish. Based on the length frequency of the catch, the last successful recruitment event appears to have been around 2011/12 as there is a distinct lack of juveniles in the catch (Figure 93). However, like the Glenelg, this could be more due to the fishing practices of the angler in recent years than to poor recruitment.

Stock status summary: The available evidence suggests that fishing mortality is likely to be relatively low for estuary perch in the Hopkins River. However, like the Glenelg River, there appears to have been several years of poor recruitment with juveniles being rare, although this may be an artefact of the angler diarist specialising in targeting large fish. If not, perhaps it is unsurprising that both rivers share similarities in recruitment given their geographic proximity. Estuary perch are a long-lived species, with this strategy thought to be required to bridge the gap between successful recruitment events, which are less prevalent in highly variable estuarine environments. Ageing data would be very useful to estimate the number of successful recruitment events that the fishery is reliant upon. It would also enable the level of fishing mortality to be estimated more accurately. Based on the evidence available the status of the Hopkins River estuary perch stock remains uncertain.

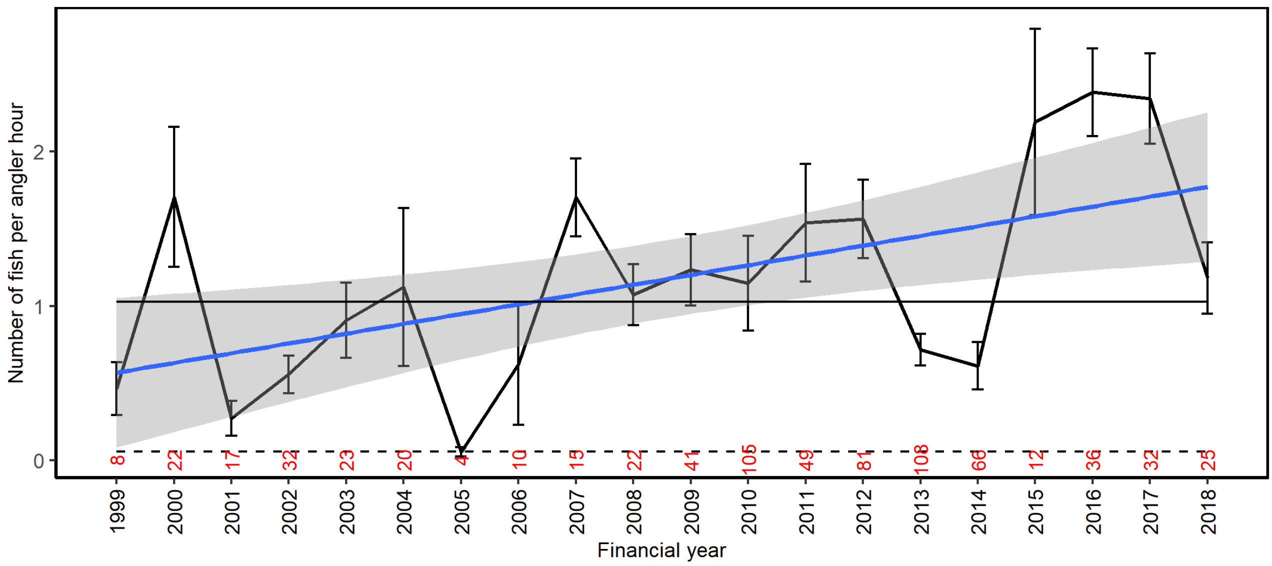
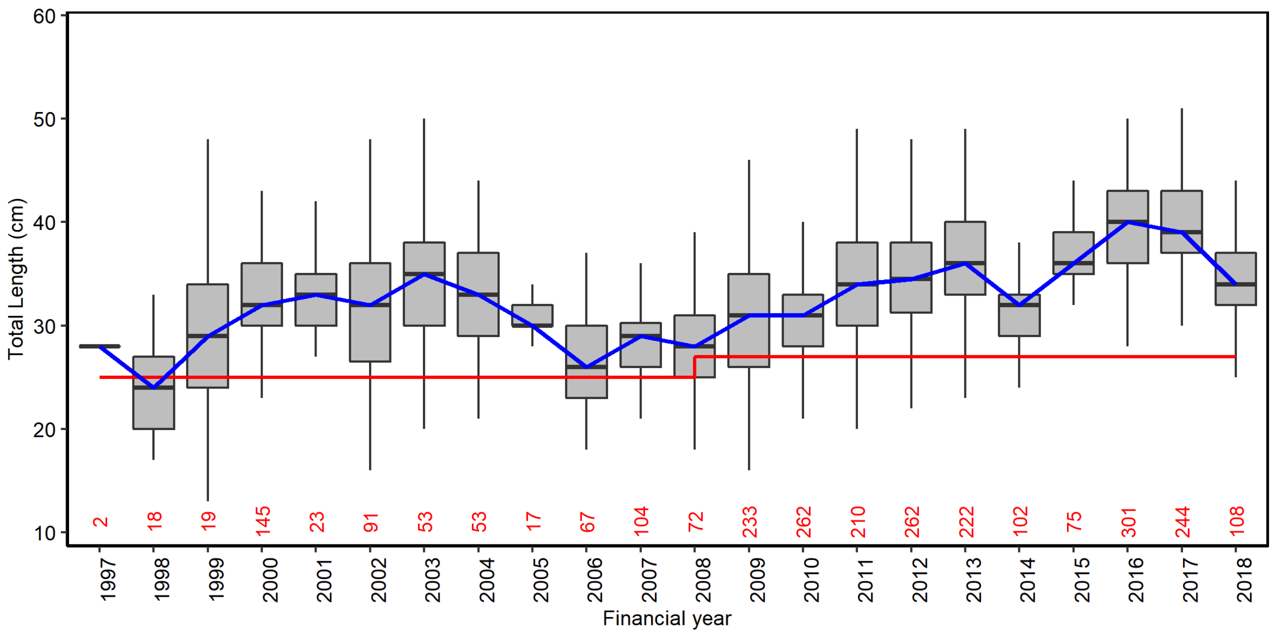


Figure 92 Nominal Catch-per-unit-effort (CPUE) (±SE) of estuary perch for diary anglers in Hopkins River (1999–2018 fiscal years). Horizontal black line is the mean CPUE during the reference period (1999 - 2015) and the dashed black line is the minimum CPUE within the reference period. Blue line is a 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 diary angler trips.

(a)



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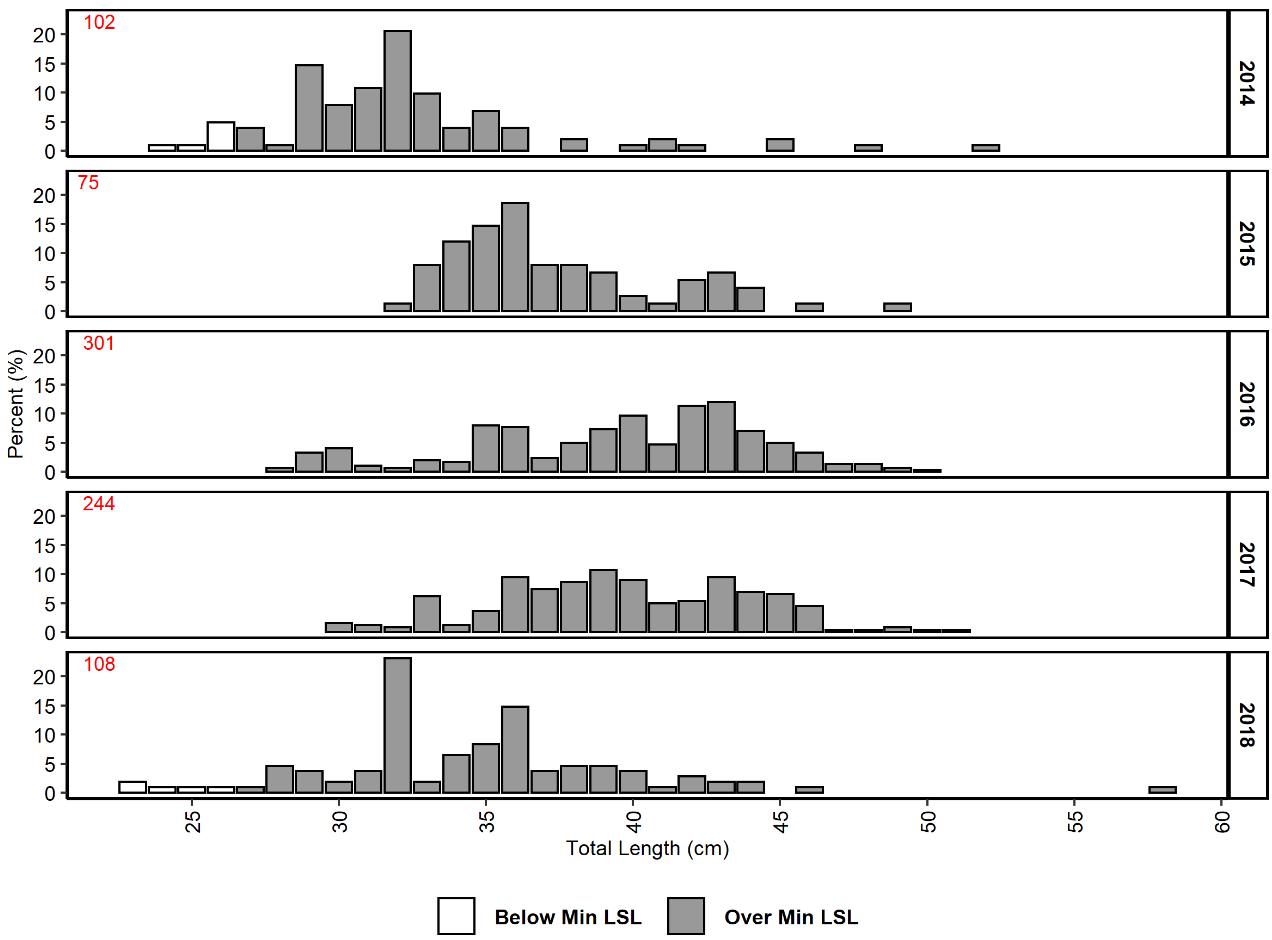


Figure 93 (a) Box-plots of Hopkins River estuary perch length composition from diary anglers for fiscal years 1999-2018. Red numbers on x-axis indicate numbers of fish sampled. Blue line = median length, red line = LML. (b) Frequency histograms of Hopkins River estuary perch length composition from diary anglers for fiscal years 2013-2018. Red numbers indicate numbers of fish measured.

Dusky Flathead (*Platycephalus fuscus*)

Stock Structure and Biology

Dusky Flathead are predominantly an estuarine species captured by commercial fishers in Gippsland Lakes and by recreational anglers in the estuaries of eastern Victoria. Contrary to the popular belief that Dusky Flathead are protandrous and change sex from male to female, studies have found that they are rudimentary hermaphrodites with sex determined at an early juvenile stage (Pollock, 2014). Females do, however, grow much larger than males. This species lives to at least 16 years of age (Gray and Barnes, 2015), though there are no published studies of the age of this species at its maximum reported size. Dusky Flathead have a protracted spawning period throughout summer, with multiple spawning events taking place near the entrance of estuaries (Pollock, 2014; Gray and Barnes, 2015). The relatively short lifespan for this species coupled with potentially high, albeit highly variable, fecundity implies that environmental conditions will have the greatest influence over recruitment to the stock (Hicks et al. 2015).

Management/Assessment Unit

Dusky flathead predominantly inhabits estuaries, with each estuary likely to support a relatively isolated stock. Considering their isolation, each estuary for which data are available is assessed independently. Commercial harvests, which have now ceased, had been restricted to Gippsland Lakes since the creation of recreational only fishing reserves in Mallacoota Inlet in 2004 and Lake Tyers in 2007 (Figure 94). The 20-year time series of data available does not rule out a decadal cycle given the pattern of recruitment expected under natural, unfished, conditions. Under these circumstances, future performance of the stock will remain uncertain until there is a much longer time series available for assessment.

Assessment Summary

The performance of the CPUE biomass proxies were assessed in relation to their average and minimum values during the reference period 1999–2015 for commercial fishing in Gippsland Lakes, and during 1999–2015 for creel or angler diary surveys undertaken in Gippsland Lakes, Lake Tyers, and Mallacoota Inlet.

Gippsland Lakes

This assessment found:

- *Fishing pressure* – Dusky flathead have historically been a by-product of commercial fishers targeting more valuable species with landings remaining around 10–20 t for the last few years (Figure 94), as they have been solely taken from Gippsland Lakes since the buyout of commercial licences from other estuarine commercial fisheries. Mesh netting effort in Gippsland Lakes is currently at about half of historic high values that occurred in the 1980s and seining effort is at historic low values (see Appendix 2). There is some indication that dusky flathead has been targeted commercially in Gippsland Lakes since the mid-2000s, possibly as a response to reduced availability of black bream.

- *Biomass* – Mesh net commercial CPUE increased during the 2000s, reaching a maximum in the mid-2000s that was well above the reference period average, before declining again to levels similar to the start of the series close to the reference period minimum. There was a moderate increase towards the end of this CPUE series (Figure 96). Despite its limitations in coverage i.e. low number of observations outside the period 2006 - 2010, and absence of data in 2011 in 12, CPUE from recreational anglers showed a clearly declining trend over almost two decades from well above the reference period average to below the minimum for that reference period (Figure 96).

Stock status summary: Current levels of fishing pressure (both mesh net and seine) are below historic highs. Mesh net CPUE remains around halfway between the reference period average and the minimum suggesting that the stock is within historic bounds. Notwithstanding the overall trend in angler diarist CPUE, and bearing in mind the limited observations, the pattern among recent nominal values has been relatively stable around the minimum. However, with the impending closure of the commercial fishery future data available to assess this species will be limited to diary angler and creel surveys which currently lack coverage for dusky flathead in Gippsland Lakes. These most recent data suggest that although the future is uncertain, there is some expectation that given the life history characteristics of dusky flathead and an absence of commercial fishing, further recruitment to the stock is likely when environmental conditions are favourable. Based on the above summary the Victorian Gippsland Lakes dusky flathead stock is depleting.

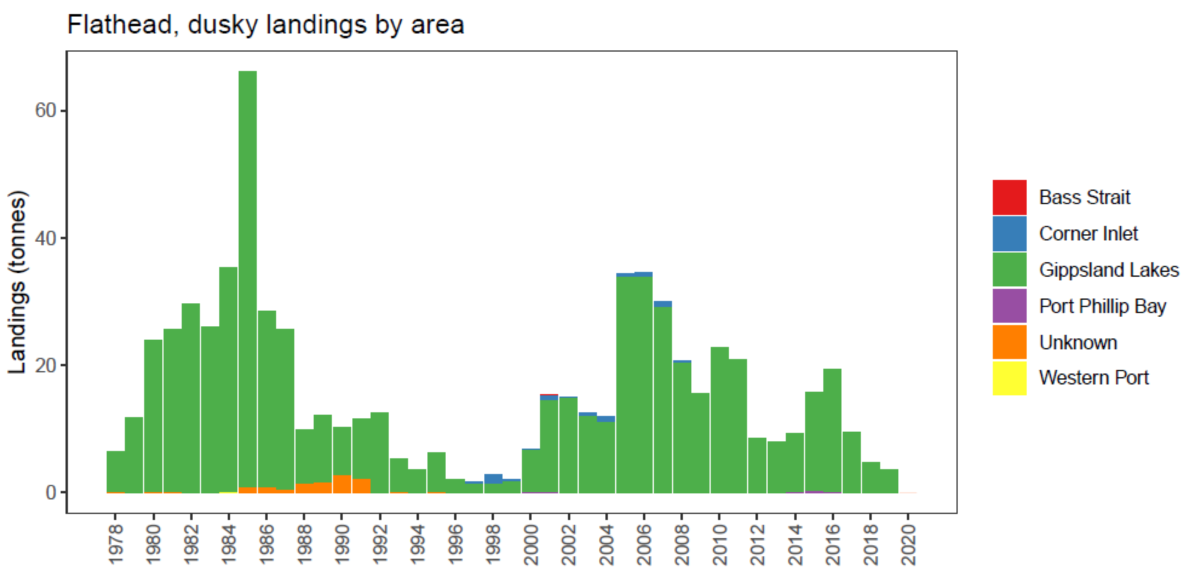


Figure 94 Total catch of dusky flathead from Gippsland Lakes by gear type, financial years 1978–2020. Note: Commercial harvests have been restricted to the Gippsland Lakes since creation of recreational only estuaries in Lake Tyers in 2007 and Mallacoota Inlet in 2004.

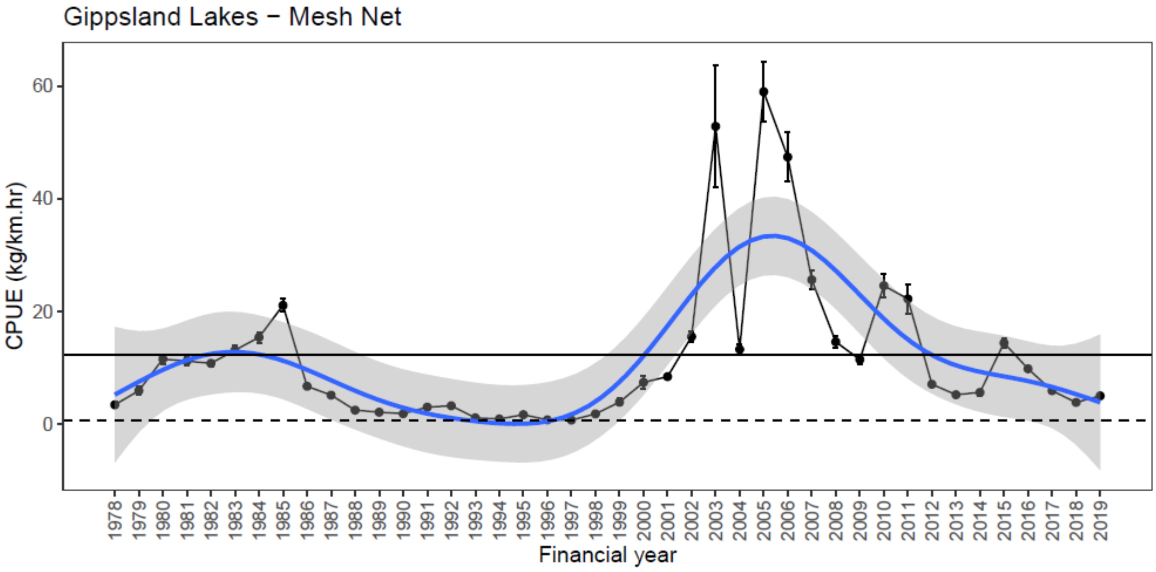


Figure 95 Dusky flathead nominal Catch-per-unit-effort (CPUE) (±SE) for a) for commercial mesh netting in Gippsland Lakes (1978–2019 financial years). Mesh net CPUE y-axis units are kg/km as fishing time was not recorded time prior to 1998. Horizontal black line is the mean CPUE during the reference 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.

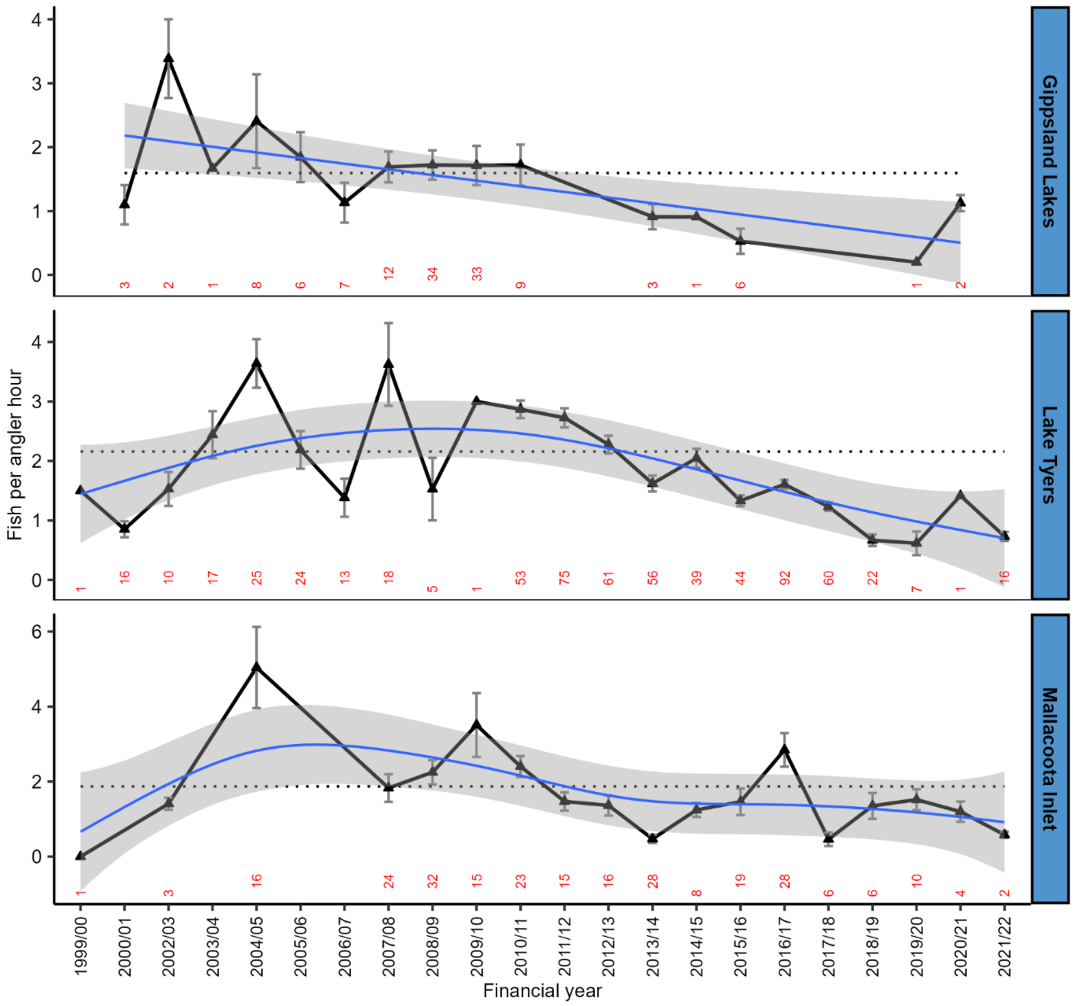


Figure 96 Dusky flathead nominal angler diarist catch-per-unit-effort (CPUE) (±SE) for the Gippsland Lakes, Lake Tyers and Mallacoota Inlet (1999/00–2021/22 financial years). Horizontal dotted black line is the mean CPUE during the reference period (1985–2015). Blue line is a generalised additive model (GAM) of the nominal CPUE trend with the shaded grey area representing the 95% confidence interval of the GAM.

Mallacoota

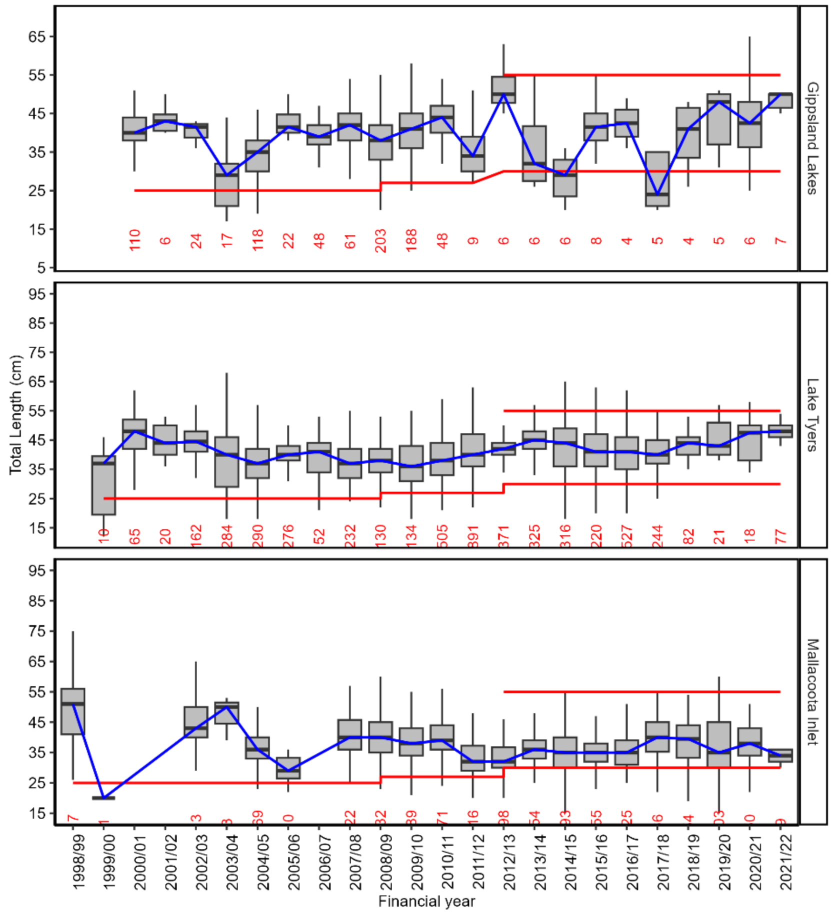
This assessment found:

- *Fishing pressure* – There is no direct measure of fishing pressure for dusky flathead in the Mallacoota estuarine system. There is some possibility that fishing mortality may be relatively high given there is a lack of very large dusky flathead in all years of the length frequency sample (Figure 97b) and the median size, and upper quantile, have declined since the late 1990s and early 2000s (Figure 97a).
- *Biomass* – There has been a variable, but increasing, trend in angler diarist CPUE during the first 5 years of the time series followed by five years at levels at or above the reference period average, before a decline since 2009 to level out at bit over one third of the rate during the preceding five years (Figure 96 lower panel) (Hamer et al 2019).

Stock status summary: The higher levels of CPUE during 2004–2009 from angler diarists fishing for dusky flathead at Mallacoota was likely reflective of a strong recruitment event. The time series is not long enough to determine if this is part of the boom-bust cycle of recruitment which characterises this species (Hamer et al 2019; Hicks et al. 2015) or represents an ongoing depleted state in which recruitment has become impaired due to changing environmental conditions. The fishing slot introduced in 2010 is regarded as generally protecting female spawning biomass from fishing and the relatively short lifespan coupled with potentially high, albeit highly variable, fecundity implies that environmental change poses the greatest threat to the stock. Although the last decade shows a pattern of depletion, this is inconclusive as the 20-year time series does not rule out a decadal cycle. Under these circumstances stock status, at least in terms of future performance, remains uncertain.

Catches have predominantly been comprised of smaller fish due the main diary angler mostly targeting bream. The diary angler CPUE is not thought to represent larger female fish, and the status of the important large female component is uncertain. While increasing use of soft plastics could be masking reductions in biomass and may explain the increasing temporal trend in CPUE, it is reasonable to assume that this would not be affecting the trend during the last 5 – 10 years and that the component of the stock within the ‘slot limit’ range (i.e. 30–55 cm) is relatively stable or increasing. There is, however, some risk that fishing mortality may be too high given relatively few very large individuals are now caught. While the relative consistency of small individuals throughout the time series suggests that recruitment is relatively consistent and remains unimpaired, it may possible that growth overfishing is occurring. Growth overfishing will only reduce angling success and not compromise the sustainability of the stock.

(a)



(b)

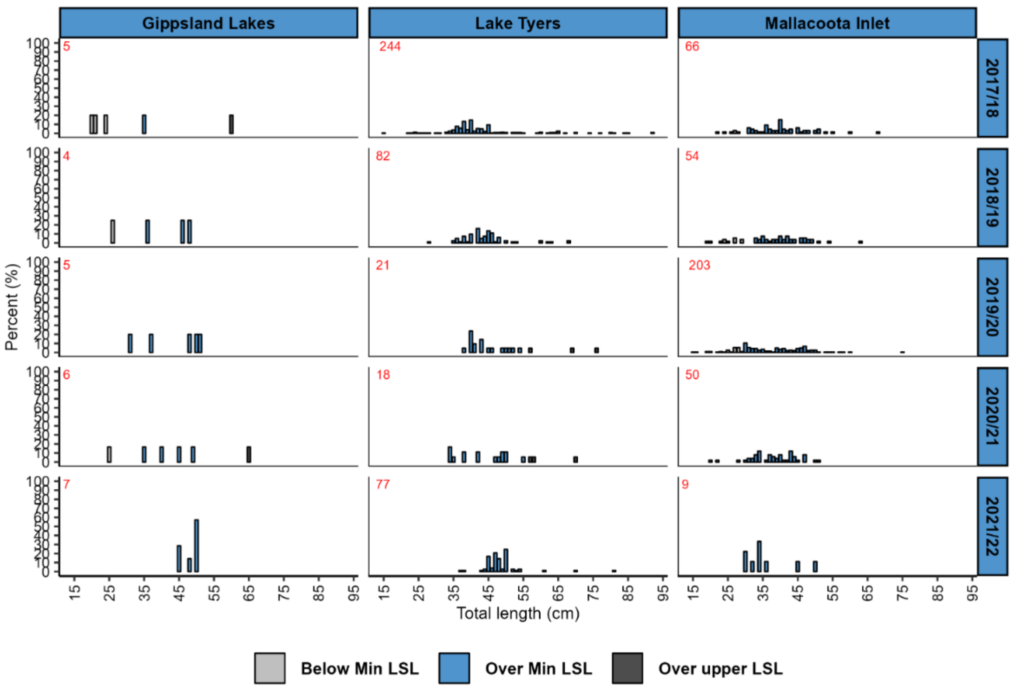


Figure 97 (a) Box-plots of Gippsland Lakes, Lake Tyers and Mallacoota Inlet dusky flathead length composition from diary anglers for financial years 1998/99-2021/22. Red numbers on x-axis indicate numbers of fish sampled. Blue line = median length, red line = lower and upper legal size limits. (b) Frequency histograms of Gippsland Lakes, Lake Tyers and Mallacoota Inlet dusky flathead length composition from diary anglers for fiscal years 2017/18-2021/22. Red numbers indicate numbers of fish measured.

Lake Tyers

This assessment found:

- *Fishing pressure* – There is no direct measure for fishing pressure in the Lake Tyers dusky flathead fishery. Based on the size composition of the angler diarists catches, there has been no long-term change in the median, or range, of sizes (Figure 99). Additionally, large individuals are present in the catch suggesting that fishing mortality is low enough to enable some females to grow through the slot limit and gain protection (Figure 99).
- *Biomass* – The CPUE of angler diarists for dusky flathead in Lake Tyers increased from 1999 – 2004 and was highly variable throughout the 2000s. From 2010 there was a consistent decline in catch rate from around 2.5 fish per hour to less than 1.0 fish per hour (Figure 98). Juveniles were present in the catch during each year suggesting recruitment has been consistent and is ongoing.

Stock status summary: The CPUE of angler diarists reduced to less than a quarter by 2018 of what it was in 2010. Although the large sample size during this period represents many more trips per diarist there was only a weakly positive relationship (20% association) between the trip count and CPUE, and there have been no major changes in fishing practices. This and the low variability in the estimates due to the large number of trips, implies that CPUE since 2010 is likely to be relatively representative of actual stock biomass. The size frequency of the catch has remained consistent and included both very large and very small fish, indicating that fishing mortality has not been so high as to prevent females from growing through the slot limit. Despite the decline in CPUE and it approaching the minimum value observed during the reference period, there is evidence for recent recruitment in the length frequency data. Based on this evidence the Lake Tyers dusky flathead stock is considered to be sustainable. The likelihood of recruitment impairment is low with the main risk being that heavy fishing pressure may limit catches until a subsequent cohort recruits to the stock.

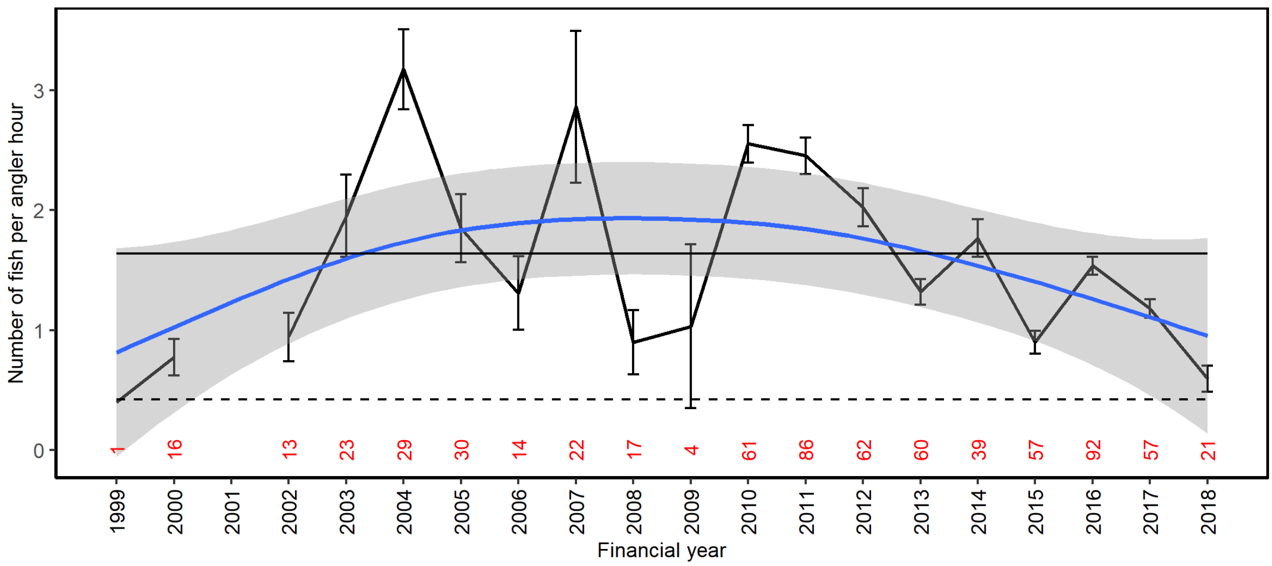


Figure 98 Nominal Catch-per-unit-effort (CPUE) (±SE) of dusky flathead for diary anglers in Lake Tyers (1999–2018 financial years). Horizontal black line is the mean CPUE during the reference period (1999–2015) and the dashed black line is the minimum CPUE within the reference period. Blue line is a 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 diary angler trips.

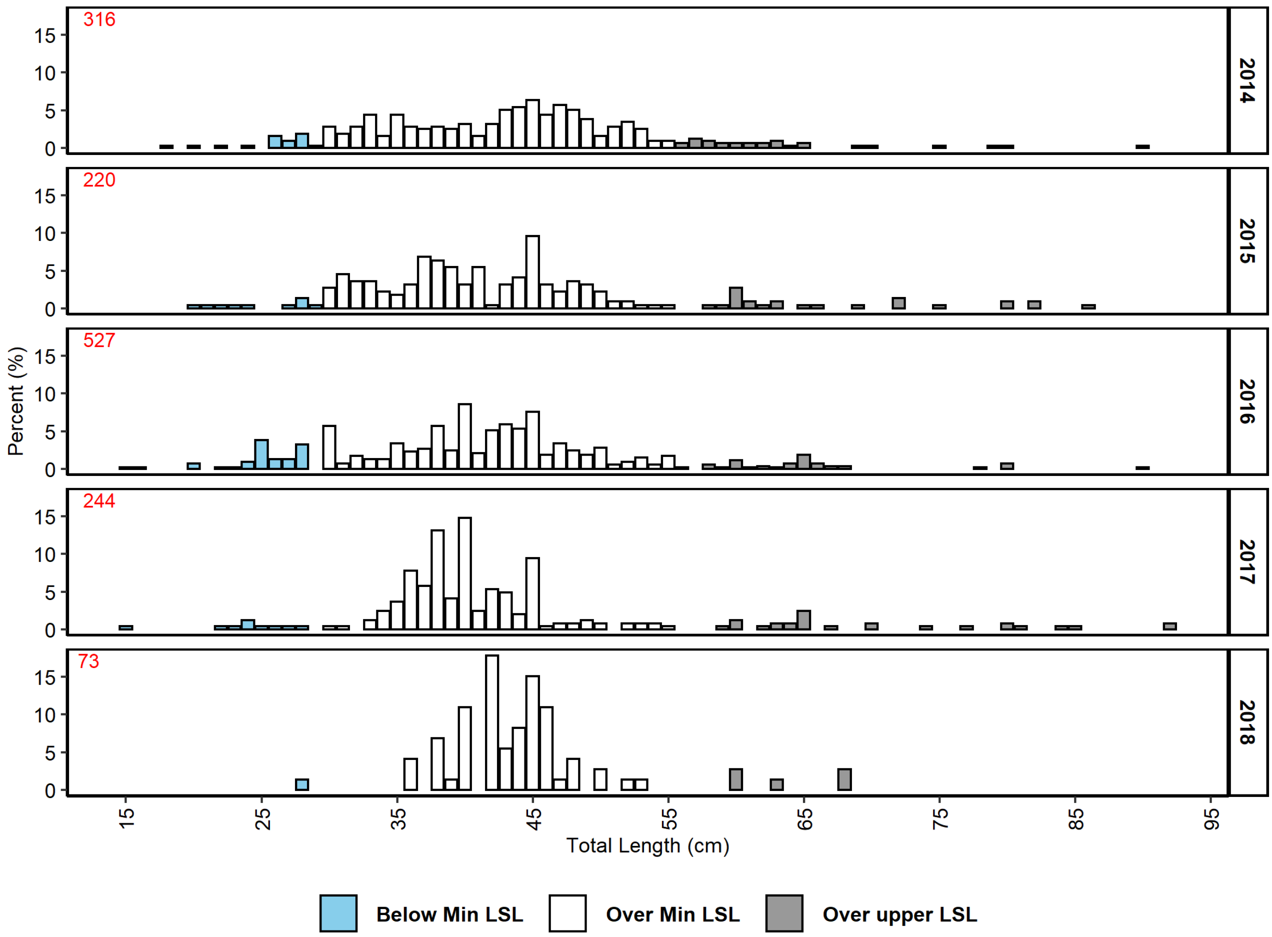


Figure 99 Frequency histograms of Lake Tyers dusky flathead length composition from diary anglers for financial years 2013–2018. Red numbers indicate numbers of fish measured.

Sea Urchins (*Centrostephanus rodgersii* and *Heliocidaris erythrogramma*)

Stock Structure and Biology

Two species of sea urchin are abundant in Victoria: the long-spined sea urchin (*Centrostephanus rodgersii*) and the short-spined sea urchin (*Heliocidaris erythrogramma*). Except for several isolated specimens found occasionally during the past two decades, the long-spined urchin is mostly confined to the reef habitats of East Gippsland from Lakes Entrance to the Victorian–NSW border where changing environmental conditions, predominantly due to strengthening of the East Australian Current, have led to them proliferating and denuding reefs of overstorey macroalgae to form barrens. Short-spined urchins can also form barrens, but these have mostly affected seagrass meadows in Corio Bay and Corner Inlet. Short-spined Sea Urchins are distributed throughout Victoria, but only harvested commercially in the eastern management zone, from Lakes Entrance to the NSW border, and in Port Phillip Bay.

Short-spined sea urchins spawn from December – March and produce lecithotrophic offspring (i.e. larvae with their own yolk sac enabling direct development) that develop, and settle, rapidly in about 3–5 days (Williams and Anderson, 1975). No information exists about their maximum age; however, it appears that they are likely to be relatively slow growing and long lived (Pederson and Johnson, 2008; Ebert, 1982).

Long-spined sea urchins live to around ten years of age (Pecorino *et al.* 2012) and have an extended spawning period from May – October (Byrne et al. 1999). The long-spined sea urchin is prolific in eastern Victoria and has been responsible for denudation of reef habitats in waters deeper than about 10 m, which has negatively impacted the Eastern Zone abalone fishery through reduction in available habitat. As a result, ongoing culling takes place on barrens habitat where roe is typically substandard (Byrne *et al*. 1999) and the urchin fishery is subsidized at times to encourage increased harvesting of urchins in areas important to the abalone fishery.

Management/Assessment Unit

The fishery is managed as two separate areas, with specific access licences for the Port Phillip Zone and Eastern Zone. Given the geographic separation between areas where short-spined sea urchins are caught (i.e. far east Gippsland and Port Phillip Bay) and the likely lack of larval dispersal due to the short larval phase of several weeks they are considered to be individual stocks. Nevertheless, because historic reporting of short-spined urchin catches from the Eastern Zone has been sporadic and at times unreliable the assessment for this species focusses on the Port Phillip Zone.

Long-spined sea urchins are only caught along the coast of far eastern Victoria and, given the extensive larval dispersal potential of this species over several months (Ling et al. 2008), it is reasonable to assume that the stocks of this species represent a single panmictic population. Long-spined sea urchins are hence assessed as a single, eastern Victorian, stock (Figure 100).

Both species are also culled under permit to varying extents by commercial abalone divers to prevent overgrazing and denudation of reef and seagrass habitats where they are overly abundant. The objective is to rehabilitate the habitat and restore abalone populations diminished by loss of habitat. This complicates the overall assessment in the sense that the aim of fisheries management is generally to prevent depletion rather than curb increasing biomass.

Assessment Summary

For this assessment, the status of short spined and long spined sea urchins was evaluated using:

- Nominal CPUE trends for the commercial dive fishery. The performance of the CPUE biomass proxy was assessed in relation the specified reference level and limit points throughout the entire time series.
- The impact of fishing pressure was assessed using time series of commercial catch and effort.

Short-spined sea urchin

This assessment found:

- *Fishing pressure* – Landings in both fisheries have been variable through time, reaching up to nearly 40 t and 50 t in the eastern zone and Port Phillip Bay fisheries respectively [Bell et al. 2023]. They were consistent between 20 and 30 t for the three years to 2017 and then halved in 2018 before tripling in 2020 and then declining (Figure 101). Landings were ~8t in the eastern zone and ~36.5 t in Port Phillip Bay in 2020/21. Short-spined Sea Urchins are also harvested by recreational fishers and although the landings are not known, they are likely to be low in comparison to commercial catches. Effort has remained more stable during this period with a sharp increase in 2020, followed by a sharp decrease in 2021 & 2022 (Figure 102).
- *Biomass* – In eastern Victoria, Short-spined Sea Urchin catch rates have remained relatively stable through time at ~40 kg/hr from 2014-2020, reaching historic highs in 2021/22 (Figure 103). Catch rates in Port Phillip Bay are lower, and more variable, with anecdotal reports by divers suggesting they are influenced by water clarity, algal growth and, as is usual in urchin fisheries, row quality, which tends to be more variable in Port Phillip Bay. Nevertheless, catch rates show no declining trend and were also the highest on record in 2021/22 [Bell et al. 2023]. In addition, large portions of Port Phillip Bay contain extensive Short-spined Sea Urchin barrens with very high densities that are not valuable to fisheries due to poor roe quantity and quality. As such, it is possible that the fishery could reach maximum production (i.e. catch as many urchins with marketable roe as is financially viable) without posing a risk to the stock as a whole. CPUE has remained stable before sharply rising in 2021 (Figure 103). However, in this instance, catch rate is likely to reflect the availability of those short-spined sea urchins with marketable roe more so than total abundance because short-spined urchins are in very high abundance throughout much of Port Phillip Bay. In eastern Victoria, Short-spined Sea Urchin exhibited a stable to slightly declining pattern of abundance in fishery independent surveys conducted during 2003–2016 (Figure 104).

Stock status summary: Catch, effort and CPUE remain relatively stable within this fishery. Conversations with industry suggest that market demand and/or price are the primary factors dictating the amount of fishing effort and hence catch. Interpretation of CPUE is complicated by the fact that this species is very abundant, but only a proportion of the stock is of acceptable quality for processing. As such, it is possible that the fishery could reach maximum production (i.e. catch as many urchins with marketable roe as is financially viable) without posing an overall risk to the stock. There is no information to suggest that the stock is in any danger of depletion. The above evidence indicates that the biomass of these stocks is unlikely to be depleted and that recruitment is unlikely to be impaired. Furthermore, the above evidence also indicates that the current level of fishing mortality in Victoria is unlikely to cause these stocks to become recruitment impaired. Based on the evidence provided above, short-spined sea urchin in Victoria is classified as a sustainable stock.

Long-spined sea urchins

This assessment found:

- *Fishing pressure* – While there have been several attempts to develop a fishery for this species in the 1980s, and late 1990s to early 2000s, it is only since around 2015 that significant quantities have been landed. Since this time, commercial landings have fluctuated between around 40-80 t. The species is also taken by recreational fishers, and although there is no information on recreational landings, they are likely to be minimal and insignificant in terms of impacts on the stock.(Figure 101, 102).
- *Biomass* – Commercial CPUE has remained very stable at ~175 kg/hr from 2014/15 to 2021/22 (Figure 106). However, CPUE is likely to be more reflective of the availability of urchins with roe of marketable quality rather than the species' abundance as a whole. This is illustrated by an increase in abundance of long-spined urchins observed in fishery independent surveys over the same period, though some areas have shown a decline, which can be linked to both fishing and urchin reduction programs to prevent denudation of productive abalone reefs [VFA, 2019]. (Figure 107). In addition, this species is very abundant on barrens in deeper waters, where little to no fishing effort occurs due to sub-optimal roe.

Stock status summary: Catch, effort, and CPUE trends, are largely reflective of market demand and can be influenced by changes in the availability of urchins with marketable roe. As such, it is possible that the fishery could reach maximum production (i.e. catch as many urchins with marketable roe as is financially viable) without posing a risk to the stock as a whole. There is no information to suggest that the stock is in any danger of depletion and is in fact likely increasing in biomass. Based on the available evidence, the Eastern Victorian long-spined sea urchin is sustainable.

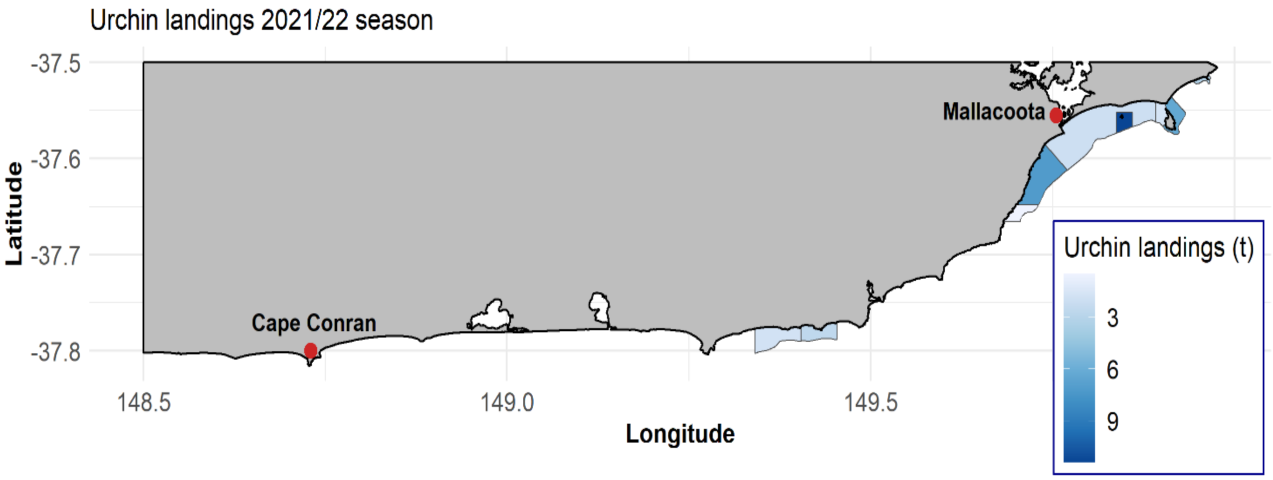


Figure 100 Spatial distribution of black sea urchin landings in Eastern Victoria from the 2021/22 season.

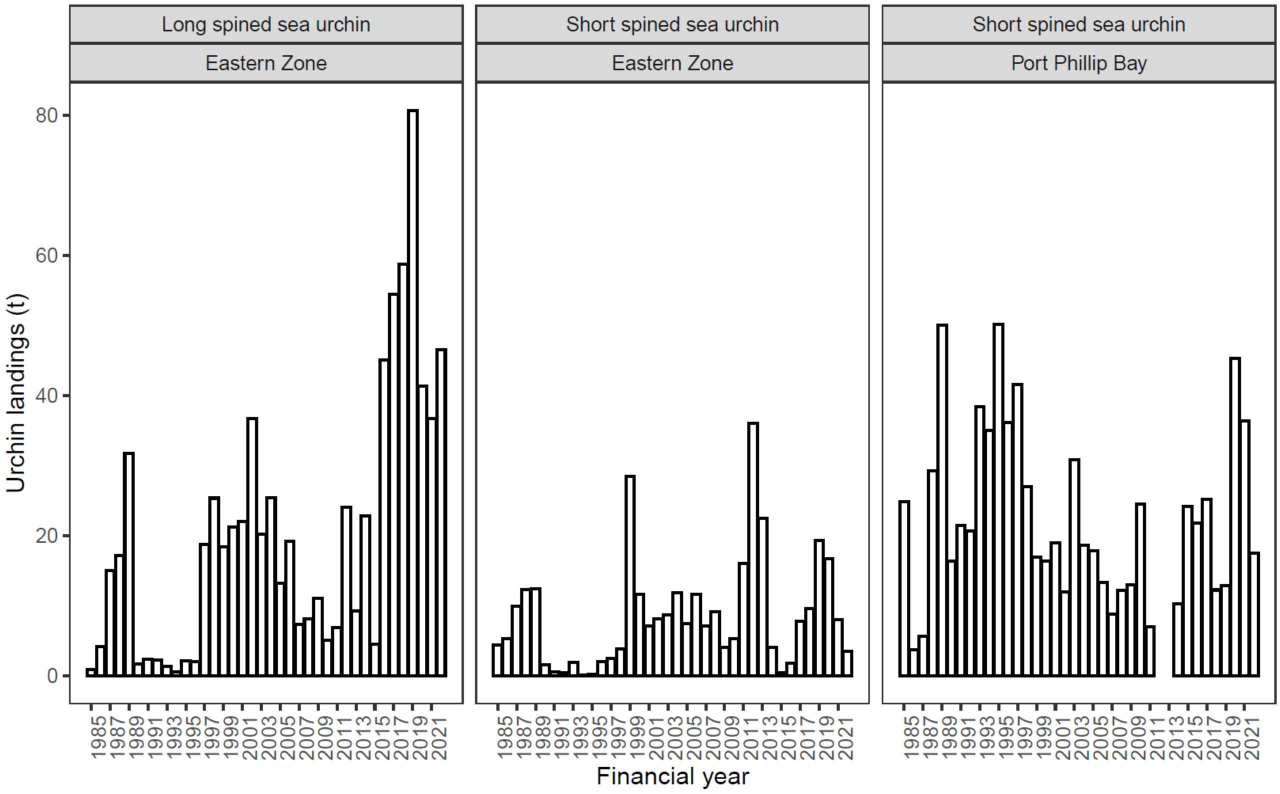


Figure 101 Annual long-spined and short-spined sea urchin landings from Eastern Victoria and Port Phillip Bay.

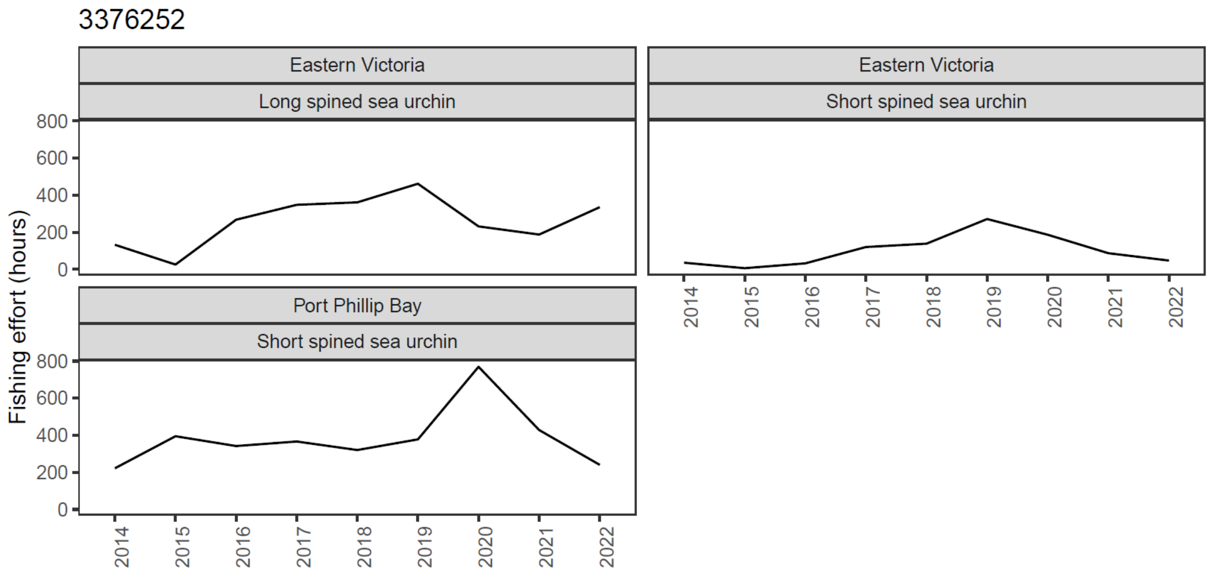


Figure 102 Annual fishing effort targeting long-spined, and short-spined, sea urchin landings in Eastern Victoria and Port Phillip Bay.

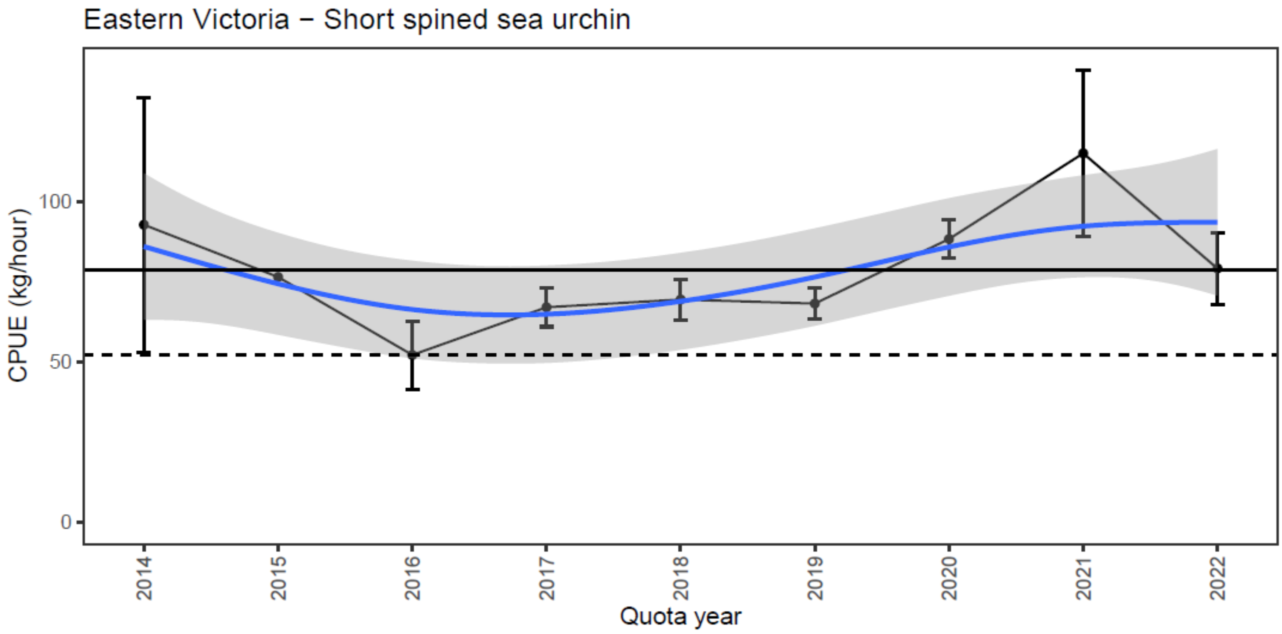


Figure 103 Nominal Catch-per-unit-effort (CPUE) of short-spined sea urchins (± SE) in Eastern Victoria (black line). Solid black horizontal line in the mean and horizontal dashed line is the minimum. Blue line is a generalised additive model (GAM) of the annual mean CPUE with the shaded area representing 95% confidence intervals of the GAM.

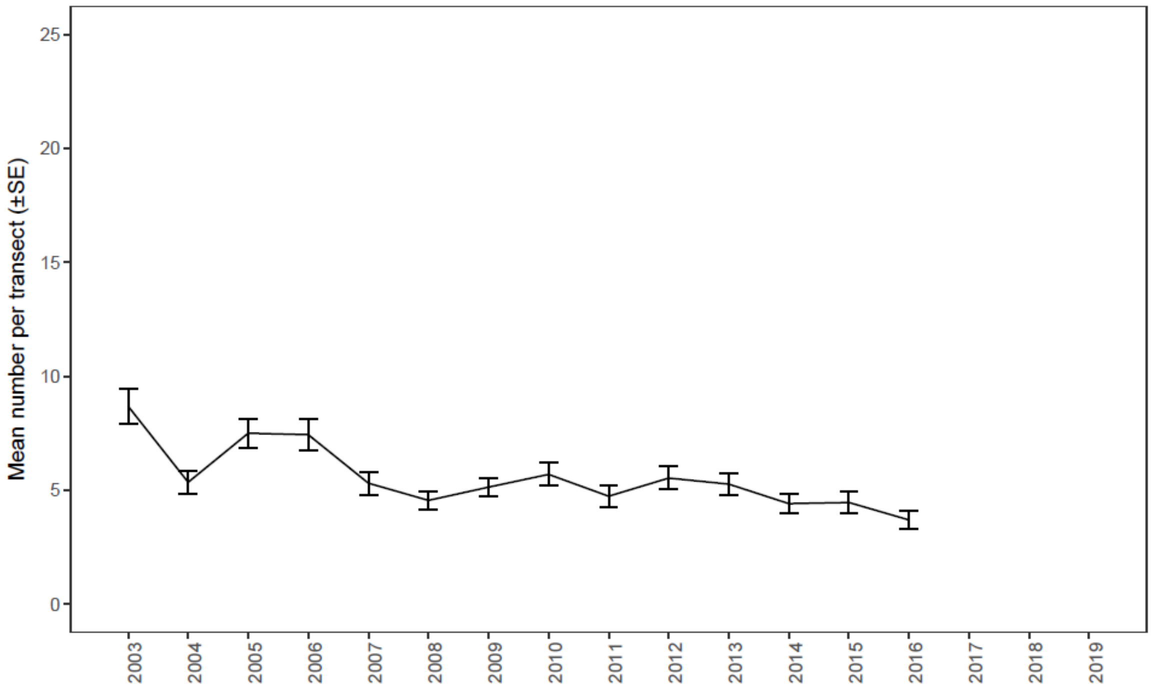


Figure 104 Temporal trend in the abundance of short-spined urchins (±SE) within the Eastern Zone. Note: analyses were limited to sites surveyed throughout entire time period, other than 2004 when Marlo was not surveyed (see results for explanation). A transect is 30 m^2.

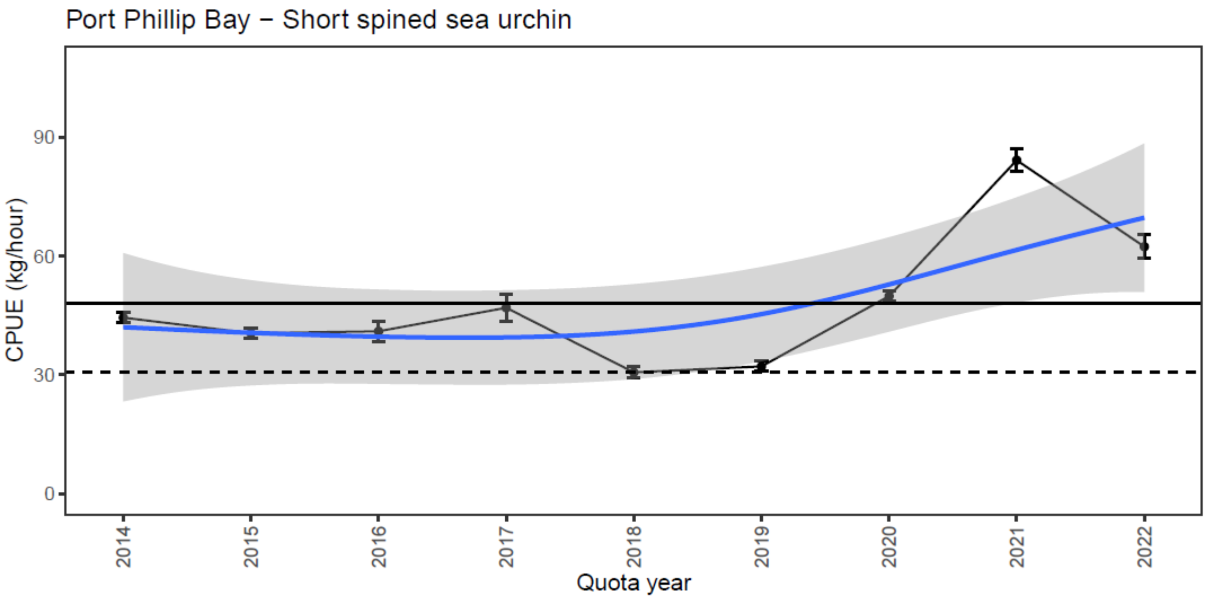


Figure 105 Nominal catch-per-unit-effort (CPUE) of short-spined sea urchins (± SE) in Port Phillip Bay (black line). Solid black horizontal line in the mean and horizontal dashed line is the minimum. Blue line is a generalised additive model (GAM) of the annual mean CPUE with the shaded area representing 95% confidence intervals of the GAM.

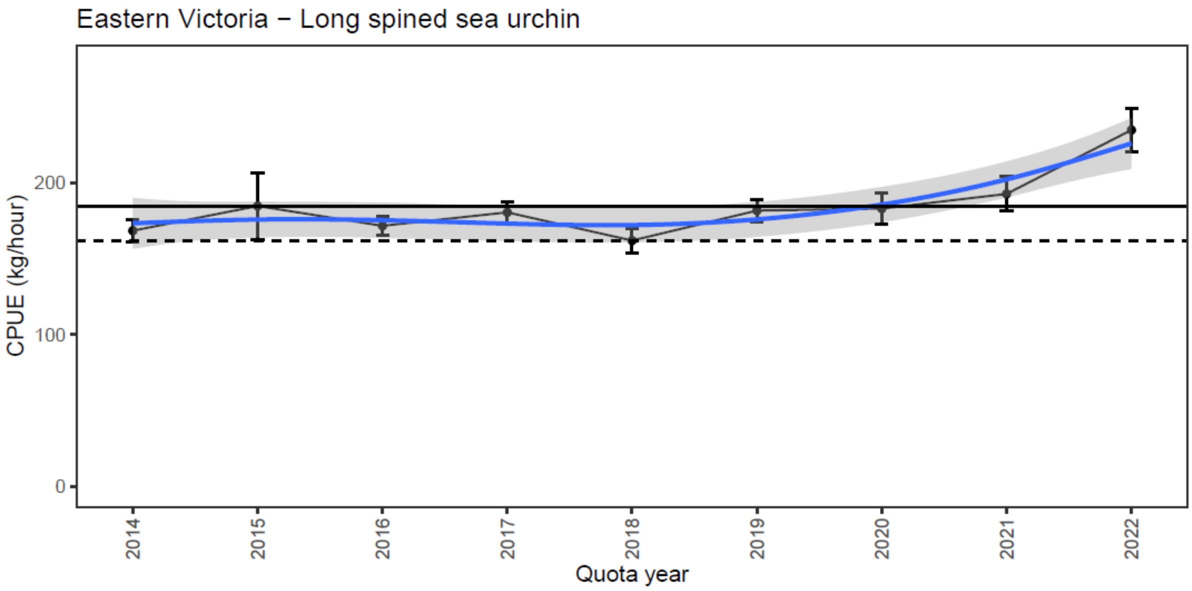


Figure 106 Nominal catch-per-unit-effort (CPUE) of long-spined sea urchins (± SE) in Eastern Victoria (black line). Solid black horizontal line in the mean and horizontal dashed line is the minimum. Blue line is a generalised additive model (GAM) of the annual mean CPUE with the shaded area representing 95% confidence intervals of the GAM.

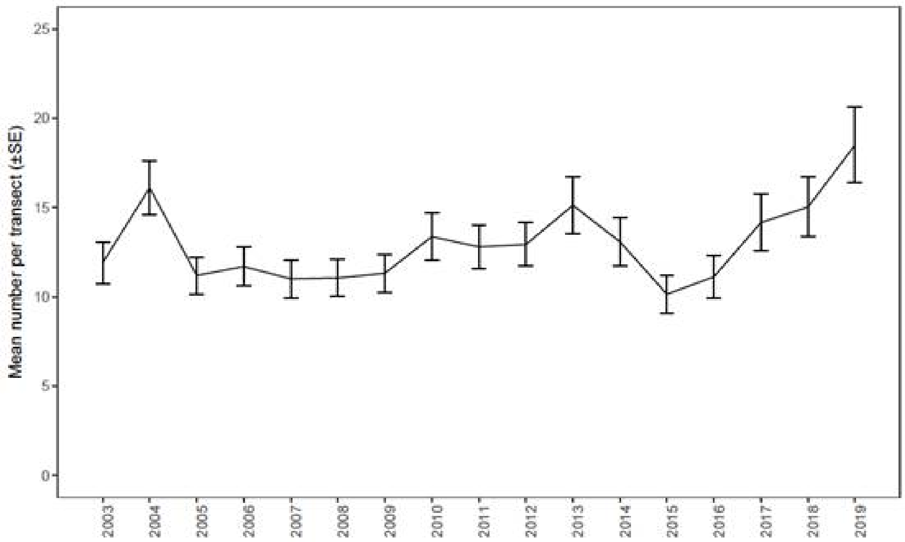
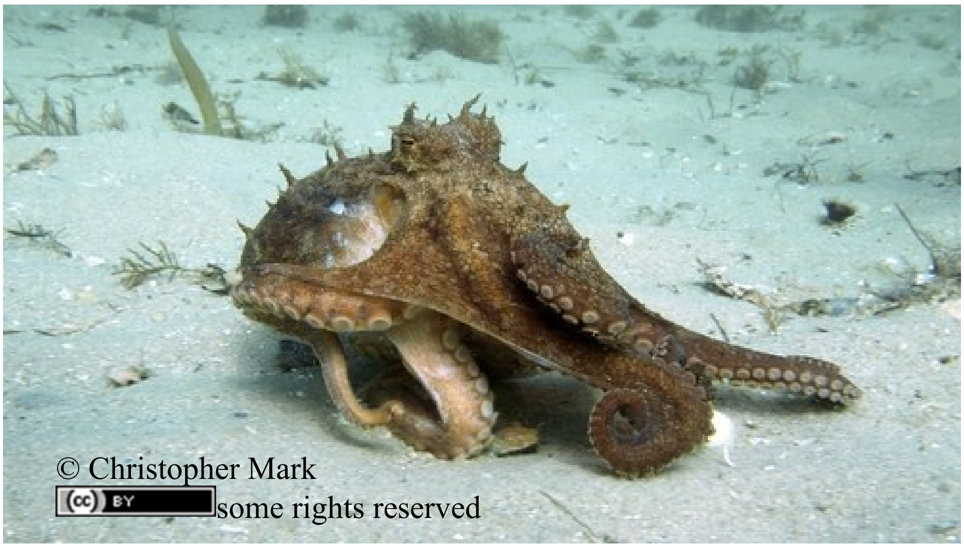


Figure 107 Temporal trend in the abundance of long-spined urchins (±SE) within the Eastern Zone estimated from independent surveys. Recent large reductions in the number of sites surveyed precludes extending this series beyond 2019.

Pale Octopus (*Octopus pallidus*)



Stock Structure and Biology

Pale octopus (*Octopus pallidus*) predominantly inhabit soft sediment habitats and are also semelparous (spawn once then die) living for 12–18 months (Leporati *et al*. 2009). They produce relatively few (450–800) very large eggs and there is no larval phase after hatching with hatchlings resembling adults in both appearance and behaviour (Leporati 2007). This reproductive strategy means that this species has limited dispersal giving rise to considerable genetic population structuring (Higgins *et al*. 2013). A fishery targeting pale octopus is developing in eastern Victoria over soft sediment habitats using passive unbaited octopus shelter pots (trigger traps are currently not permitted). Maori octopus (*Macroctopus maorum*) and gloomy octopus (*Octopus tetricus*) are also landed, in relatively low quantities, the former mostly as a by-product of the southern rock lobster fishery. With low catches and consequently limited information these species were not assessed.

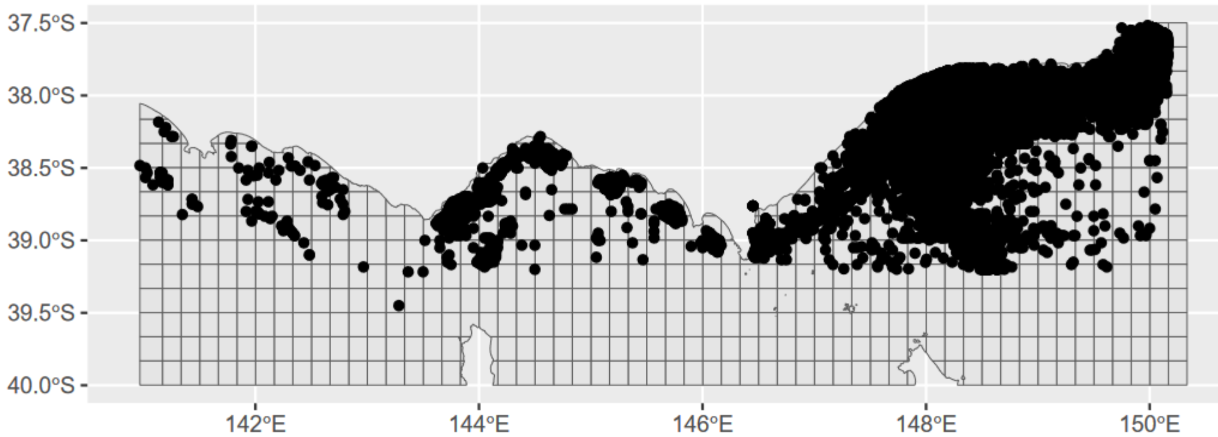


Figure 108 State-wide approximate spatial distribution of landings of all octopus species since 1998

Management/Assessment Unit

The dedicated Octopus Fishery commenced in 2020 in eastern Victoria as a limited entry fishery with 11 licences and 1000 individual transferable quota units (see https://vfa.vic.gov.au/__data/assets/pdf_file/0003/971733/Octopus-supplement.pdf, accessed on 1 Feb 2024). Prior, octopus had been caught commercially in the eastern zone for many years, with pot fishing operating since at least 1998. Pale octopus have historically been caught by a variety of gears but not differentiated from other species of octopus in catch and effort reporting. Catch and effort by a small number of operators within the Ocean Fishery began rapidly increasing in 2015–16, with average octopus catch reaching about ten times 2006–15 levels. This led the VFA to remove octopus from the large, multi-species and multi-gear Ocean Fishery (Figure 108) and set up a new, quota-based Octopus Fishery Licence class.

The targeted octopus fishery has a dedicated management structure comprising three management zones. Currently, the 11 Eastern Zone Octopus Fishery licence holders are authorised to take octopus from the eastern zone (Figure 109), where most of the commercial octopus fishing in Victoria has occurred to date, with the other two zones currently operating under exploratory permits. The eastern zone extends approximately from Seaspray to the Victorian/NSW border and out to 20 nautical miles offshore, except for marine reserves.

A TACC of 68.7 t based on the average annual octopus catch in eastern zone during 2018 and 2019 by Ocean Fishery licence holders was set for the eastern zone and remains in place to date (2023/24, see https://vfa.vic.gov.au/__data/assets/pdf_file/0020/945200/FINALOctoFQO_2023-24_CEO11May23.pdf, accessed on 1 Feb 2024).

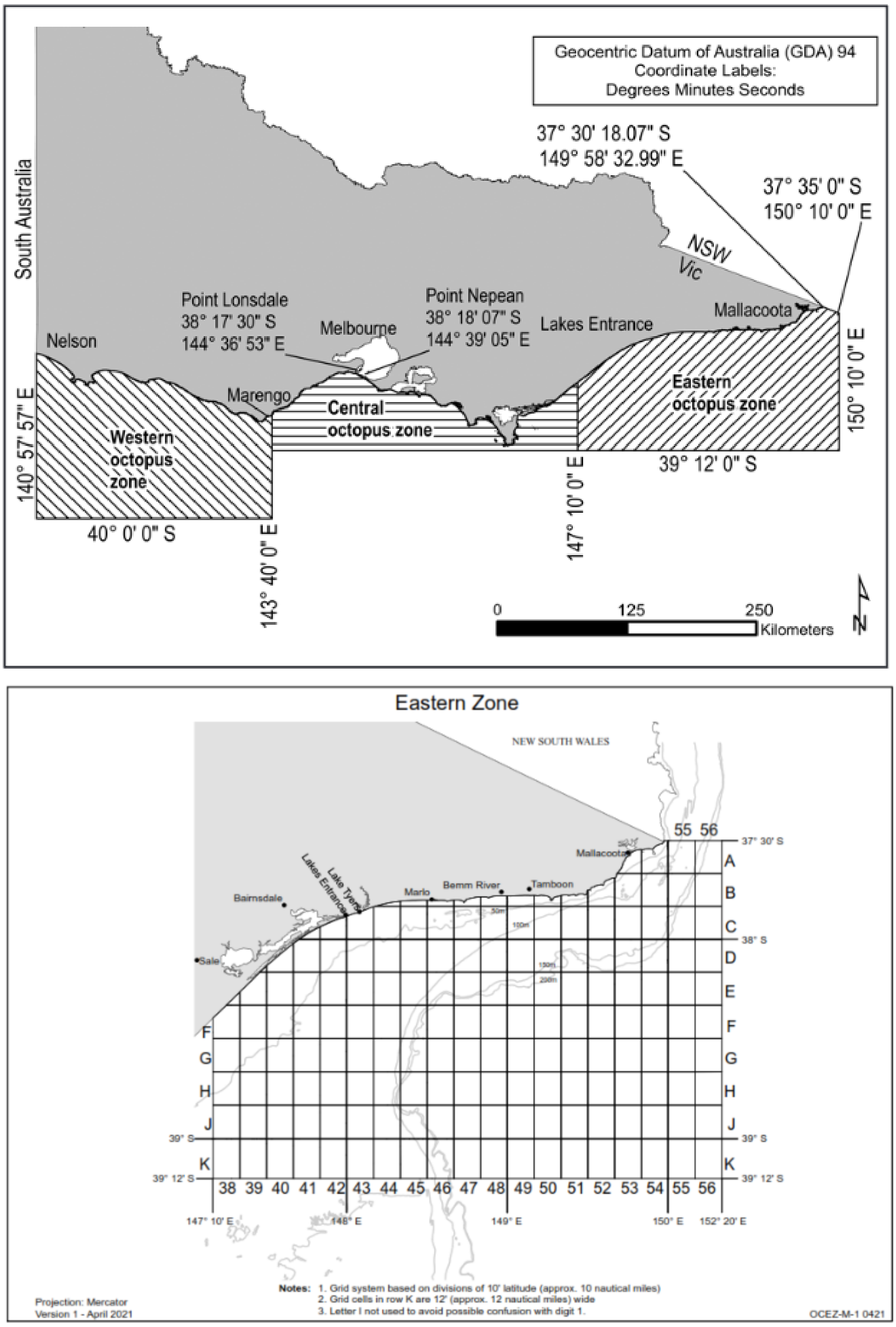


Figure 109 Management Zone boundaries (upper panel) and statistical catch and effort reporting grid for the eastern management zone (lower panel) of the Victorian octopus fishery.

Assessment Summary

This assessment found:

- *Fishing pressure* - Pale octopus have been caught, and retained, by a variety of gears and fisheries operating in eastern Bass Strait (Figure 110). Landings of 'octopus' were recorded by Danish seine vessels up until the mid-1990s. Trawl vessels also report landings of around 10 t in some years but analysis of CPUE data indicated that there was likely to be a relatively high rate of discarding in earlier years. In recent years, many of these vessels are predominantly targeting species managed by the Commonwealth and reporting their landings to AFMA. Recently there has been a sharp increase in catches by seiners operating in Bass Strait (Figure 110). A fishery using octopus pots was operational from 1998 – 2003 and it is likely that some octopus were caught prior to this time but the gear was not accurately reported. Small amounts of octopus (< 2 t p.a.) were subsequently caught using pots up until 2015 when landings began to increase reaching 113.5 t among all fisheries under Victoria's jurisdiction in 2021/22 (Figure 110) and recent evidence shows the fishing grounds have stabilised spatially with much of the variation attributable to changes in licence ownership among the small number of operators and where they choose to fish (Figure 111 and Figure 112). Increases in trawl catches during recent years reflects changes in net type to coarser nets targeting finfish with much longer shot durations than the much briefer shots when targeting prawns with finer mesh to ensure the prawns remain undamaged by avoiding entrapment of large finfish (Figure 111). Examination of spatial detail via mapping the distribution of catch shows a westerly expansion among eastern zone grid cells being fished whilst maintaining continuity of fishing within cells adjacent to Lakes Entrance, i.e. the fleet is not serially shifting from depleted to unfished cells (Figure 112).
- *Biomass* – Although catch history of all stocks state-wide, and CPUE from Bass Strait trawl are available since 1998/99, for determining trends from a consistent performance measure as a proxy for stock biomass for the contemporary octopus fishery, shelter pot CPUE is presented for eastern zone from 2016/17 onwards. Shelter pot CPUE has been relatively stable to increasing (Figure 113). In the trawl fishery current values are noticeably much higher than during the period up to 2019 when values fluctuated between several small peaks and very low troughs (Figure 114). This may be related to the type of gear used in this period, with the recent sharp increase reflecting a change in the type of net being used but catch and effort were so low during the period up until the recent expansion of the fishery that it is unlikely that CPUE currently represents a reliable proxy for biomass.

Stock status summary: All the gears that are likely to be able to be used to estimate the stock status (trawl, Danish seine and octopus pot) of pale octopus show high variability in annual landings and CPUE. The type of gear that would most likely reflect abundance is the octopus shelter pot which is highly selective and are not subject to changes in fishing practices or selectivity. Early trends in pot CPUE are nevertheless variable, likely due to the low effort during much of the time-period and possibly due to changes in the type of pot. Reliance is instead placed on the contemporary shelter pot series since 2016/17, which is becoming progressively more informative with the acquisition of additional years of data. Due to a lack of historic species-specific reporting, that pale octopus represent an incidental byproduct of many fisheries and appear to have been discarded at times, and the relatively brief history of targeted fishing effort in the dedicated fishery, considerable uncertainty about the current stock status of Victorian pale octopus persist despite stable to slightly increasing CPUE. While targeted octopus catch rates remain stable, the fishery has been expanding spatially and with the low number of active fishers it is difficult to determine the extent to which this represents serial depletion and/or responsible fishing of the resource by spreading effort. Mapping the spatial distribution of catch nevertheless shows a westerly expansion among eastern zone grid cells being fished, whilst maintaining continuity of fishing within cells adjacent to Lakes Entrance i.e., the fleet does not appear to be serially shifting from depleted to unfished cells. Despite this observation, there remains a potential risk that fishing practices could result in local depletion. In addition, the landings of other Victorian and Commonwealth fisheries are increasing as demand for the product increases. The above uncertainties make it difficult to determine whether current fishing practices could lead to recruitment impairment, although it appears unlikely that this has already occurred and there is no evidence that the stock biomass is depleting.

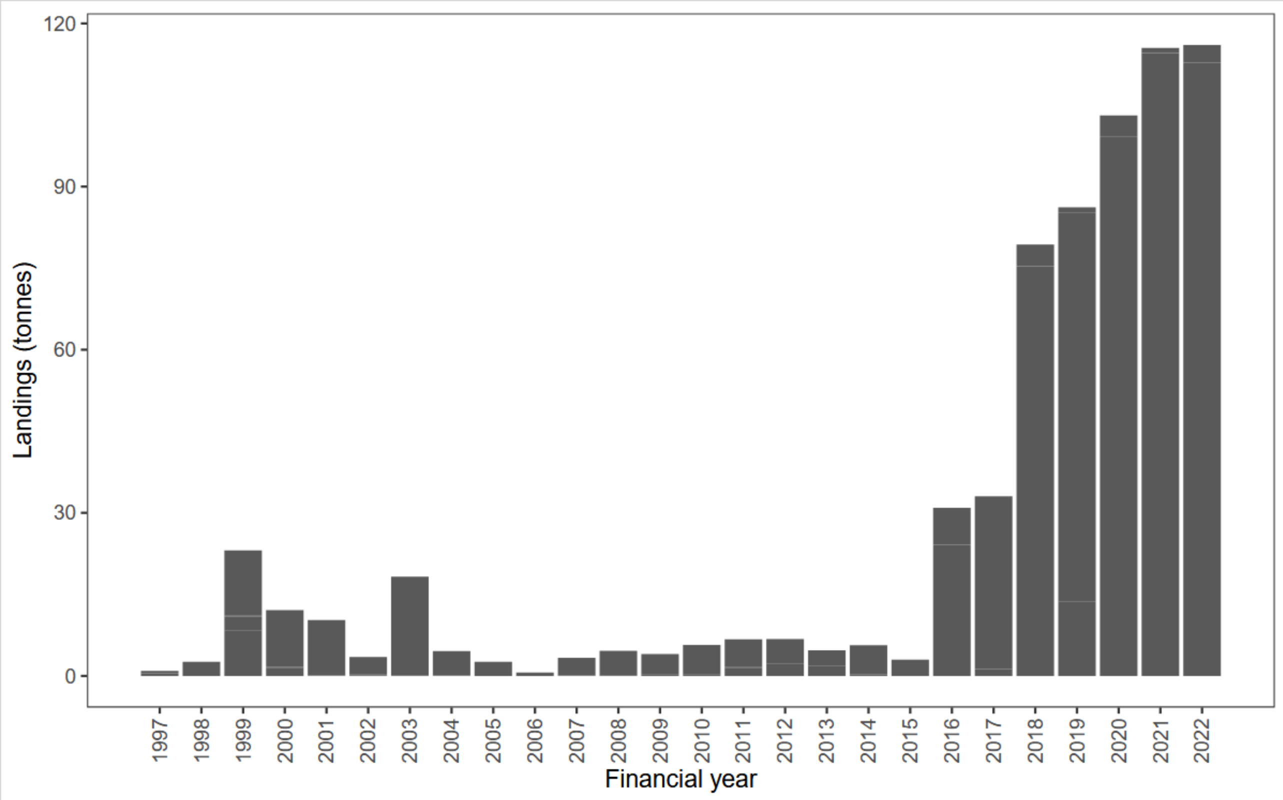


Figure 110 Total catch of octopus (all species) for financial years 1999/2000–2022/23.

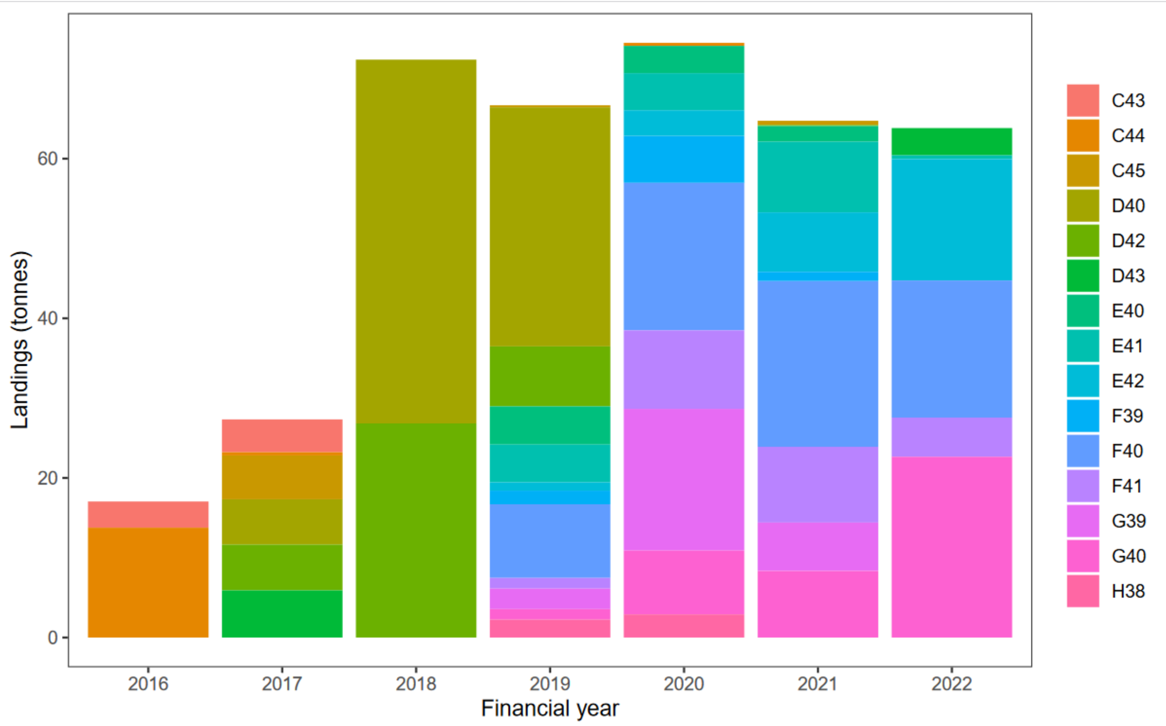


Figure 111 Total catch of Victorian octopus (all species) from the commercial fishery by grid cell (top 15) for financial years 2016/17–2022/23.

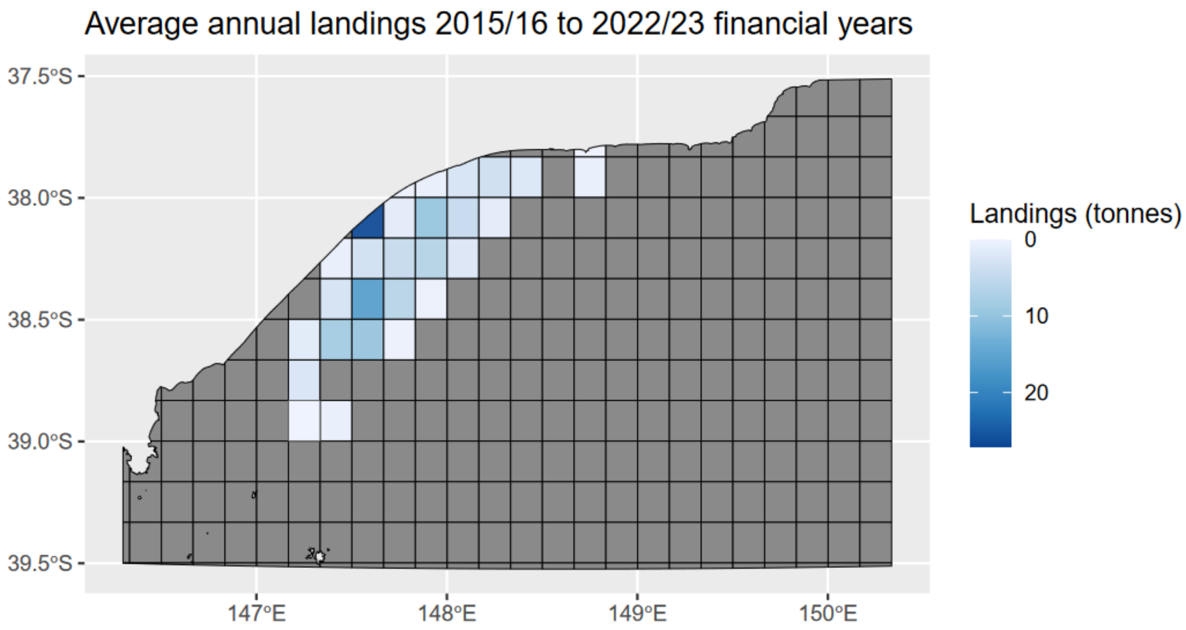


Figure 112 Annual commercial fishing catch effort using unbaited octopus shelter pots in eastern Victoria during 2015/16–2022/23.

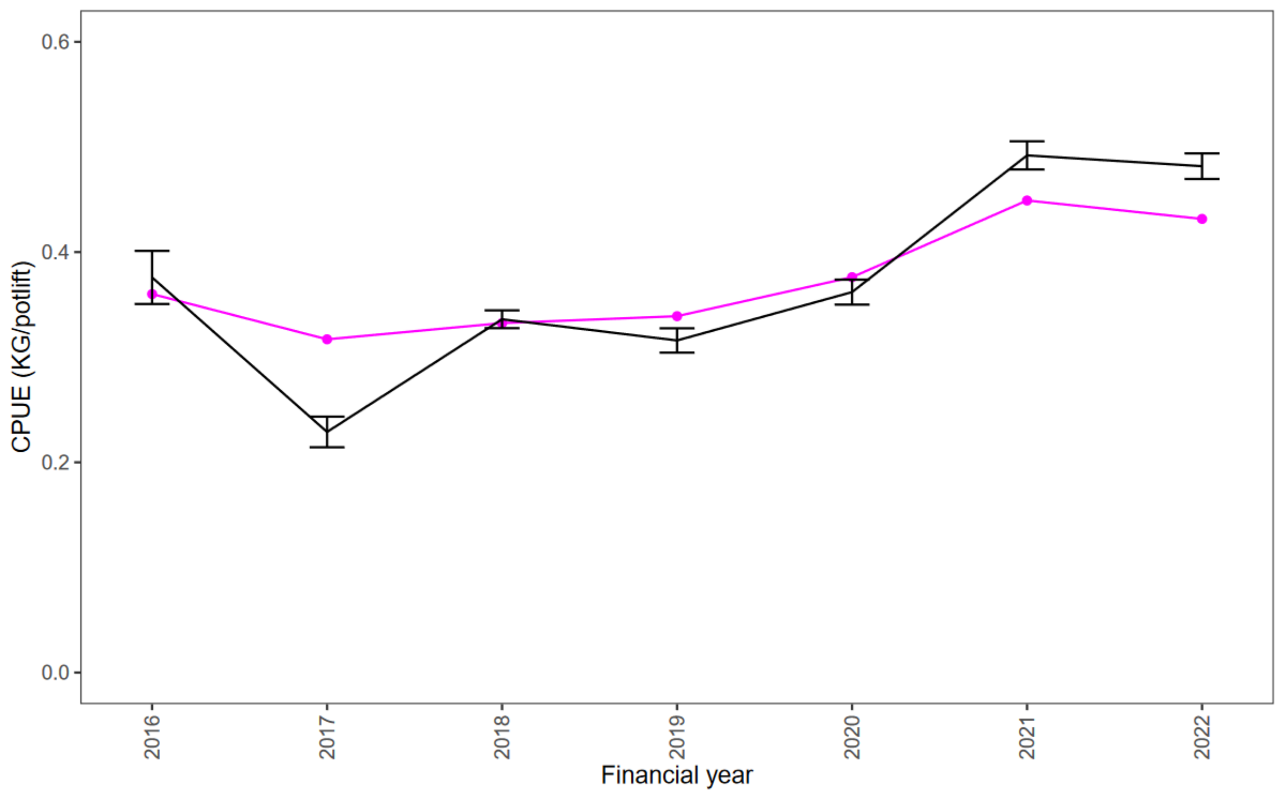


Figure 113 Catch-per-unit-effort (CPUE) of octopus in the eastern Victoria fishery (2016/17–2022/23 financial years). The pink line is the standardised (LMM) trend and the black line with error bars shows the mean nominal pattern with standard errors.

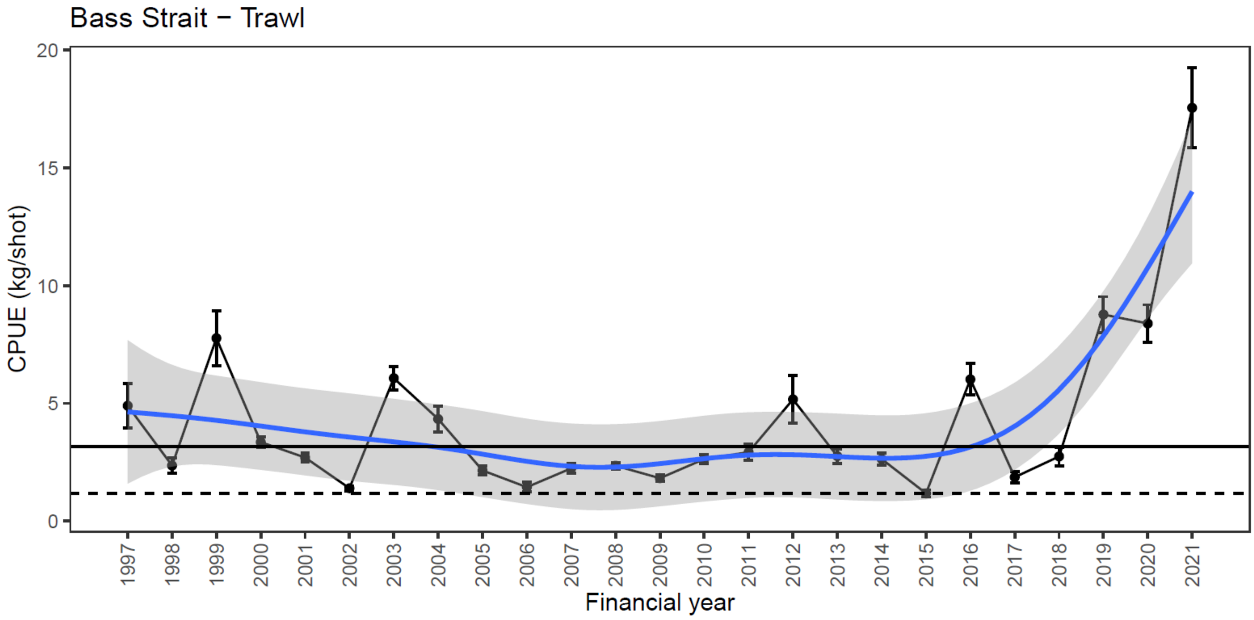


Figure 114 Catch-per-unit-effort (CPUE) of octopus from Bass Strait trawl (1997/98–2021/22 financial years). Note: the period commenced in 1997 (reference period broken line: 1997–2015) to eliminate the prior effect of discarding.

Banded Morwong (*Cheilodactylids spectabilis*)

Attar: Photographer: Mark Norman

Stock Structure and Biology

In Australia, banded morwong (*Cheilodactylus spectabilis*) inhabit temperate reefs from around Sydney to south-eastern South Australia, including all of Tasmania (Gomon et al. 1994). The species also inhabits waters around New Zealand. Banded morwong are very long lived, with a maximum reported age of 97 years (Ewing, 2007). There are notable differences between the sexes with males growing much faster than females and to a much larger size (Ziegler, et al. 2007). Little is known about the stock structure of banded morwong but it has been hypothesised that, due to extended larval phases (~6 months) that it is unlikely that there is fine scale genetic differentiation (Moore et al. 2018).

Banded morwong were historically a by-product or discard species, however, in the early 1990's, fisheries developed in Tasmania, and later eastern Victoria, to supply the domestic live fish market. In both states, banded morwong are targeted using mesh nets over inshore reefs as the species has exceptionally high post release survival (Bell et al. 2016) and rarely displays scarring from where it was in contact with the net.

Management/Assessment Unit

The banded morwong fishery operates exclusively out of eastern Victoria (Figure 115). The Victorian banded morwong fishery is therefore considered a single stock for management purposes.

A specific banded morwong licence was implemented in 2000 because of increasing catch by ocean general licences and licences were allocated to two fishers based on catch history. As such, this analysis only includes data since the implementation of the target fishery (i.e. from 2000 onward). Fishing is now only undertaken by mesh netting, so this gear is used to calculate CPUE given that it is more likely to be a reliable proxy for abundance of the species than CPUE from other gear types used in the past.

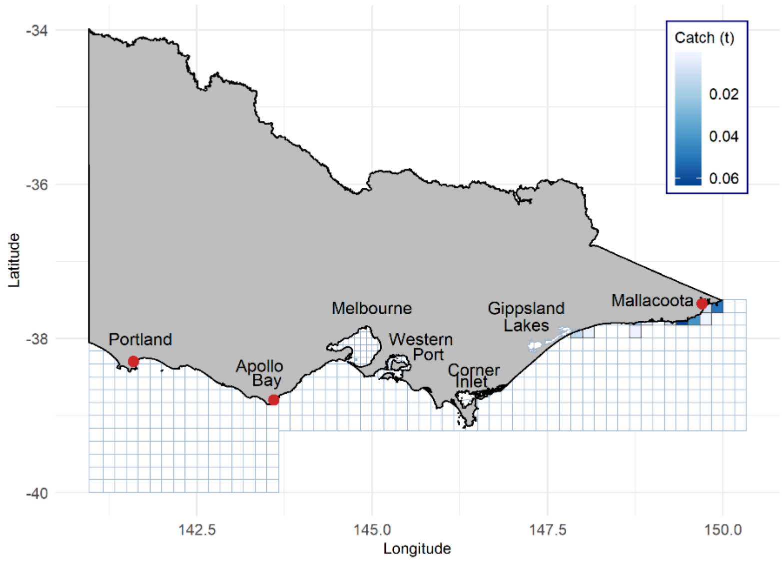


Figure 115 Spatial distribution of state-wide landings of banded morwong from Victorian fisheries during the 2018/19 financial year.

Assessment Summary

This assessment found:

- *Fishing pressure* – Fishing effort, and catch, in the commercial live banded morwong fishery reached a peak from 2001–2003 soon after the banded morwong licence was implemented (Figure 116 & Figure 117). Both fishing effort and catch began to decline soon after and have remained relatively consistent since 2005.
- *Biomass* – The decrease in catch and effort were brought about by localised depletion of stocks (fisher's observations), but fishers were able to maintain relatively high CPUE by spreading their effort throughout the extensive inshore reef systems in eastern Victoria (Figure 117). Nevertheless, catch rates began to decline after 2006, falling below the reference period average, and reaching a low in 2010, which was associated with a voluntary decline in fishing effort. The two active operators in the fishery have maintained relatively low levels of fishing effort in recent years, resulting in an increase in CPUE from the low in 2010 until 2016, which was well above the reference period average. However, CPUE has since declined to below the reference period average for the last four years. It will be important to monitor this fishery during the coming years to ensure this is not an indication of stock depletion. It is important to note, however, that both licenses were transferred simultaneously and with <50 days of fishing effort in most years driving the trend in recent years (some <20 days), CPUE may not be a reliable indicator of biomass across the entire breadth of the fishery.

Stock status summary: The banded morwong fishery was likely fully exploited by Ocean Access License holders before it was licensed as a specialised target fishery with two operators. This is corroborated by observations by fishers during the mid-to-late 2000's when further declines were observed. This is consistent with the longevity of this species and the pattern observed in Tasmania where a full quantitative stock assessment of the fishery is undertaken. As a result, fishers decreased fishing effort with consequent increases in CPUE. However, declines in CPUE to below the reference period average in the last four years are associated with increasing fishing effort and it will be important to monitor how this fishery performs in the coming years. The available evidence indicates that the commercial banded morwong fishery in eastern Victoria is depleting but not recruitment impaired. However, the considerable uncertainty surrounding the reliability of CPUE as an indicator of biomass makes it hard to reliably define the status of this stock.

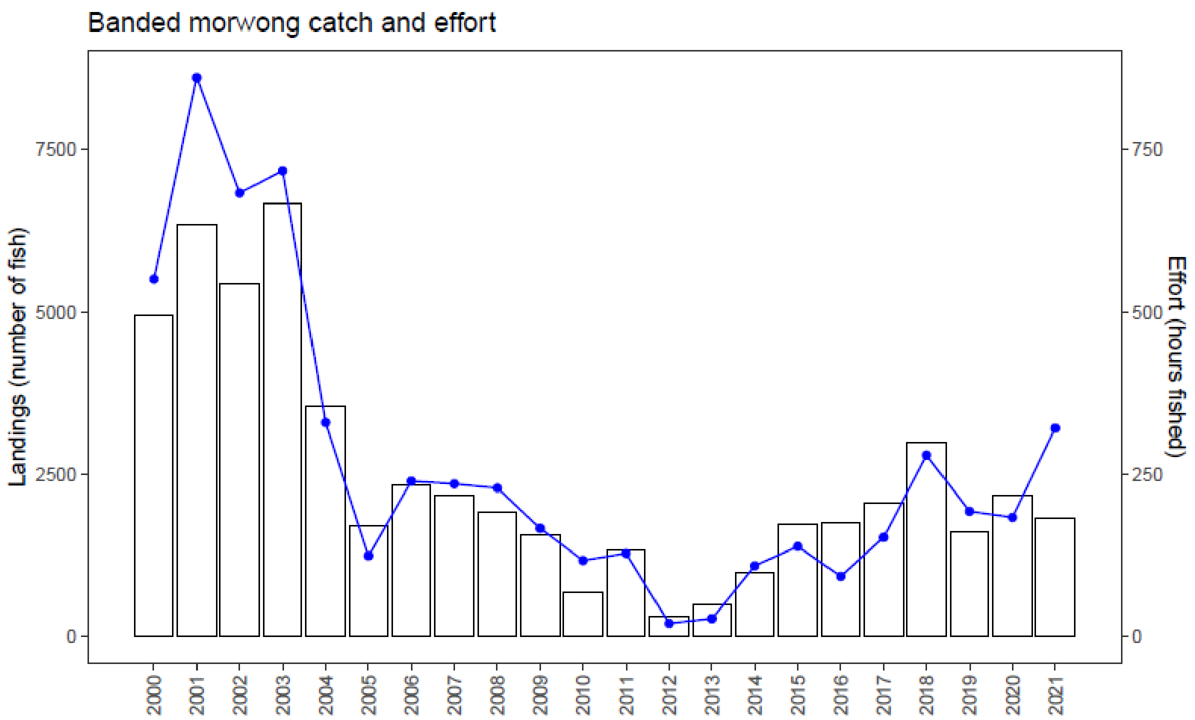


Figure 116 Annual landings and fishing effort in the commercial live banded morwong fishery (2000/01–2021/22 financial years).

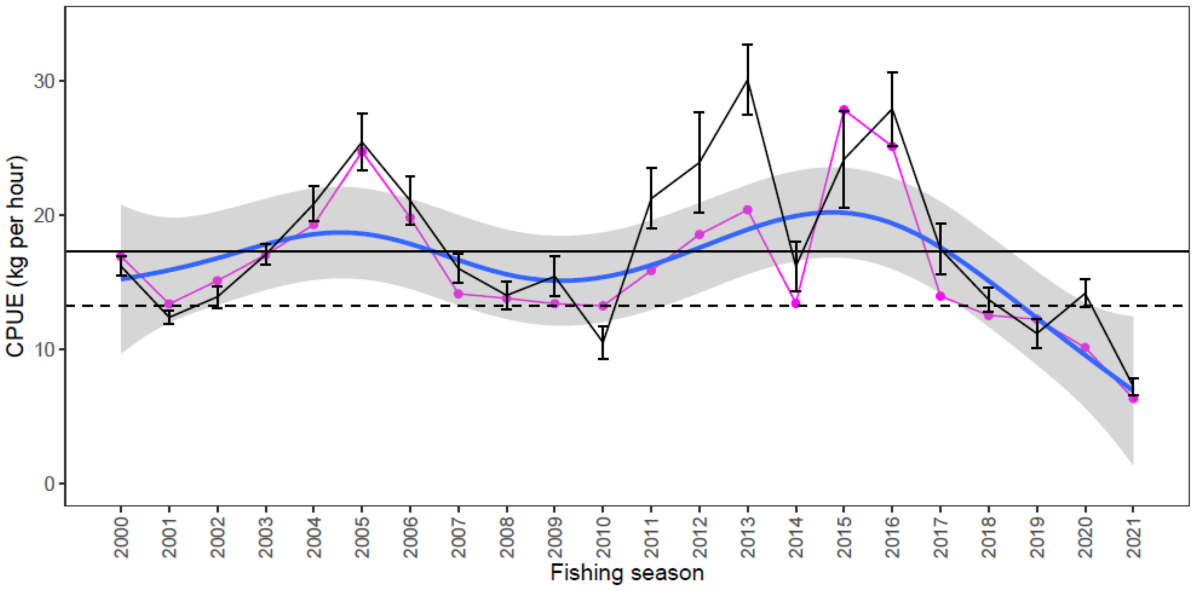


Figure 117 Nominal catch-per-unit-effort (CPUE) (±SE) of live banded morwong for the commercial mesh net fishery (2000/01–2021/22 financial years). The blue line is a generalised additive model (GAM) of the CPUE trend with the shaded area representing 95% confidence intervals of the model. The black horizontal line is the average of the reference period (2000–2015) and the dashed line is the minimum observed value during the reference period.

Port Phillip Bay Commercial Scallop (*Pecten fumatus*)

Stock Structure and Biology

The commercial scallop (*Pecten fumatus*) is a large mollusc that inhabits soft sediment habitats throughout southern Australia from Shark Bay in Western Australia to central Queensland, including Tasmania (Edgar et al. 2008). The commercial scallop, as its name implies, is the major target of scallop fisheries in southern Australia with fisheries historically operating throughout eastern Tasmania, Bass Strait and Port Phillip Bay with several localised fisheries in New South Wales and South Australia and being taken as by-product in fisheries operating for other species in West Australia (Kailola, *et al*. 1993).

Scallops are fast growing, maturing after just 1–2 years and reaching a harvestable size in around three years, but growth can vary spatially (Kailola, *et al*. 1993). Scallops can live for >10 years but are prone to large die-offs leading to large natural fluctuations in abundance (Coleman, 1998).

Commercial scallops in the D'Entrecasteaux Channel and Port Phillip Bay are genetically distinct from most other regions with beds in northeast Bass Strait also being different from central and southern Bass Strait (Ovenden, et al., 2016). This implies that there are likely at least two genetically distinct commercial scallop populations in Victoria: 1) Port Phillip Bay, and 2) northeast Bass Strait.

Management/Assessment Unit

Commercial scallop fishing in Victorian-managed waters of northeast Bass Strait are assessed externally by consultants (https://www.fishwell.com.au/project/ocean-scallop-biomass-survey/ , https://vfa.vic.gov.au/commercial-fishing/commercial-fisheries/scallop, accessed on 19 Oct 2023), thus, the current assessment only considers the Port Phillip Bay dive fishery. Note that there have been no doughboy scallops landed since the development of the Port Phillip Bay dive fishery so only results pertaining to commercial scallops are presented.

Commercial scallops are only permitted to be hand caught in Port Phillip Bay and because they tend to live in waters >5 m, compressed air diving (i.e. Hookah or SCUBA) is necessary to access the beds. Thus, the current assessment uses the number of diver hours as the effort metric for CPUE calculation in this assessment.

Assessment Summary

This assessment found:

- *Fishing pressure* – Fishing commenced in the Port Phillip Bay commercial scallop dive fishery in 2014, the year after the single exclusive license was issued, and effort increased gradually over the next two years reaching a maximum in 2016 and 2017 (Figure 118). Effort then decreased slightly in 2018. Catch has followed a similar trend, increasing from 2014 through to highs in 2016 and 2017, but decreased substantially in 2018 (Figure 119).
- *Biomass* – CPUE increased from 2014 to 2016, with nominal CPUE reaching 93 kg/hr, and remained relatively stable in 2017 (Figure 120). In 2018, however, nominal CPUE almost halved to 54 kg/hr, because of the slight decline in effort coupled with a large decline in the total catch landed. Importantly, the standardised results were higher but followed a similar pattern, indicating that bias in the data was consistent over time and that the

somewhat symmetrical pattern of increase followed by decrease reflected the actual biomass. Data since 2018 is insufficient to extend these trends with any confidence. Data acquired since 2018 are insufficient to extend these trends with any confidence due to the extremely low catches so this fishery is becoming data limited and the impact of fishing will become negligible if low catches persist.

Stock status summary: Commercial scallop abundance naturally fluctuates by several orders of magnitude, which has been well documented in Port Phillip Bay (Coleman, 1998). As a result, the decrease in CPUE observed in 2018 is not necessarily a sign of overfishing and is unlikely to be so given the very conservative landings (<60 t) within the context of the total abundance, which was estimated to be >11,000 t in 2015 (Gwyther, 2015) i.e. ~0.5% of the total biomass. As a result, it is likely that the decrease in CPUE observed in 2018 is largely due to naturally lower scallop abundance, which has resulted in a decrease in fishing effort as fishers are receiving lower returns for their effort. As time progresses it will become apparent how the natural variation in scallop abundance effects the dive fishery, but at present, given the very conservative landings, it is highly unlikely that the Port Phillip Bay commercial scallop dive fishery will cause recruitment impairment and the stock can be considered as sustainable.

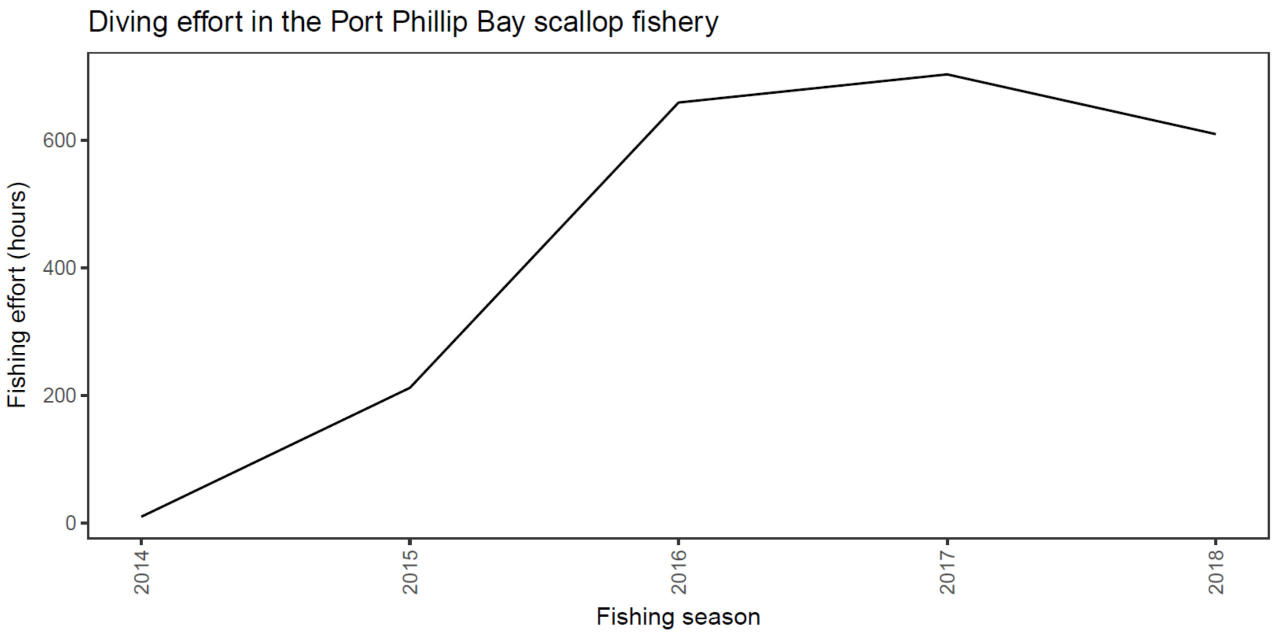


Figure 118 Annual fishing effort in the Port Phillip Bay commercial scallop dive fishery (2014–2018 fishing seasons).

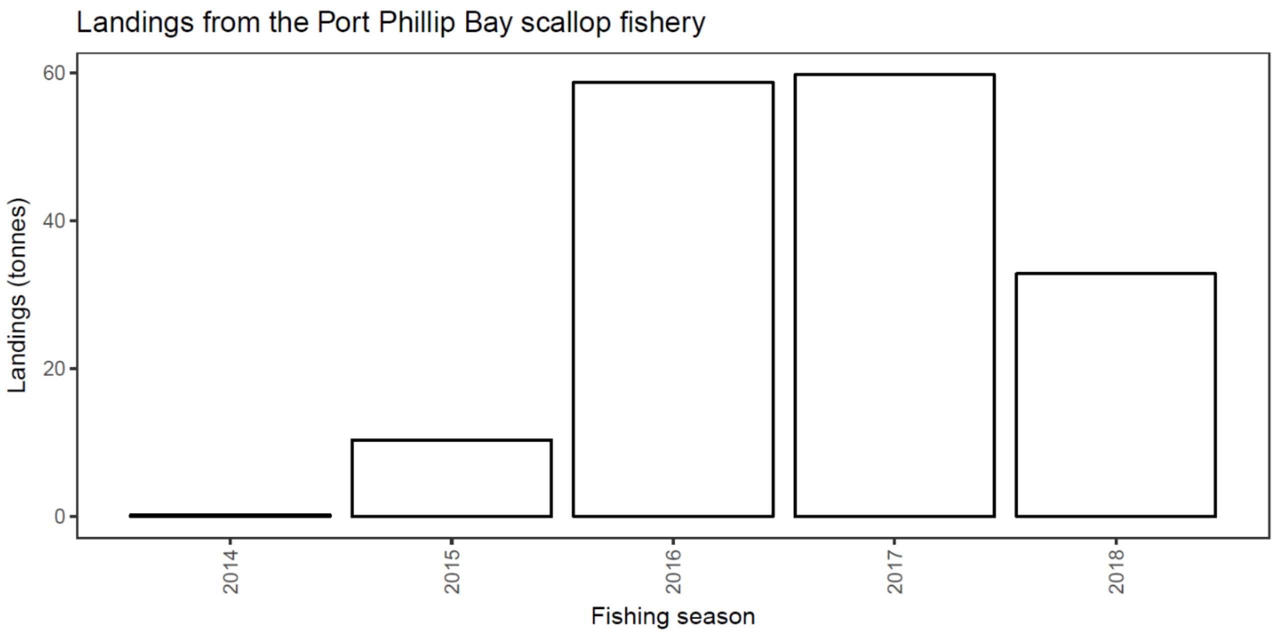


Figure 119 Annual landings of commercial scallops from the Port Phillip Bay commercial scallop dive fishery (2014–2018 fishing seasons).

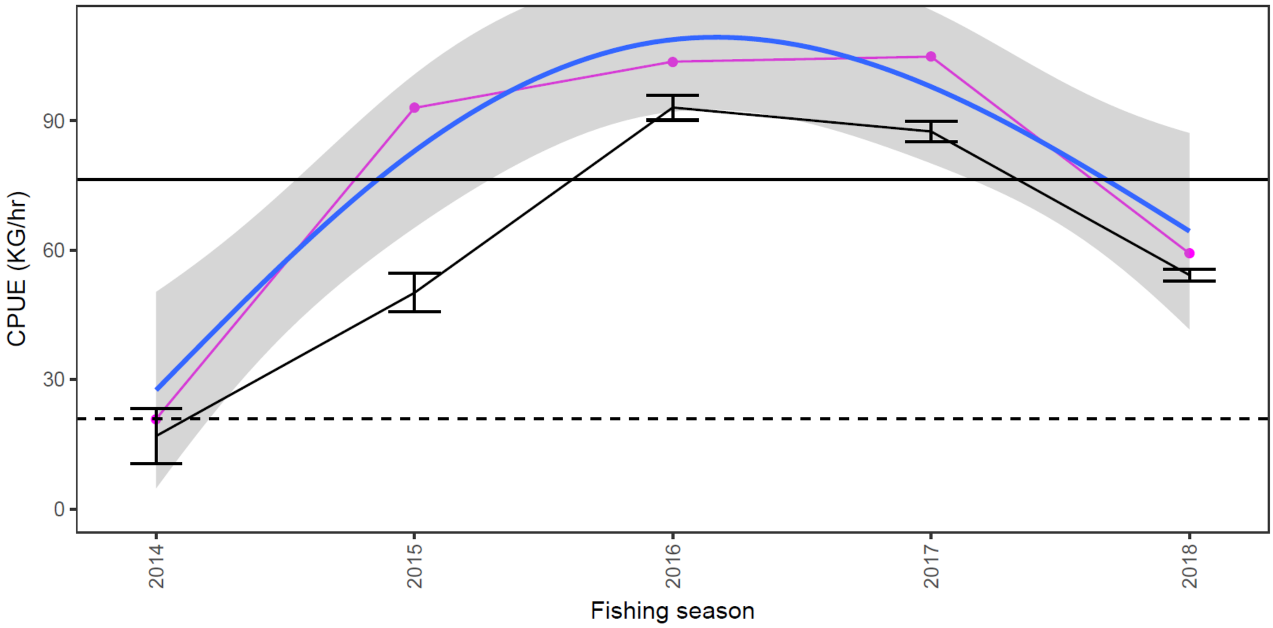


Figure 120 Catch-per-unit-effort (CPUE) (±95% CL) in the Port Phillip Bay commercial scallop dive fishery (2014–2018 fishing seasons). Black line is nominal CPUE (±SE), magenta line is standardised CPUE, blue line is a generalised additive model (GAM) of the standardised CPUE trend with the shaded grey area representing the 95% confidence interval of the GAM. The black horizontal line is the average CPUE and the dashed line is the minimum observed during the time series. No reference period used due to the short period the fishery has been operating.

Mulloway (*Argyrosomus japonicus*)

Stock Structure and Biology

Mulloway (*Argyrosomus japonicus*) are widely distributed in temperate waters of the Atlantic, Indian and Pacific Oceans. In Australia they are distributed from Bundaberg in Queensland, throughout southern Australia, excluding Tasmania, to North West Cape in Western Australia (Kailola *et al*. 1993).

Mulloway are relatively fast growing, with males reaching 50% maturity in 5 years at 78 cm and females in 6 years at 85 cm respectively (Ferguson *et al.* 2014) but this varies spatially. Mulloway are relatively long lived, living to >40 years of age (Ferguson et al. 2014). Mulloway spawn in marine environments from October to January (Ferguson *et al.* 2014; Griffiths, 1996), with evidence suggesting that spawning takes place near the entrance of estuaries that subsequently act as nurseries for the juveniles (Ferguson *et al*. 2014). Juveniles remain in estuaries until they around the size of maturation, after which they predominantly inhabit coastal waters and are capable of relatively large migrations (Griffiths, 1996).

Nothing is known of the stock structure of mulloway in Victorian waters. In South Australia, otolith microchemistry and shape analysis revealed at least two distinct stocks with the central region showing similarities to both the east and western stocks, potentially representing a third stock (Ferguson *et al*., 2011). Molecular analyses support this notion with two additional separate Australian stocks: the first in New South Wales and another in West Australia. As such, it is reasonable to assume that multiple stocks exist in Victoria with it being most likely that the western part of the state shares a stock with eastern South Australia and the eastern part of the state shares a stock with New South Wales, as is the case for a variety of other species (e.g., Australian salmon, snapper, white sharks). Preliminary results from a study in western Victoria indicated that mulloway in the Glenelg River is likely to be a component of the south-eastern South Australia population, which includes the Coorong (Lauren Brown, unpublished data).

Management/Assessment Unit

Less than 3 t of mulloway (<50 individual catches) has been landed by all Victorian commercial fisheries (predominantly Port Phillip/Western Port Bays and the Gippsland Lakes) during the last 20 years, which is insufficient to facilitate meaningful analyses. The only data with which to assess the status of Victorian mulloway stocks comes from angler diarists fishing in the Glenelg River in western Victoria. As such, this assessment will use catch rates, and length frequency, from those anglers to evaluate the status of this part of the south-eastern South Australia stock likely to also encompass other coastal and estuarine habitats in western Victoria. As a formal stock assessment has been undertaken for the south-eastern South Australian stock (Earl and Ward, 2014), albeit six years ago, this information was used to augment information from the Glenelg River.

Assessment Summary

This assessment found:

- *Fishing pressure* – Less than 3 t of mulloway have been landed in Victorian commercial fisheries in 20 years suggesting there is minimal fishing pressure from commercial fisheries. There is no quantitative information on the fishing pressure of recreational anglers targeting mulloway in Victoria. Anecdotal reports from fishers suggest there has been an increase in recreational fishing pressure in the Glenelg River in recent years, with charter operators also running guided tours in the system.

- *Biomass* – Catch rates of mulloway in the Glenelg River have been variable through time but increased from relatively low levels during the 1990s with a peak from 2012/13 to 2015/16 at over 0.5 fish per angler hour (Figure 121). This was followed by a slight reduction before increasing again in 2018/19. High recent catch rates, along with length frequency data (detailed below), indicate that there has been relatively strong recruitment in recent years. Additionally, anglers report that mulloway have been abundant and the fishery performing well. This is consistent with findings of a stock assessment undertaken in the Coorong, South Australia, in which catch rates of commercial mesh net fishers targeting mulloway has increased from the mid-1980s through until 2013/14 when the study was undertaken (Earl and Ward, 2014). Furthermore, in the Coorong, there was a distinct peak in catch rate in 2012/13 and 2013/14, which corresponds with similarly high catch rates in the Glenelg River.
- *Length compositions* – There is some evidence that a particularly strong year class entered the Glenelg River fishery in 2014 at around 40 cm TL, with individuals growing to around 55 cm over the subsequent two years (Figure 122). During 2018, a wide range of sizes were present in angler diary catches suggesting additional recruitment to the system. The lack of large individuals is not unexpected, or necessarily representative of high fishing mortality, as mature mulloway tend to inhabit oceanic waters.

Stock status summary: A wide range of sizes were observed in angler diary catches in 2018 suggesting there has been regular successful recruitment. However, this alone is insufficient to conclude that recruitment is unimpaired despite the Glenelg being only one small part of a stock that incorporates multiple estuaries and hundreds of kilometres of coastline. Additionally, there is no information available about the adult proportion of the stock and no stock assessment has been undertaken in South Australia for >5 years. While there are positive signs for the Glenelg River mulloway fishery in terms of increasing catch rates and some regular recruitment, there is currently insufficient evidence to reliably assess the status of the stock, therefore, the stock status for Victorian mulloway remains uncertain.

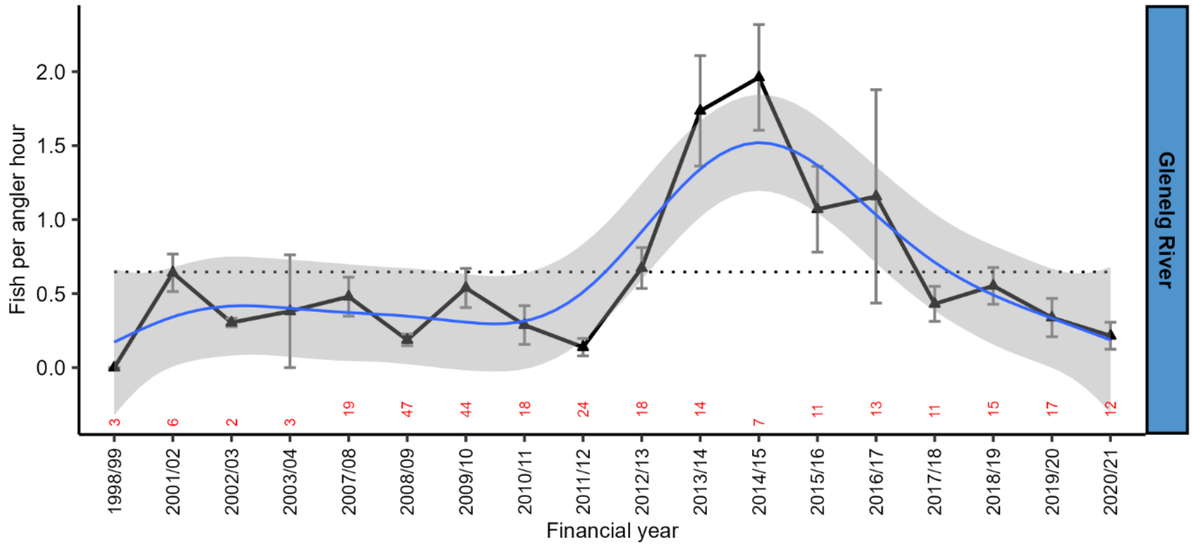
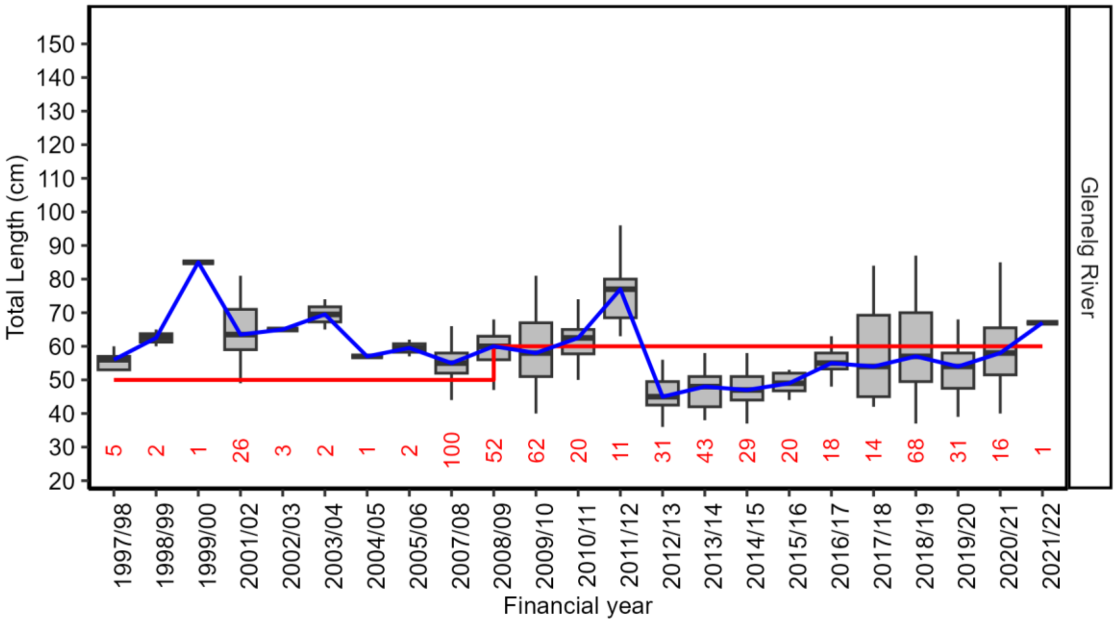


Figure 121 Mulloway nominal catch-per-unit-effort (CPUE) (±SE) for a) in the Glenelg River (1998/99–2020/21 financial years). Horizontal doted black line is the mean CPUE during the reference period (1998 - 2015). Blue line is a generalised additive model (GAM) of the nominal CPUE trend with the shaded grey area representing the 95% confidence interval of the GAM.

(a)



(b)

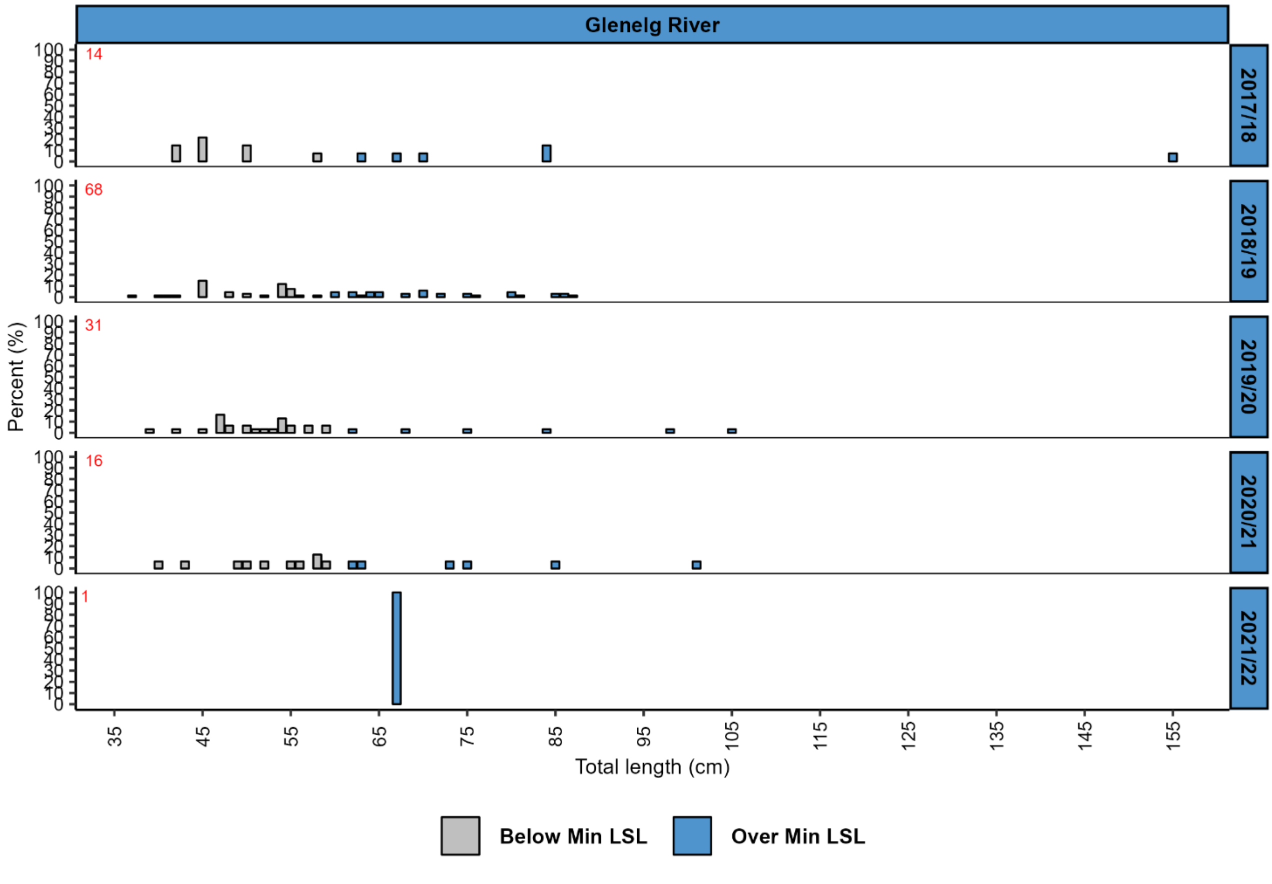


Figure 122 (a) Box-plots of Glenelg River mulloway length composition from diary anglers for financial years 1997/98-2021/22. Red numbers on x-axis indicate numbers of fish sampled. Blue line = median length, red line = LML. (b) Frequency histograms of Glenelg River mulloway length composition from diary anglers for fiscal years 2017/18-2021/22. Red numbers indicate numbers of fish measured.

Murray Cod (*Maccullochella peelii*)

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 123). 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 123). 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 123). 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.

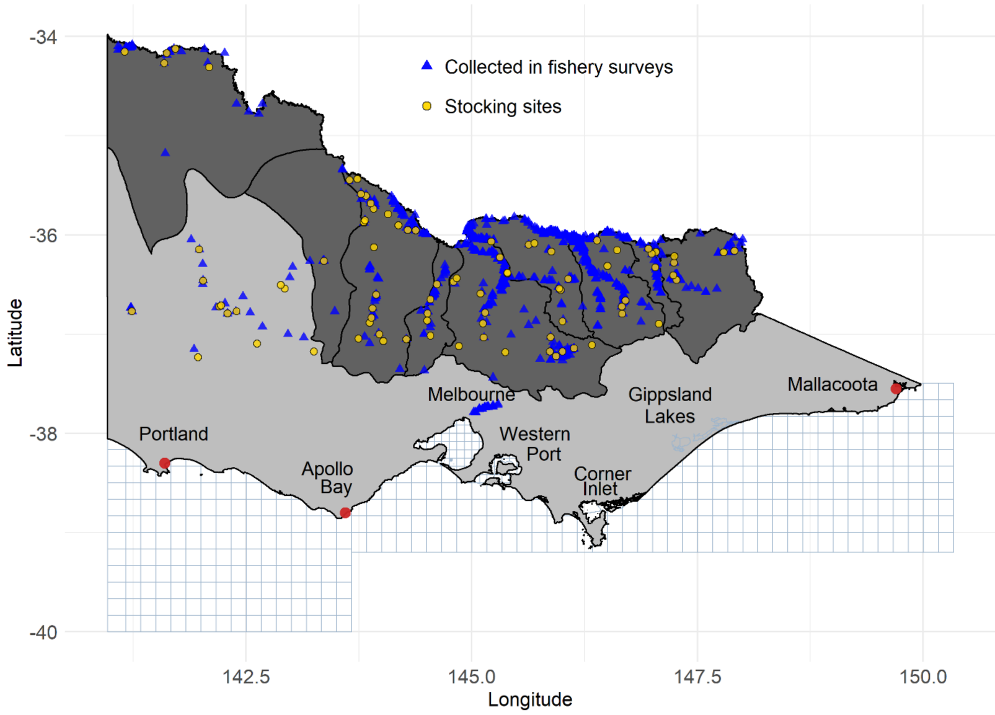


Figure 123 Victorian Murray Cod distribution and stocking sites.

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 seven indicator riverine populations, three rivers (Goulburn River, Gunbower Creek and Ovens River) from the native fish report card program (NFRC, accessed on 4 June 2024) and four rivers (Broken Creek, Broken River, Campaspe River and Loddon River) from Victorian Environmental Flows Monitoring Assessment Program (VEFMAP, accessed on 4 June 2024). A reference period was selected from first record since 1990–2015. 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 124). Since about 2014–2015 CPUE appears to have increased relative to the reference period in most indicator rivers (except the Loddon River). CPUE in the Broken Creek, Broken River, Campaspe River, Goulburn River, Gunbower Creek and Ovens River has shown two to five-fold increases and has been above the reference level [Bell et al. 2023]. However, CPUE in the Loddon River has remained low for most of the last decade.
  Murray Cod have been stocked into Victorian rivers since 1979 to enhance populations. During the 1990s and 2000s, 0.06 – 0.4 million were stocked annually but since then the number of fish stocked has increased dramatically and in the last six years (2017-2022) 1.16 --3.65 million were stocked annually into the state's water bodies, including six of the seven indicator rivers (excluding the Ovens River). Murray Cod less than one year old were present in most rivers in recent years indicating either natural recruitment (Ovens River) or presence of stocked of hatchery-reared fish. 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.
  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 125). A wide range of fish size were observed in most waterways (except the Loddon river) 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 except for the Loddon River. 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 125). Mature fish (> 55 cm) were present in six of the seven indicator rivers (except the Loddon River), but in low proportions in most rivers. Between 2015-2022, the proportion of fish that were mature was >5 per cent in six rivers, >10 per cent in most years in three rivers and exceeded 20 percent in some years in three rivers.

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 seven indicator riverine populations (Broken Creek, Broken 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 most 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 seven indicator waterways the Murray Cod stock status has been assessed as recovering.

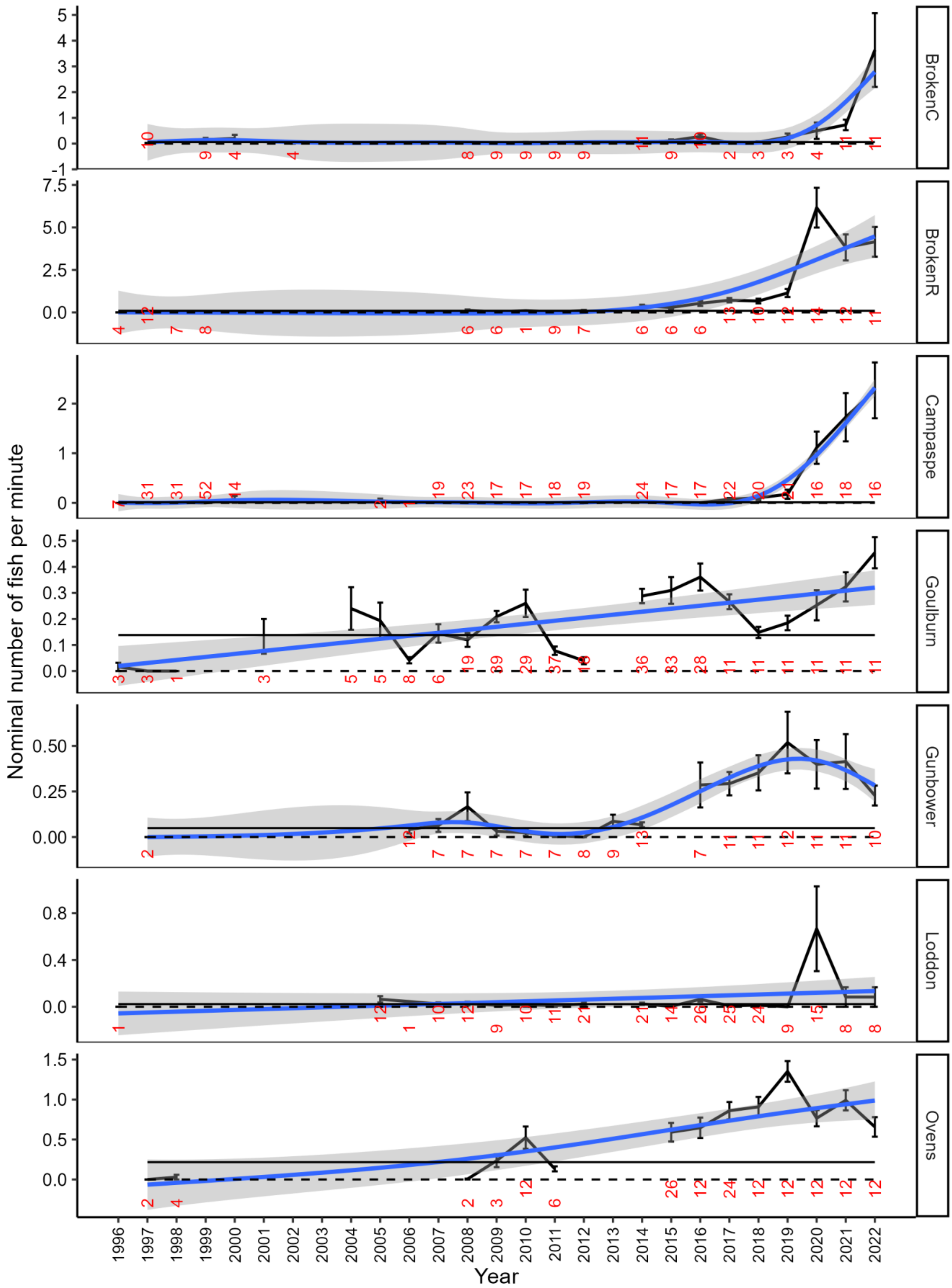


Figure 124 Electrofishing fishery survey catch-per-unit-effort (CPUE) (nominal) for Murray cod in seven indicator rivers during 1996–2021. Horizontal black line is the mean nominal CPUE during the reference period (first record since 1990

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.

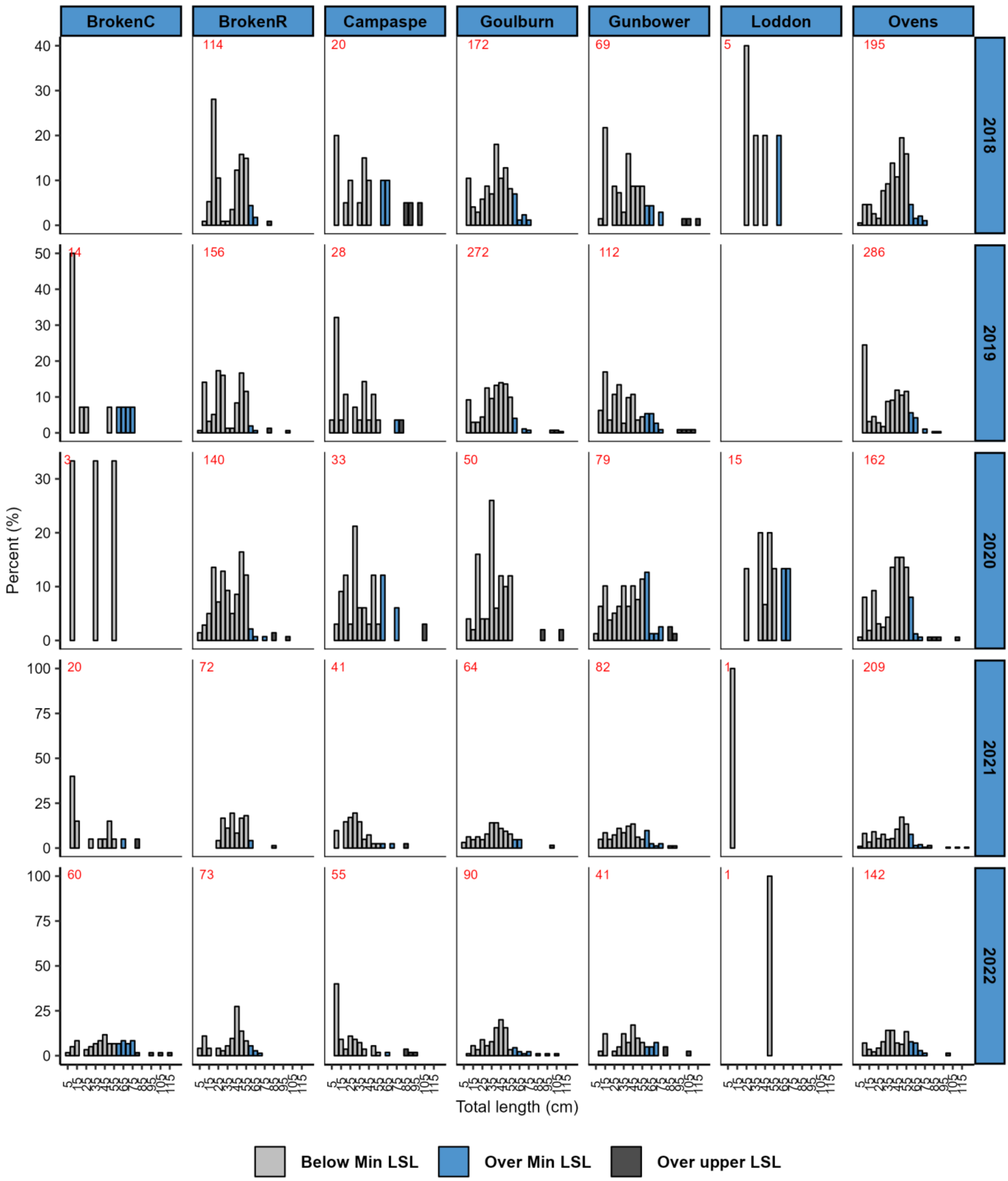


Figure 125 Length (TL) frequency histograms of Murray Cod electro-fishing survey catches from 2018–2022 for seven indicator creeks and rivers. Red numbers indicate quantity of fish measured.

Snook (*Sphyraena novaehollandiae*)

Stock Structure and Biology

Snook (*Sphyraena novaehollandiae*), a relative of the Barracudas, are distributed throughout southern Australia and New Zealand (Gomon et al. 2008). Relatively little is known about snook, including the stock structure, as they are landed in relatively low quantities in Victoria, South Australia and Tasmania (Moore, 2018; Steer, 2018) being a by-product taken while targeting other more valuable species. Snook reach maturity at 40–42 cm and spawn from late November to February (Bertoli, 1994). Snook grow quickly and have a maximum age of at least 10 years (Bertoli, 1994).

Management/Assessment Unit

Commercial landings of Snook (Shortfin Pike) and Longfin Pike (*Dinolestes lewini)* are frequently combined, or misreported, particularly in early years. Longfin Pike are typically discarded so the combined landings of both species are likely to be a relatively reliable representation of Snook landings. Historically, snook were landed commercially in the largest quantities in Port Phillip Bay, however, since effort in Port Phillip Bay has declined following the buyout, the largest quantities are now landed in Corner Inlet. As nothing is known about the stock structure of snook, and the only fishery that lands significant quantities in Victoria is in Corner Inlet, the status of snook in Victoria is assessed using data from Corner Inlet alone.

In Corner Inlet, <2 tonnes of snook have been landed by mesh nets in all years other than 2018/19, which is considered insufficient to provide a reliable CPUE indicator of biomass. Landings from seine in Corner Inlet have generally been >5 tonnes; as such, seine CPUE is used as the primary indicator of stock performance.

Assessment Summary

This assessment found:

- *Fishing pressure* – Snook landings have mostly varied between around 20 and 50 t from 1978/79 to 2015/16 when they reduced dramatically as a result of the reduction, and ultimate closure, or net fishing methods in Port Phillip Bay, where the majority of the catch had historically come from (Figure 126). Landings in recent years have been 10–20 t and predominantly come from Corner Inlet-Nooramunga. Snook are rarely targeted by recreational anglers but are occasionally caught and landed none-the-less. While current landings are unknown recreational catches are likely to be small and thus not a major source of mortality:
- *Biomass* – CPUE in Corner Inlet-Nooramunga has remained relatively consistent from 1978/79–2019/20, albeit with some interannual variability, before increasing to historic highs in the last two years (Figure 127). This interannual variability may be a result of natural variation in the population or because Snook represent a relatively minor by-product of this fishery (i.e. not targeted and hence caught in relatively low quantities). CPUE for snook in Corner Inlet using seine nets shows a steadily increasing trend from 2009/10 to 2021/22. Prior to this time CPUE trends are likely unreliable due to potential discarding and misreporting.

Stock status summary: With stable, and more recently increasing, catch rates there is no evidence that Snook abundance has declined in Corner Inlet-Nooramunga over the last 45 years and reduced landings from Port Phillip Bay further reduce mortality on the state-wide Snook management unit. Thus, the available information indicates that the biomass is not depleted, and recruitment is unlikely to be impaired. The current level of fishing mortality is unlikely to lead to recruitment impairment. On the basis of the available evidence the stock status of Snook in Corner Inlet, and more generally throughout Victoria is sustainable.

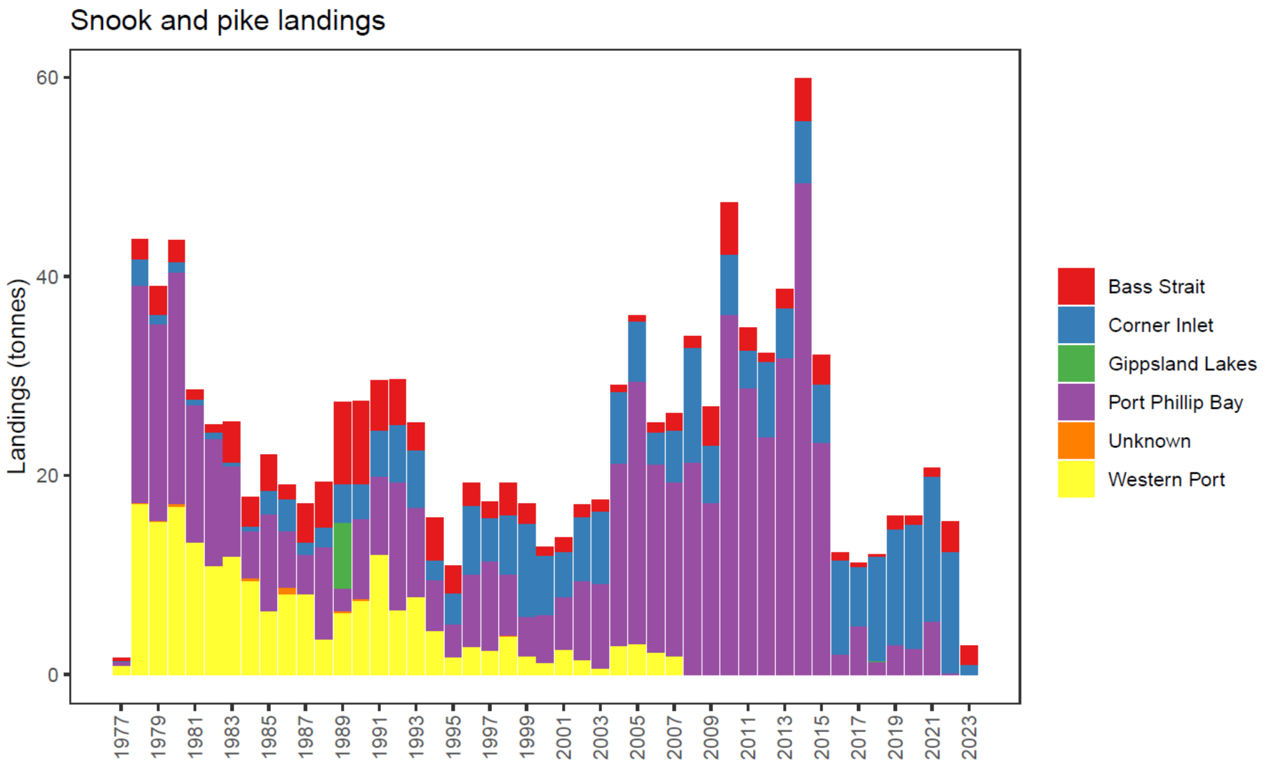


Figure 126 Total Victorian commercial catches of snook and pike by area (1978/79–2020/21 financial years).

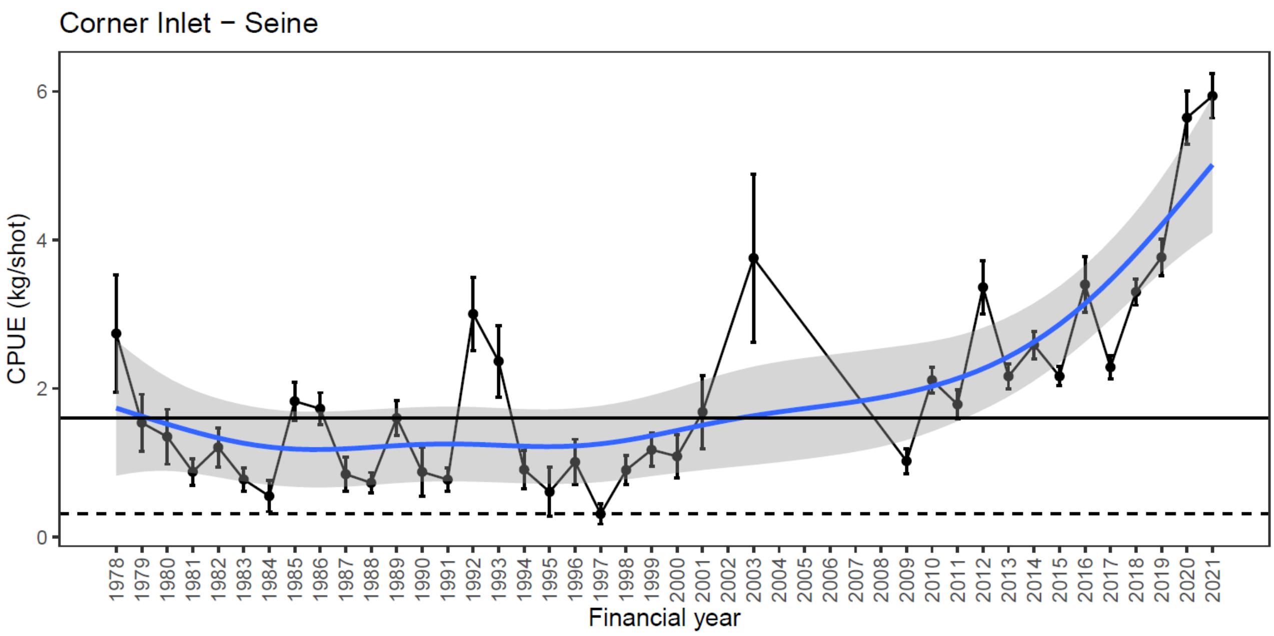


Figure 127 Catch-per-unit-effort (CPUE) of snook taken by seine net from the Corner Inlet fishery (1978/9–2020/21 financial years).

Golden Perch (*Macquaria ambigua*)

Stock Structure and Biology

Golden Perch 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 golden perch 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 128). Phylogenetic analyses based on mitochondrial DNA suggests golden perch in the Murray-Darling basin (including Victorian waters) represents one monophyletic clade (Faulks *et al.* 2010). Golden Perch have been translocated into waters outside their natural range, including the Wimmera River and lakes in western Victoria (Figure 128). Hatchery-bred juvenile golden perch are also stocked into selected waters, mainly within its natural range and mainly within impoundments, to maintain and enhance the recreational fishery (Figure 128). Golden Perch completes its lifecycle solely within freshwater. Spawning in Victoria occurs mainly in spring and early summer (October to February), usually in association with elevated temperatures and increasing water flow and flooding. Populations in rivers are sustained by both natural recruitment and stocking whereas populations in impoundments are sustained by stocking only. Maturity occurs at about 4 years (>1.5 kg) for females and 3 years for males. Golden Perch supports a highly valuable and popular recreational fishery. There is no commercial harvest of golden perch in the state. The recreational fishery is managed through strict recreational bag and size (slot) limits, restrictions on fishing methods such as set lines and supplementation by stocking hatchery-bred fish.

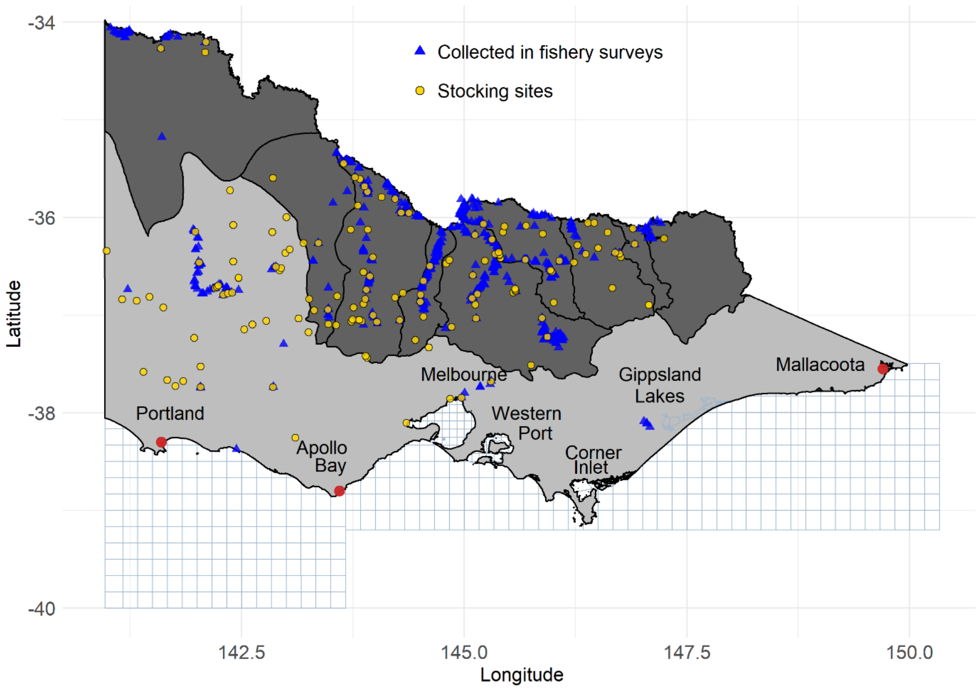


Figure 128 Victorian golden perch distribution and stocking sites.

Assessment Summary

In the absence of consistent, long-term estimates or population abundances and harvest by anglers, the status of the Victorian golden perch stock and associated fisheries were evaluated using:

- Nominal catch estimates (fish per machine minute) and length composition from fishery-independent (electrofishing) surveys of six indictor riverine populations (Broken Creek and River, Campaspe River, Goulburn River, Gunbower Creek, Loddon River and Wimmera River) (Conron *et al. 2020,* Ingramand Lieschke 2023) (reference period first record since 1990–2015).

This assessment found:

- *Fishing pressure* – commercial harvest of golden perch in Victoria ceased in 2001. There is no recent information on recreational harvest or effort at state level.
- *Biomass* – In recent years, electrofishing survey catch per unit effort (CPUE; number of fish per machine minute) has increased in five indicator rivers (Broken Creek and River, Campaspe River, Goulburn River, Loddon River and Gunbower Creek), and declined in one river (Wimmera River), the CPUE of which was below the average CPUE for the reference period (1996–2015) for the recent three years (Figure 129). The CPUE for the Goulburn River and Gunbower Creek have been above the average for the reference period since the early 2010s, for the Campaspe River and Broken Creek and River, Goulburn River since the mid-2010s and for the Loddon River since the late 2010s.
  All six indicator rivers are stocked annually with hatchery-bred juveniles, which may be masking natural recruitment. Regular stockings into the Campaspe, Goulburn and Loddon rivers are making a substantial contribution to populations (Ingram *et al*. 2015, Tonkin *et al*. 2019). All golden perch sampled from the Campaspe River above Rochester were stocked and the majority of fish sampled from the Goulburn and Loddon rivers were stocked (Tonkin *et a*l. 1919). There is no information available to determine if stocked fish are contributing to fisheries in the Broken Creek and River, Gunbower Creek, Loddon River and Wimmera River.
- *Length compositions* – Long-term length composition data for electrofishing surveys is limited for much of the assessment (Figure 130). Most fish measured were above the LML whereas small fish (recruits presumed to be less than one year old and <10 cm) were uncommon (and absent in some years) in all rivers (Figure 130, Figure 131) . Small fish that were present may indicate recent stockings of hatchery-bred fish (all rivers are stocked annually), but some fish may also be from natural recruitment (Figure 131). Mature fish (> 30 cm) were common and present in all rivers in recent years (Figure 131).

Stock status summary: As there is no consistent, long-term estimates of population abundances and recreational harvest for golden perch, 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 Wimmera River). Although information from these rivers is limited to infrequent and irregular annual electro-fishing surveys, CPUE appears to be increasing in five rivers and declining in one river. All rivers are stocked annually. There is no information on fishing pressure, biomass and size composition for golden perch 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 five of six indicator rivers it is anticipated that the golden perch stock will progressively improve under favourable environmental conditions.

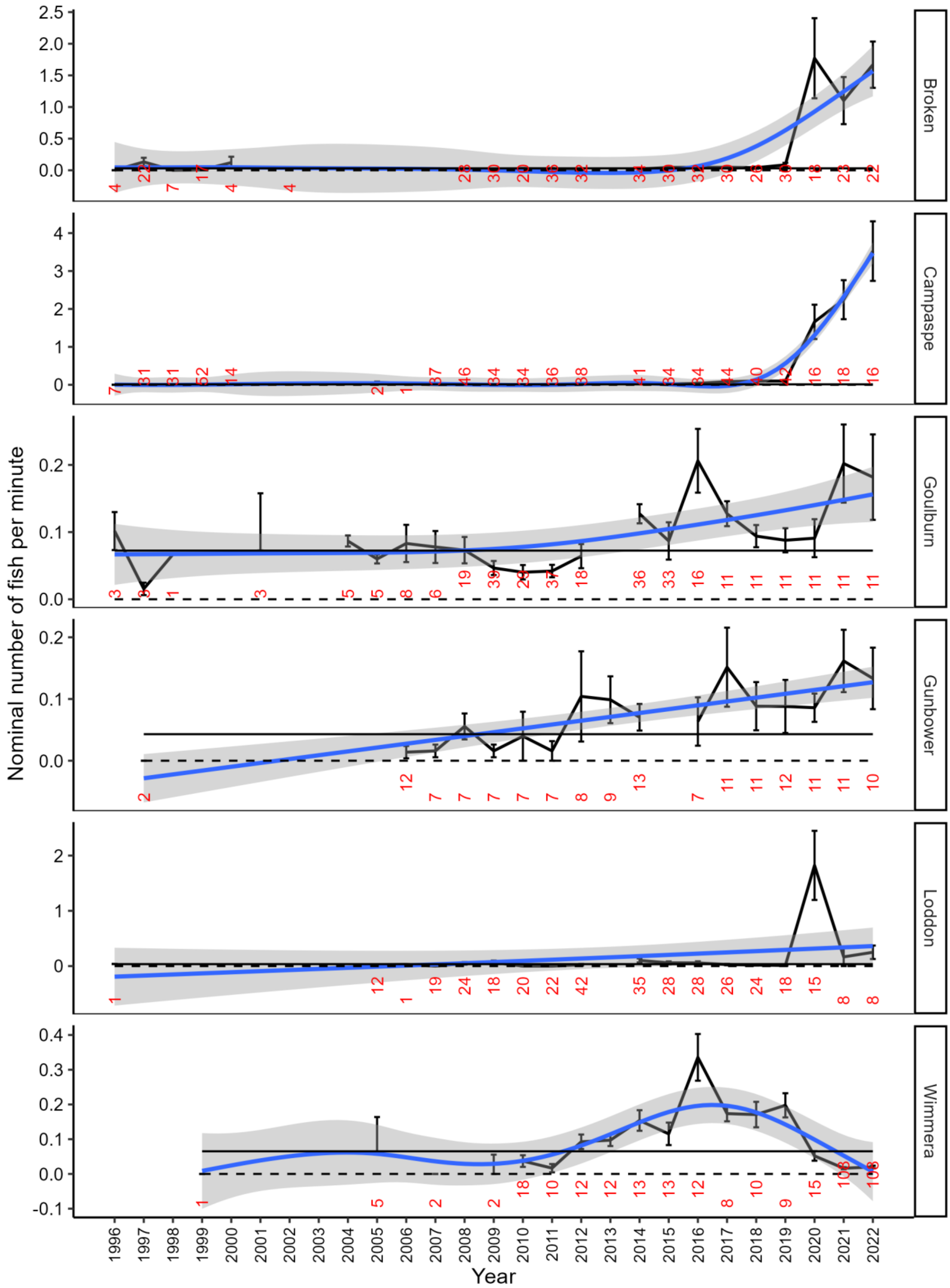


Figure 129 Electrofishing fishery survey catch-per-unit-effort (CPUE) (nominal) for golden perch in six indicator rivers. Horizontal black dashed line is the mean nominal CPUE during the reference period (first record since 1996 to 2022) and the dashed black line is the minimum CPUE within the reference 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.

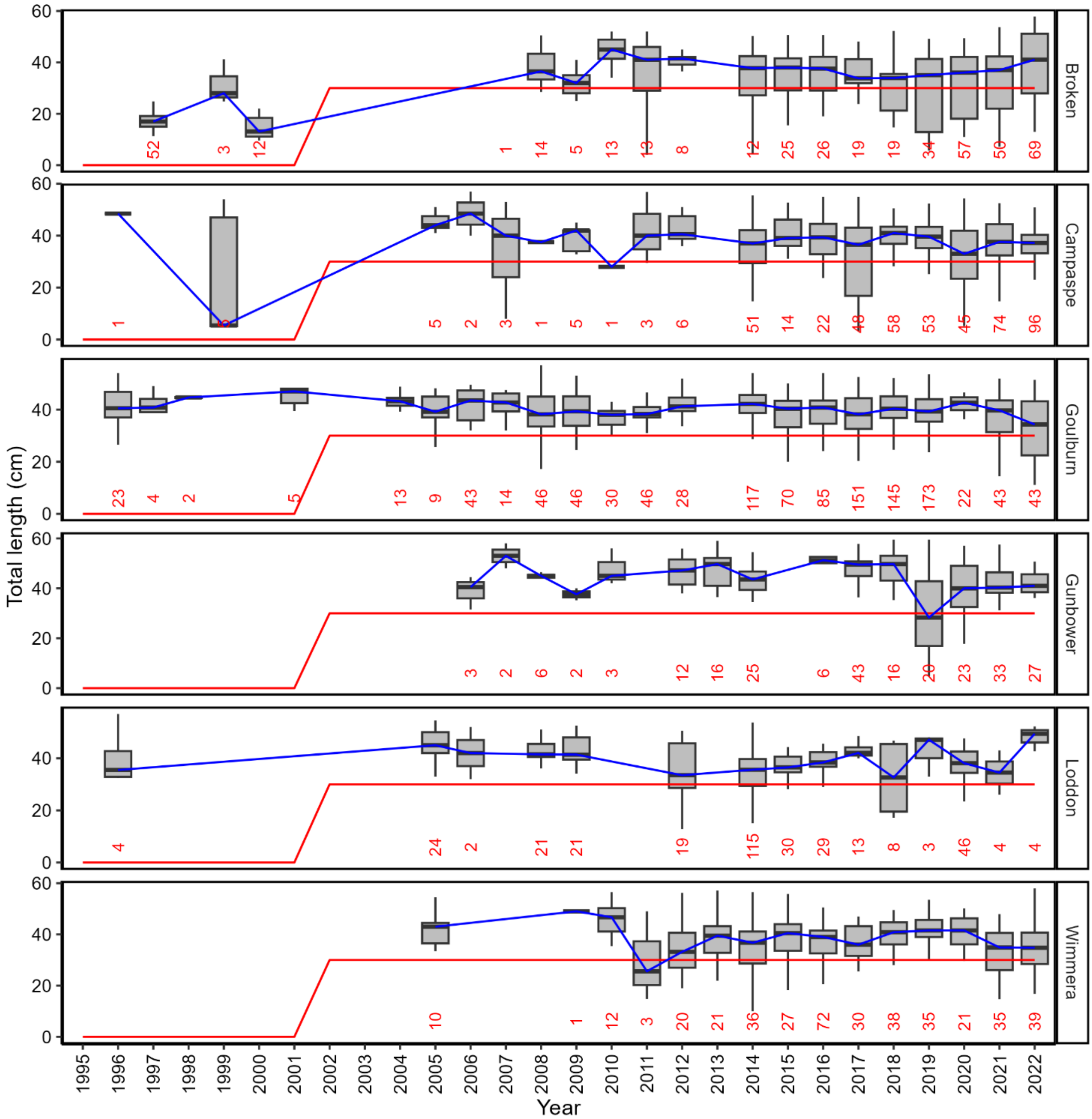


Figure 130 Box-plots of golden perch electro-fishing survey length composition 1995-2022 for six indicator rivers. Red numbers on X-axis indicate number of fish sampled. Blue line = median length, red line = LML.

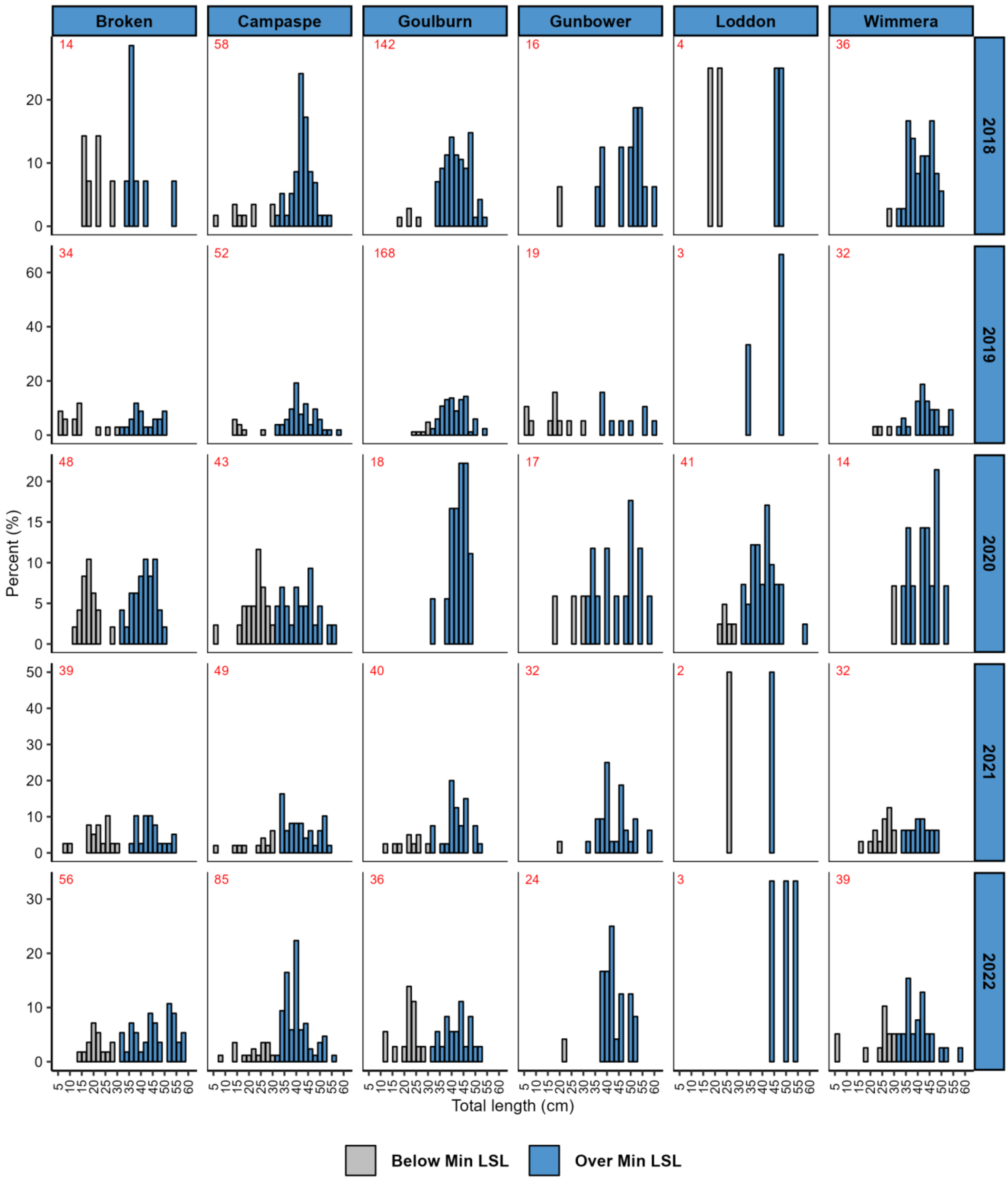


Figure 131 Length frequency histograms of golden perch electro-fishing survey catches from 2018–2022 for six indicator rivers. Red numbers indicate number of fish measured.

Greenback Flounder (*Rhombosolea tapirina*)

Stock Structure and Biology

Greenback Flounder has a wide distribution in Australia, from Jervis Bay on the central coast of New South Wales, around the south of the continent including Tasmania, and up to Mandurah on the south-eastern coast of Western Australia [Kailola et al. 1993]. They also occur in New Zealand [Sutton et al. 2010].

The broad distribution of Greenback Flounder in Australia is thought to be divisible into a number of separate biological stocks. Genetic studies have demonstrated that the most significant division occurs between Australian and New Zealand populations [van den Enden et al. 2000]. Within Australia, there is strong evidence that populations in western Tasmania are genetically isolated from populations in Victoria, and northern and south-eastern Tasmania. These results are consistent with those of Kurth [1957], who identified distinct western and eastern Tasmania populations based on morphometrics. Biological stock structure along the southern mainland coasts of Australia is not known.

Assessment Summary

In the absence of consistent, long-term estimates or population abundances and harvest by anglers, the status of the Victorian Greenback Flounder stock and its associated fisheries were evaluated using standardised CPUE from haul seine and mesh net catches of flounder and sole from commercial landings in Corner Inlet. This enabled use of the entire time period for which catch and effort were available, noting that there have been shifts in species reporting from 'Flounder, unspecified' to species-specific reporting. Given this, and the fact that Greenback Flounder are the most common all flounder (Greenback and Long-nosed) and sole species were combined (Figure 132). There could be disagreement with this, but it is reasonable to assume that many fishers may have misidentified these species in the past, and this was the only way to analyse the data back to 1978. Gear type was also limited to the two types based on catch history (Figure 133).

This assessment found:

- *Fishing pressure* – Victorian catches of this species have averaged 11 t annually over the past two decades and accounted for 73% of the national cumulative commercial catch over the past five years.

- *Biomass* – Haul seine catch rates have shown an increasing trend in the standardised curve since a trough in the early 1990s (Figure 134) but have been highly variable over time with peaks in the raw data in 1978/79, 1984/85, 1997/98, 2004/05 and 2011/12 (Conron et al. 2016). In contrast, the trend for mesh net catch-per-unit-effort (CPUE) follows a consistently negative trajectory which levelled out close to zero after the mid-2000s (Figure 134). This produces a conflicting impression about stock status, but the mesh net results have much higher uncertainty and hence are less reliable. This is because of a history of commercial operators targeting flounder, likely with specifically designed mesh nets (loosely slung with small drop), whereas in recent years fishers in Corner Inlet have predominantly targeted rock flathead and mesh net flounder landings are low. The two species would rarely be encountered together given that flounder live entirely on sand and rock flathead live entirely on seagrass in Corner Inlet so this would have a major bearing on CPUE unrelated to changes in biomass.

  The increasing trend in haul seine CPUE slowed asymptotically from the mid-2000s reaching its zenith in

2018/19 (Figure 134). It is unclear if it has now stabilised or is at the top of a cycle that will show a decreasing pattern over the next two decades like it did from the late1970s to early 1990s. Although the CPUE trends from the two different types of nets would indicate an undefined classification if the assumption that CPUE was reflecting biomass in each instance, the uncertainty in this assumption for mesh net CPUE supports relying exclusively on haul seine CPUE.

Stock status summary: Biomass proxy (CPUE) from haul seining is currently 1.5 times its long-term average (1986–2015). This is evidence that there is no recruitment impairment or biomass depletion, thereby implying that the stock of Greenback Flounder in Corner Inlet is sustainable.

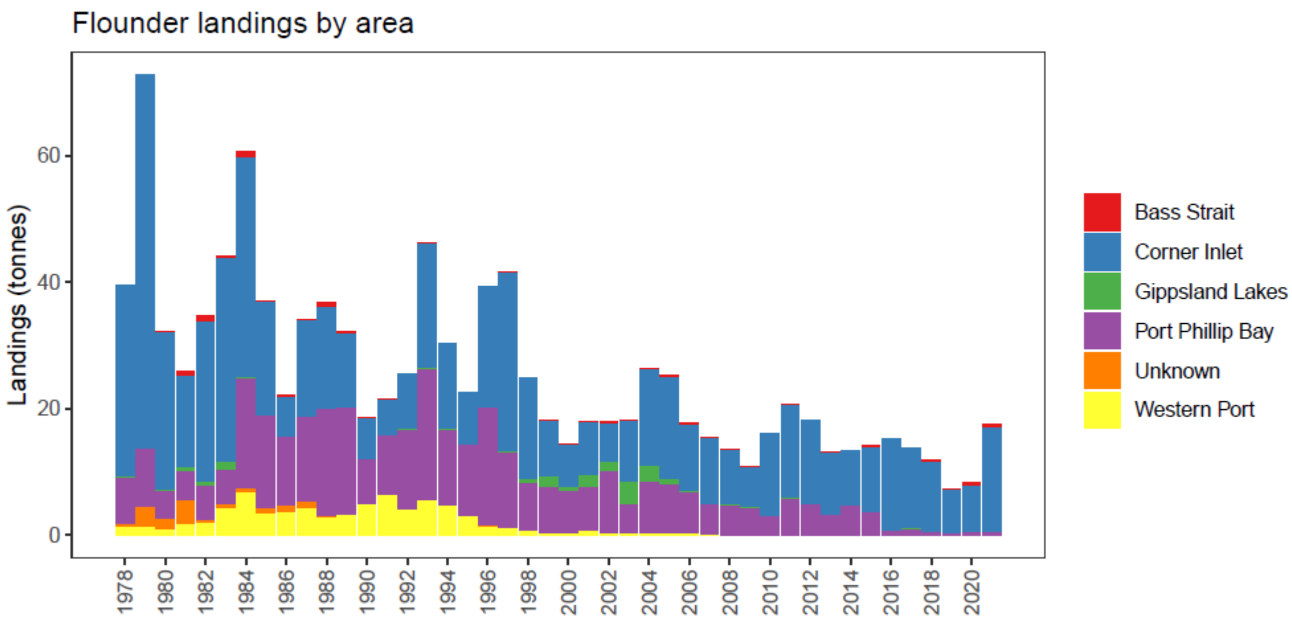


Figure 132 Catches of flounder and sole combined from reported commercial landings among Victorian bays and inlets (1978/79–2020/21 financial years).

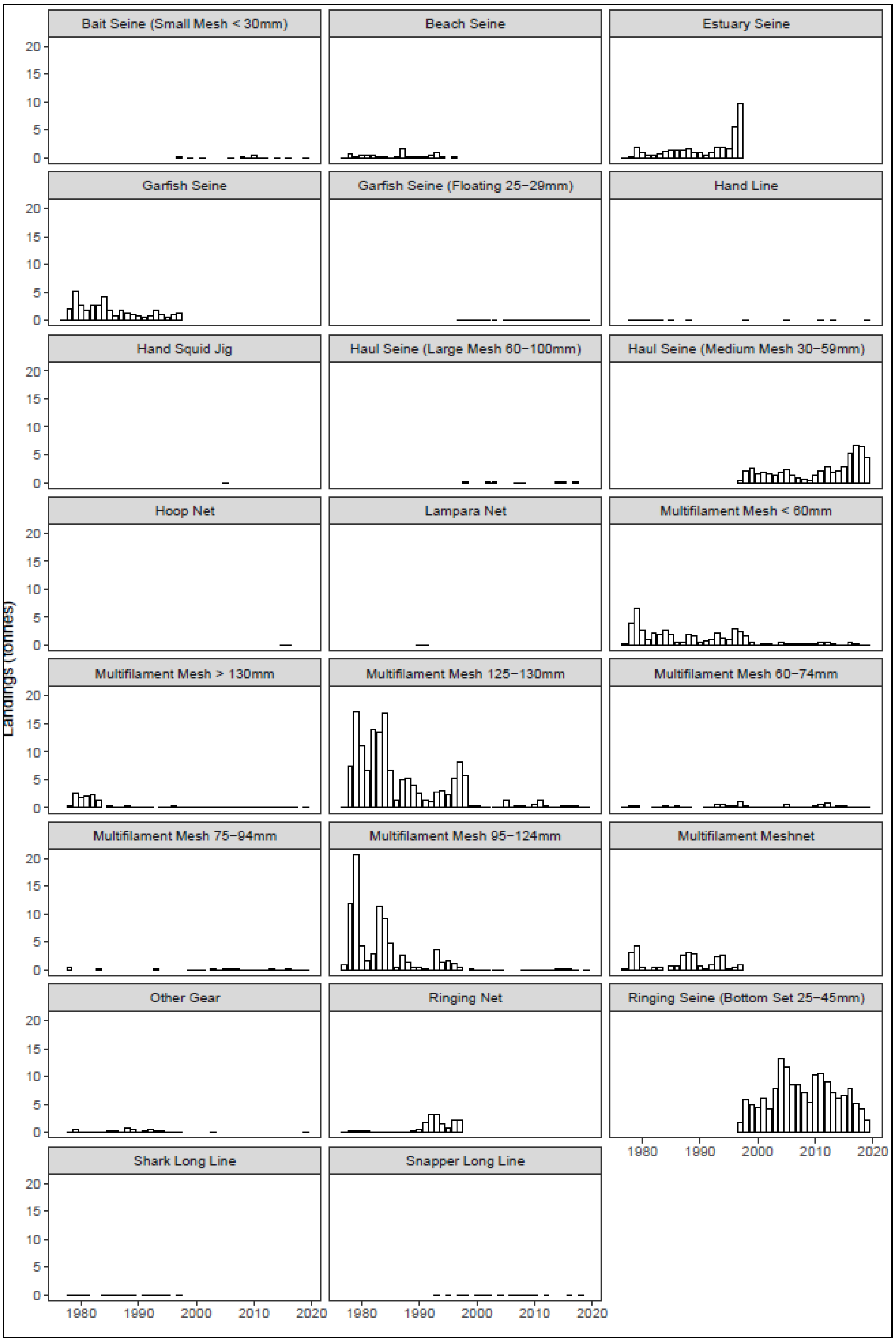
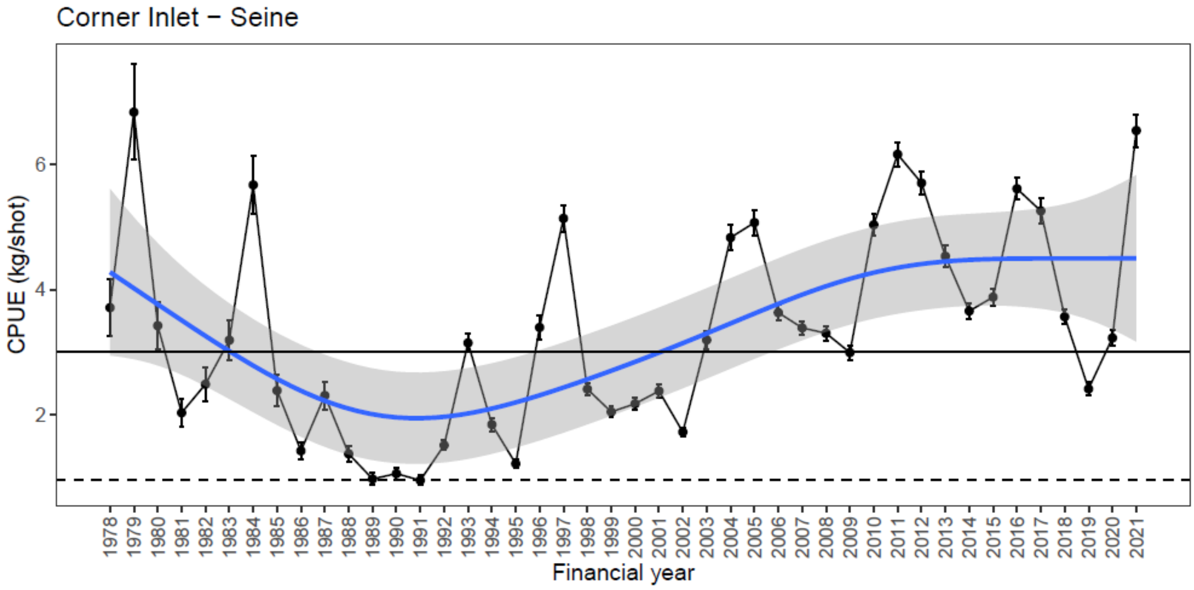


Figure 133 Catches of Greenback Flounder among gear types reported from Victoria during the past four decades.



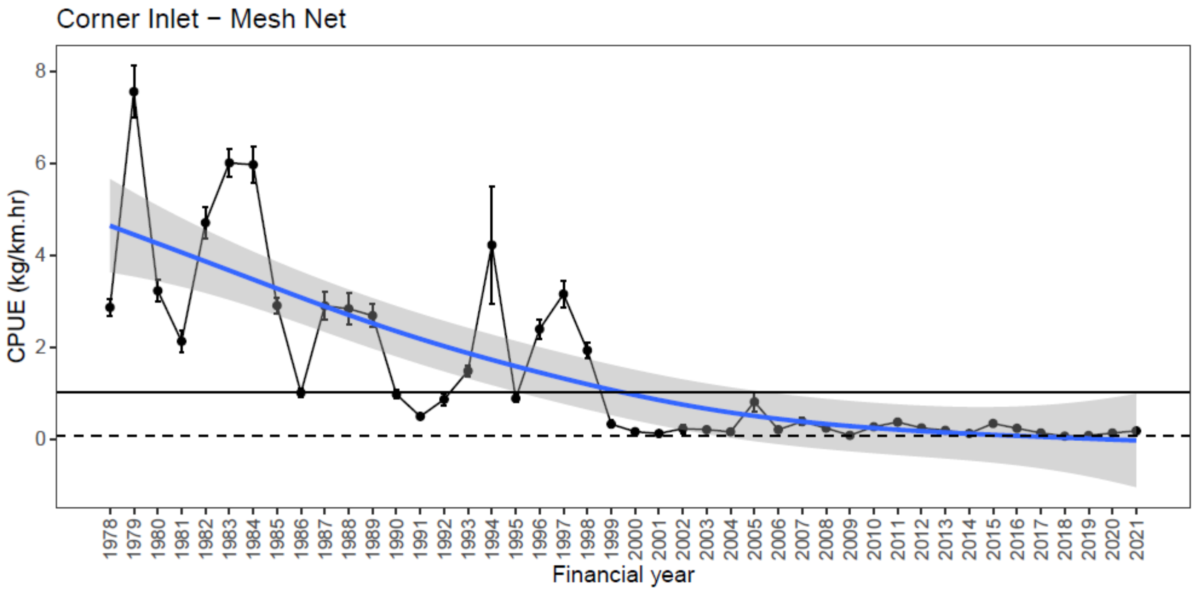
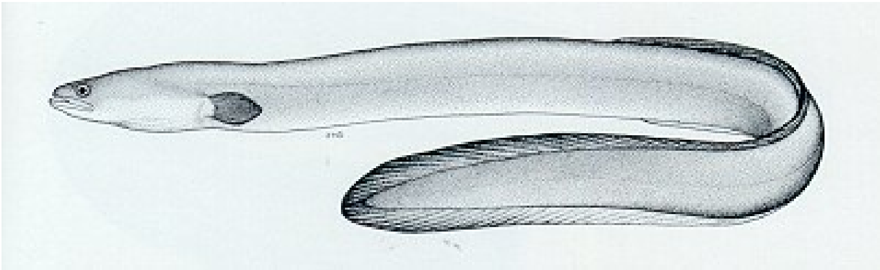


Figure 134 Catch-per-unit-effort (CPUE) for haul seine and mesh net catches from corner inlet during 1978/79 – 2020/21.

Southern Shortfin Eel (*Anguilla australis*)



Stock Structure and Biology

Southern Shortfin Eel is widespread in coastal streams of south-eastern Australia, from the Pine River in southern Queensland to the Murray River in South Australia, and Tasmania, and also occurs in New Zealand and western Pacific Islands (Beumer 1996). In Victoria, the species occurs in all coastal river catchments (Cadwallader and Backhouse 1983) and has been stocked into several inland lakes for aquaculture (REF). Genetic studies indicate that Southern Shortfin Eel represents two geographically separate subspecies; *A. australis australis* in Australia and *A. australis schmidtii* in New Zealand and western Pacific islands (Shen and Tzeng 2007). Three other eel species occur in Australia, *A. reinhardtii* (Longfin Eel) (*see chapter*), *A. obscura* and *A. bicolor*, the latter two being tropical species with limited distribution in Australia and with limited commercial harvest (Jellyman 2016). Shortfin eels reach a size of up to 1.1 m and 3.2 kg for females, and 0.5m and 0.25 kg for males (Beumer 1996). Shortfin eels, as with other *Anguilla* species, are catadromous, spending much of their life cycle in estuaries or fresh water, before returning to the ocean to reproduce and die. At time of migrating shortfin eels may be 10-30 years old. Australian eel species are thought to spawn in the Coral Sea region of the West Pacific Ocean. Based on collection of larvae, their ages and oceanic currents, Kuroki et al. (2020) suggested that shortfin eels spawn in June and July at locations between the Solomon Islands and Fiji. Following hatching, larvae (leptocephali) are transported toward the eastern Australian coastline by the South Equatorial Current, and then along the coast by the East Australian Current. Larvae metamorphose to glass eels, which actively swim toward and into the embayments and estuaries of the eastern Australian continent. Based on its life history and migration patterns, the shortfin eel is thought to constitute single biological stock across its range.

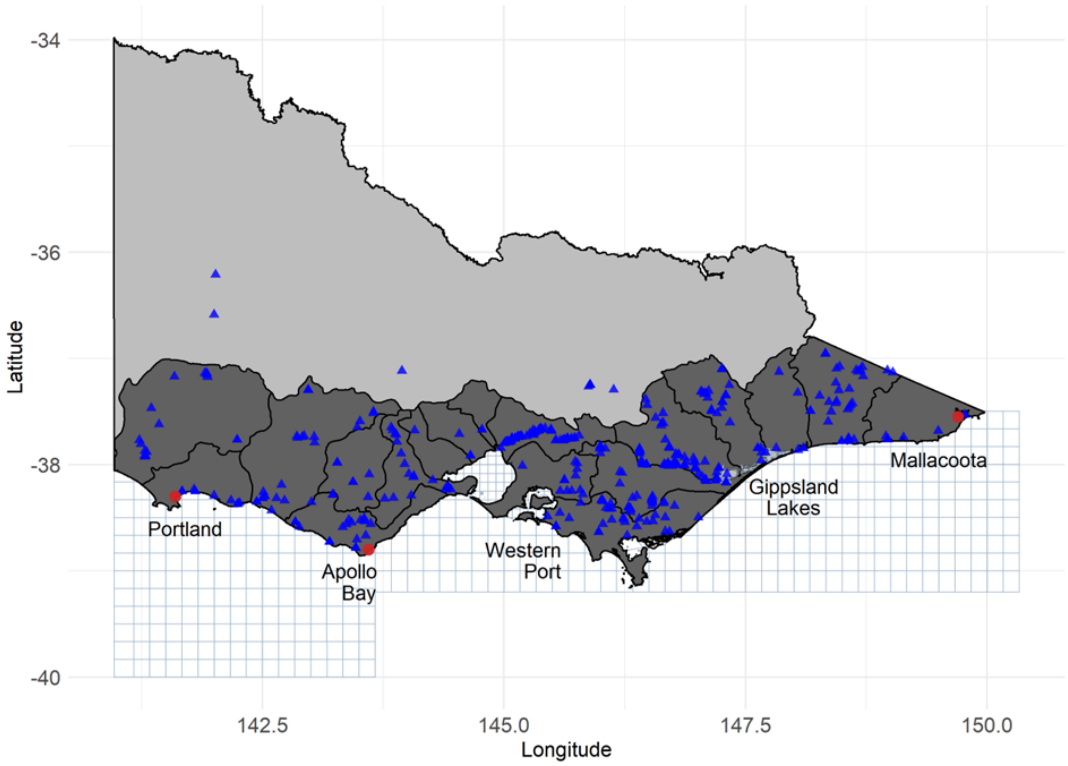


Figure 135 Southern Shortfin Eel distribution in Victoria (Dark shaded area = coastal river basins. Blue triangle = catch records from fisheries surveys).

Assessment Summary

The Victorian Eel Fishery is comprised of both Longfin Eel and Southern Shortfin Eel, which have different but overlapping distributions in estuarine and freshwaters east and south of the Great Dividing Range. Commercial fishing is generally confined to lower and estuarine reaches of waters that are open to fishing and predominantly targets migrating eels. The Victorian Southern Shortfin Eel Fishery, which is managed as one stock, supports both recreational and commercial fisheries.

The status of Southern Shortfin Eel was evaluated using:

- Available harvest information for the commercial eel fishery
- Nominal catch per unit effort (CPUE) for the commercial eel fishery fishing with fyke-nets.

This assessment found:

- *Fishing pressure* – The Victorian Southern Shortfin Eel Fishery is managed using a range of input controls and at least thirty per cent of all connected rivers, creeks and streams with a common opening to the sea are closed to commercial fishing (Victorian Fisheries Authority 2017). Since 1979/80 annual catch has been highly variable (Figure 136). Throughout the 1980s and 1990s annual catch ranged from 131–310 t, but thereafter declined considerably to an historic low of 32 t in 2010/11. This decline is attributed to the Millennium Drought (2000–2011), which ended following emergence of La Niña weather conditions. Since then annual catch has continued to vary, averaging 58 t per year with a low of 36 t in 2016/17 and a high the following year of 84 t (Figure 136).

  There is no long-term estimate of recreational harvest, but it is believed to be very low. In recent surveys of recreational fishing licence holders, <0.4 per cent of anglers fishing in rivers and lakes preferred to catch eels and just 2.6 per cent indicated their favourite fish in inland waters to catch was eel (Australian Survey Research 2012, 2018).

  Eel is an important resource for some Aboriginal communities. The use of fish traps, channels and aquaculture systems (ponds and dam walls) in western Victoria dates back tens of thousands of years (Head 1989, Richards 2011). However, no quantitative estimates of the Aboriginal harvest of eels from Victorian waters are available.

- *Biomass* – Annual CPUE during normal fyke net fishing operations (excluding large scale removals of many tonnes of stocked eels with seine nets ahead of impending drought), has ranged from 0.4 to 66 kg/net-day with an overall average of 18.7 kg/net-day since 1979/80 (Figure 137). Annual CPU declined following the Millennium Drought and since 2011/12 has been then has been low but relatively stable, ranging from 0.4 to 17.6 kg/net-day.

  Juvenile and undersized eels (elvers and “snigs”), known as “restock”, are netted from coastal rivers and relocated to designated culture lakes (confined lakes and impoundments) in inland western Victoria for on-growing to market size under an Aquaculture Licence. This practice, which commenced in the 1960s, is dependent on access to restock eels. Productivity from culture lakes is highly susceptible to short and long term and seasonal environmental variations, particularly drought (Victorian Fisheries Authority 2017). Since 2003 restock Southern Shortfin Eels have represented on average 14 per cent (2.8–48 per cent) of the total annual catch.

Stock status summary: The eel fishery is subject to strong environmental drivers that can severely reduce productivity. Nonetheless, the above 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 also 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, Southern Shortfin Eel in Victoria is classified as a sustainable stock.

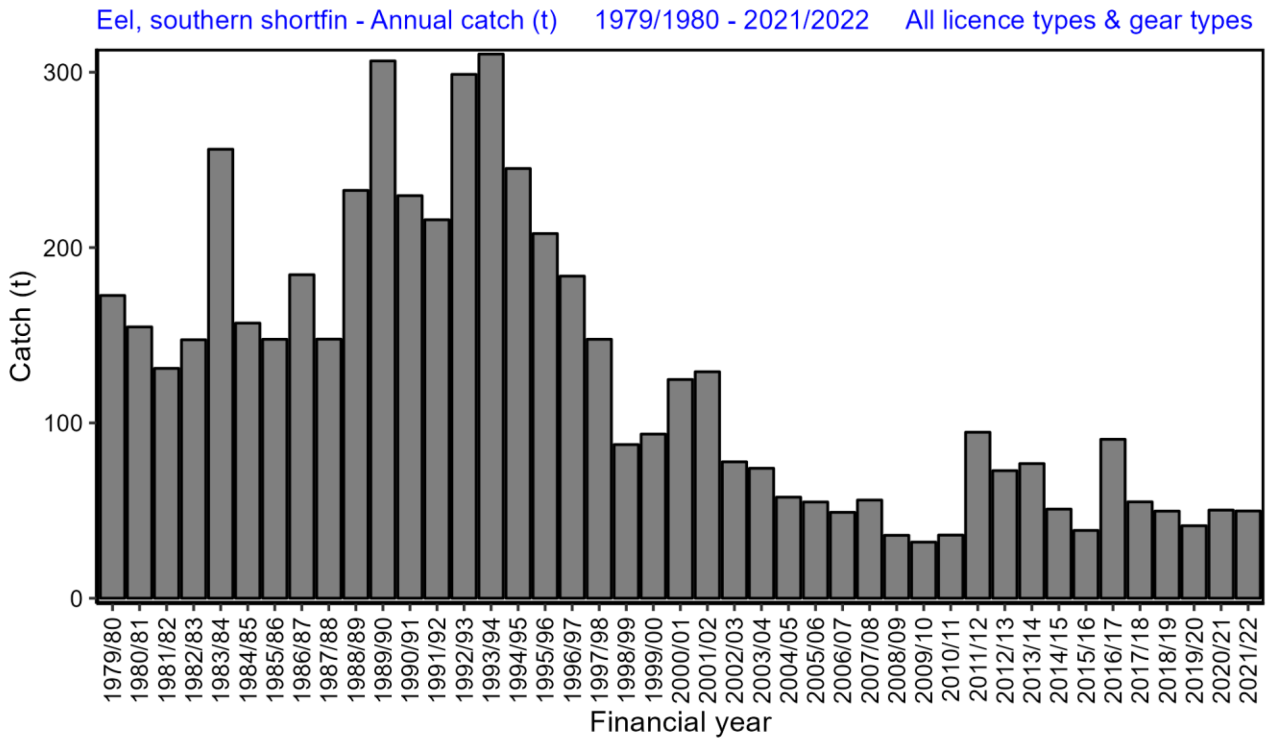


Figure 136 Southern Shortfin Eel harvest by Victorian licenced commercial operators during financial years 1979/79–2021/22.

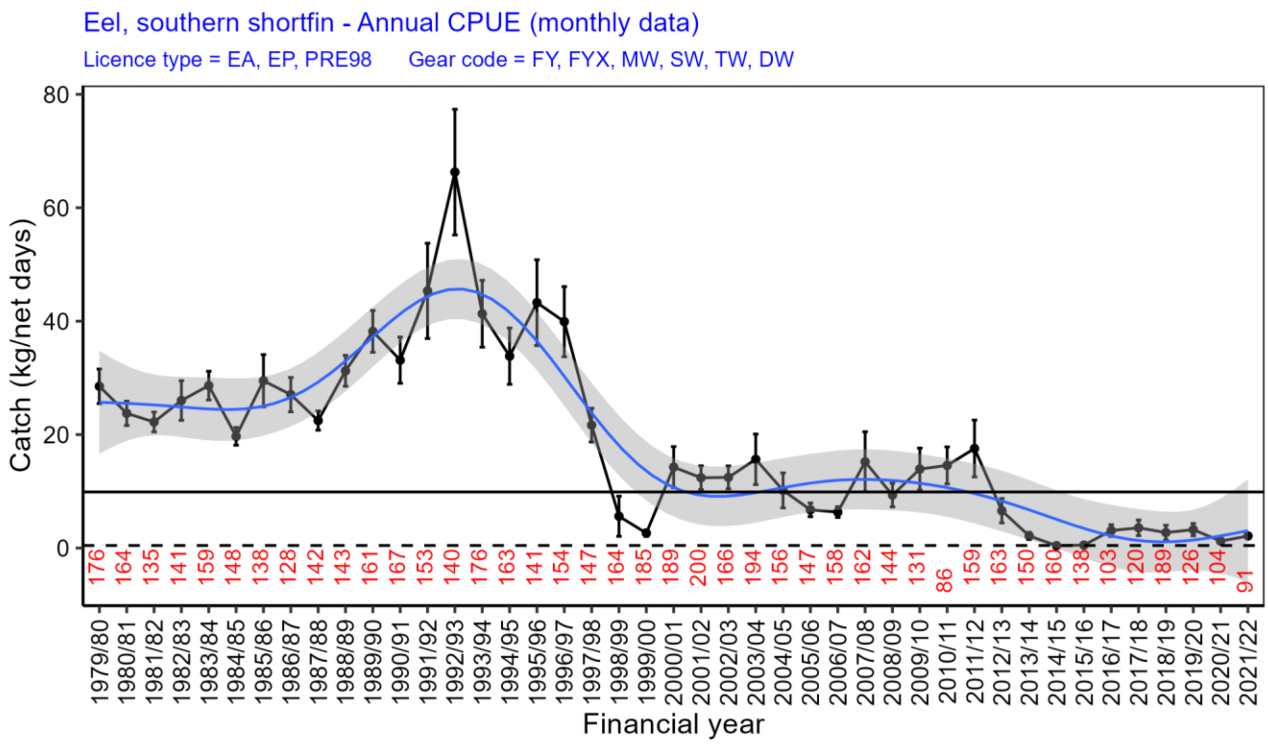
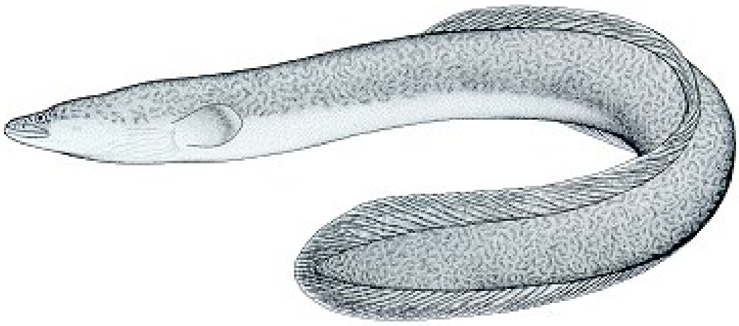


Figure 137 Nominal catch-per-unit-effort (CPUE) for commercial fyke net catches of Southern Shortfin Eels during 1979/80 – 2020/21.

Longfin Eel (*Anguilla reinhardtii*)



Stock Structure and Biology

Longfin Eel (*Anguilla australis*) occur in coastal streams from the Jardine River in northern Queensland to rivers east of Melbourne in Victoria (FIG), as well as northern and eastern Tasmania, New Caledonia and New Zealand (Cadwallader and Backhouse 1983, Beumer 1996). Spatial and temporal population genetic analysis of Longfin Eels in from east Australia indicate that populations are panmictic (Shen and Tzeng 2007). Longfin Eels reach a size of up to 1.65 m and 22 kg for females, and 0.65 m and 0.0.6 kg for males (Beumer 1996). Longfin Eels, as with other Anguilla species, are catadromous, spending much of their life cycle in estuaries or fresh water, before returning to the ocean to reproduce and die. Longfin Eels are relatively slow-growing and long-lived with estimates of maturity ages up to 52 years for females and 22 years for males being reported (Walsh 2004). Australian eel species are thought to spawn in the Coral Sea region of the West Pacific Ocean and small Longfin Eel (12.4, 12.5 mm) leptocephali have been collected south of the Solomon Islands (Kuroki et al. 2020). Following hatching, larvae (leptocephali) are transported toward the eastern Australian coastline by the South Equatorial Current, and then along the coast by the East Australian Current. Larvae metamorphose to glass eels, which actively swim toward and into the embayments and estuaries of the eastern Australian continent. Based on its life history and migration patterns, the Longfin Eel is thought to constitute single biological stock across its range.

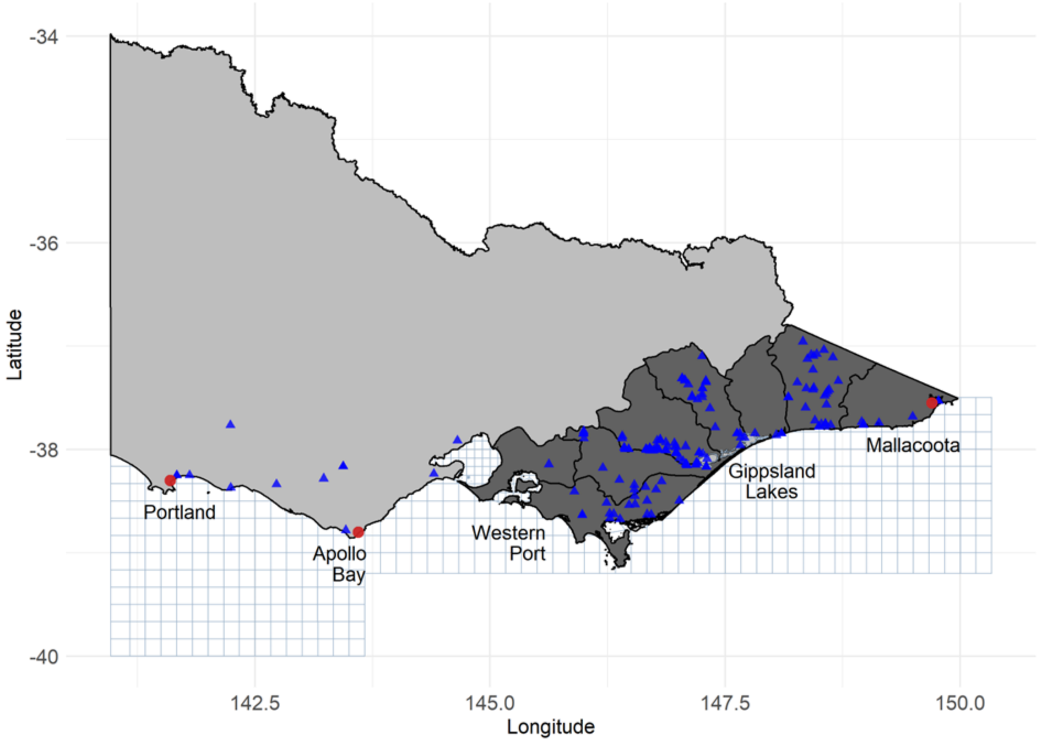


Figure 138 Longfin Eel distribution in Victoria (Dark shaded area = coastal river basins. Blue triangle = catch records from fisheries surveys).

Assessment Summary

The Victorian Eel Fishery is comprised of both Longfin Eel and Southern Shortfin Eel, which have different but overlapping distributions in estuarine and freshwaters east and south of the Great Dividing Range. Commercial fishing is generally confined to lower and estuarine reaches of waters that are open to fishing and predominantly targets migrating eels. The Victorian Longfin Eel Fishery, which is managed as one stock, supports both recreational and commercial fisheries.

The status of Longfin Eel was evaluated using:

- Available harvest information for the commercial eel fishery
- Nominal catch per unit effort (CPUE) for the commercial eel fishery fishing with fyke-nets.

This assessment found:

- *Fishing pressure* – The Victorian Longfin Eel Fishery is managed using a range of input controls and at least thirty per cent of all connected rivers, creeks and streams with a common opening to the sea are closed to commercial fishing (Victorian Fisheries Authority 2017). From 1979/80, annual catch increased to a peak of 59 t in 2004/05 (Figure 139). The Millennium Drought (2001–11) affected Longfin Eel catch less than that of Southern Shortfin Eel. Fishing pressure (effort) increased dramatically in the late 1990s but declined into the early 2000s, after which it was variable from year-to-year. Since the Millennium Drought annual catch has been variable, ranging 2.7–17.8 t (Figure 139).

  There is no long-term estimate of recreational harvest but it is believed to be very low. In recent surveys of recreational fishing licence holders, <0.4 per cent of anglers fishing in rivers and lakes preferred to catch eels and just 2.6 per cent indicated their favourite fish in inland waters to catch was eel (Australian Survey Research 2012, 2018).

  Eel is an important resource for some Aboriginal communities. The use of fish traps, channels and aquaculture systems (ponds and dam walls) in western Victoria dates back tens of thousands of years (Head 1989, Richards 2011). However, no quantitative estimates of the Aboriginal harvest of eels from Victorian waters are available.

- *Biomass* –Between 1979/80 and 2000/01 nominal average annual CPUE was 1.6-18.8 kg per net-day (mean 10.3 kg per net-day). Throughout the Millennium Drought CPUE declined, reaching its lowest value of 0.24 kg per net-day in 2011-12. Since then, however, CPUE has been slowly but steadily increasing to an annual average of 0.5–1.09 in the last three years (Figure 140).

  Juvenile and undersized eels (elvers and “snigs”), known as “restock”, are netted from coastal rivers and relocated into designated culture lakes (confined lakes and impoundments) in inland western Victoria for on-growing to market size under an Aquaculture Licence. This practice, which commenced in the 1960s, is dependent on access to restock eels. Productivity from culture lakes is highly susceptible to short and long term and seasonal environmental variations, particularly drought (Victorian Fisheries Authority 2017).

Stock status summary: Despite strong environmental drivers that can severely reduce productivity, the Victorian Longfin Eel fishery is well-managed using a range of input controls and at least thirty per cent of all connected rivers, creeks and streams with a common opening to the sea are closed to commercial fishing. The above evidence indicates that the biomass of this stock is unlikely to be depleted and that recruitment is unlikely to be impaired. The above evidence also indicates that the current level of fishing mortality is unlikely to cause the stock to become recruitment impaired. On the basis of the evidence described above, Longfin Eel in Victoria is classified as a sustainable stock.

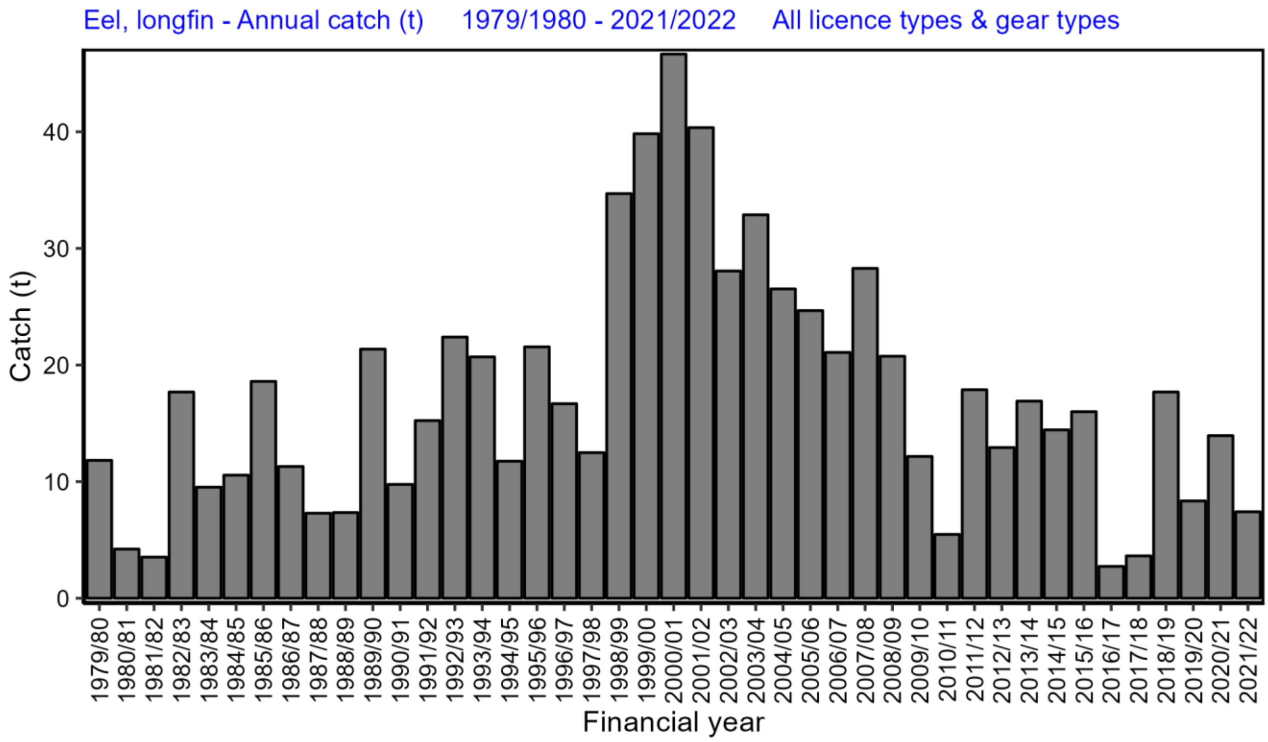


Figure 139 Longfin Eel harvest by Victorian licenced commercial operators during financial years 1979/79–2021/22.

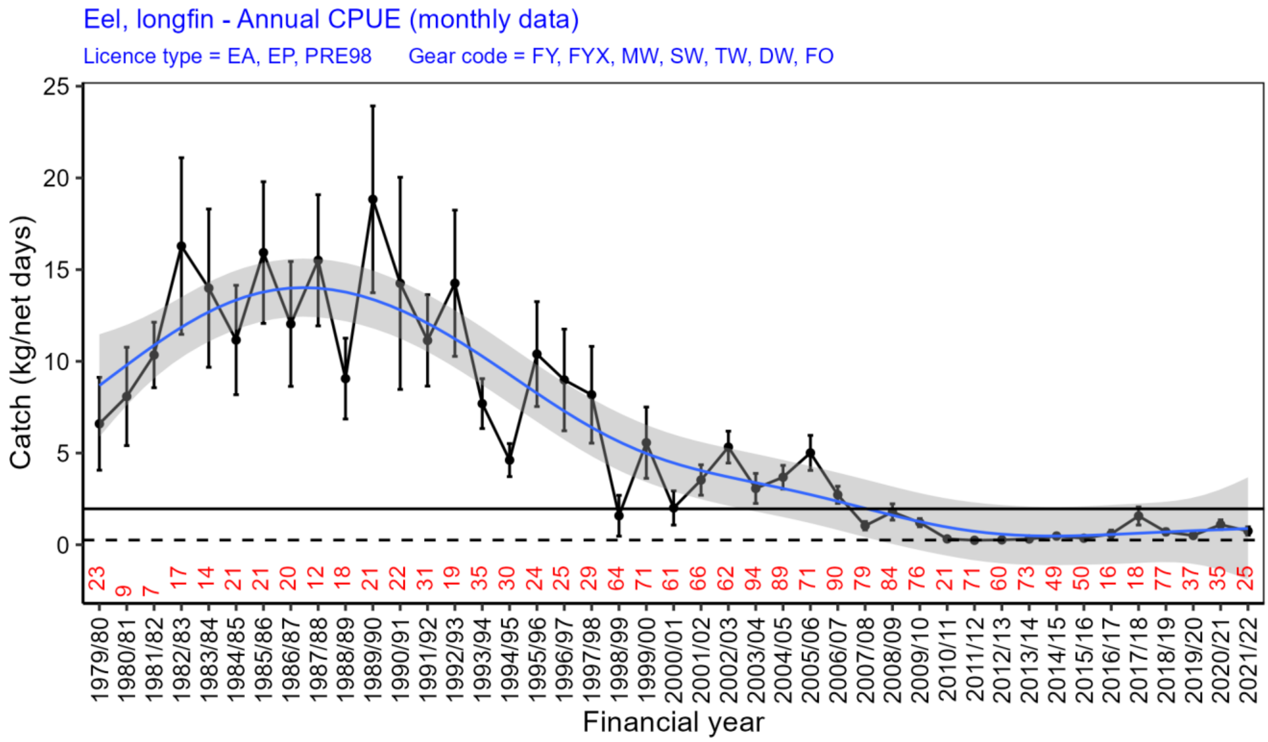


Figure 140 Nominal catch-per-unit-effort (CPUE) for commercial fyke net catches of Longfin Eels during 1979/80 – 2020/21.

Eastern School Prawn (*Metapenaeus macleayi*)

Stock Structure and Biology

Eastern School Prawn fisheries occur along the east coast of Australia, in Queensland, New South Wales and Victoria. Genetic work on the biological stock structure of this species is limited. There is evidence for some minor genetic differentiation of Eastern School Prawn in the Tweed River and Noosa River from Eastern School Prawn in other estuaries, but estuaries within New South Wales appear to be generally genetically homogenous [Mulley and Latter 1981]. No genetic information is available for Victorian populations.

Assessment Summary

The Victorian Eastern School Prawn is caught primarily as part of the commercial Inshore Trawl Fishery (ITF), operating mainly off the Gippsland coast of eastern Victoria and accounting for 97% of the total Victorian catch of this species since 2000. The fishery is seasonal with effort concentrated in the warmer months. The balance of the catch used to come from the Gippsland Lakes Fishery (GLF), which closed at the end of March 2020 following a buy-out of all commercial netting licences. Recreational catch is unknown. School prawns are mostly taken incidentally while targeting king prawns.

This assessment found:

- *Fishing pressure* – Average annual catch since 2000–01 was 27.8 t. Since the early 2000s annual catch has generally increased to a peak of 113.7 t in 2016–17 but then declined and since 2020–21 has been between 16.2 and 24 t (Figure 141). Daily landings over the past three decades have typically varied between 50 and 175 kg (Figure 142).

- *Biomass* – CPUE (kg/trawl hour) has undergone several large fluctuations in the nominal data every 3–5 years since 2000–01, and since 2020–21 has been below the mean CPUE of 2.46 kg/trawl hour) for the reference period 1986–2015. CPUE prior to mid to late 2000s are unreliable, but reporting is accurate from 2010 onwards. Biomass now appears to be depleting over the last five years following the unprecedented peak in reported catch during 2016, is below the target reference line but is still well above the limit reference point (Figure 143).

Stock status summary: Despite explanations other than declining biomass for the recent trend in CPUE including that it is mainly a by-product species, that there are likely be very strong environmental drivers influencing recruitment independently of fishing mortality, and uncertainty about the data quality influencing the trend prior to 2010, quantitative evidence since indicts the stock is depleting. It is unclear if the much-reduced catch is sufficiently low for the stock biomass to increase in future years.

The above evidence indicates that the biomass of this stock is unlikely to be depleted and that recruitment is unlikely to be impaired, but although the current level of fishing mortality might cause the stock to become recruitment impaired, this is uncertain.

On the basis of the evidence described above, Eastern School Prawn stock status for the component taken by Victoria’s ITF cannot be determined.

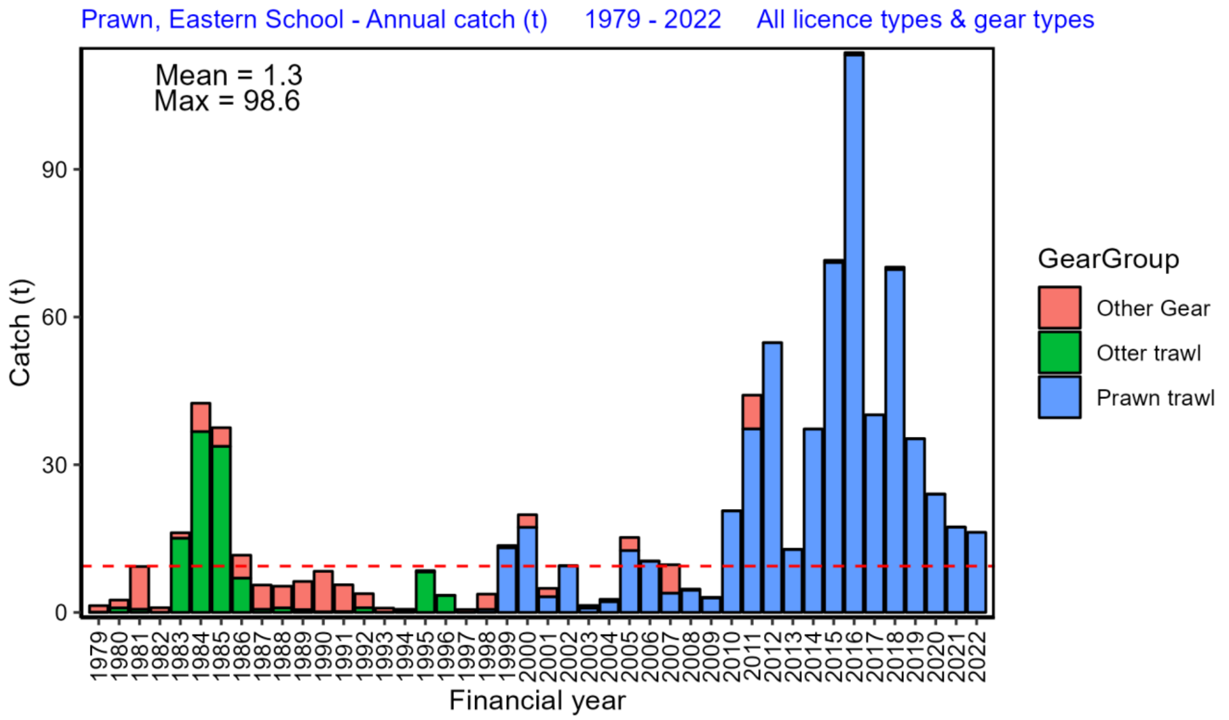


Figure 141 Catches of Eastern School Prawn by gear type from Victorian-managed waters during 1979 to 2022.

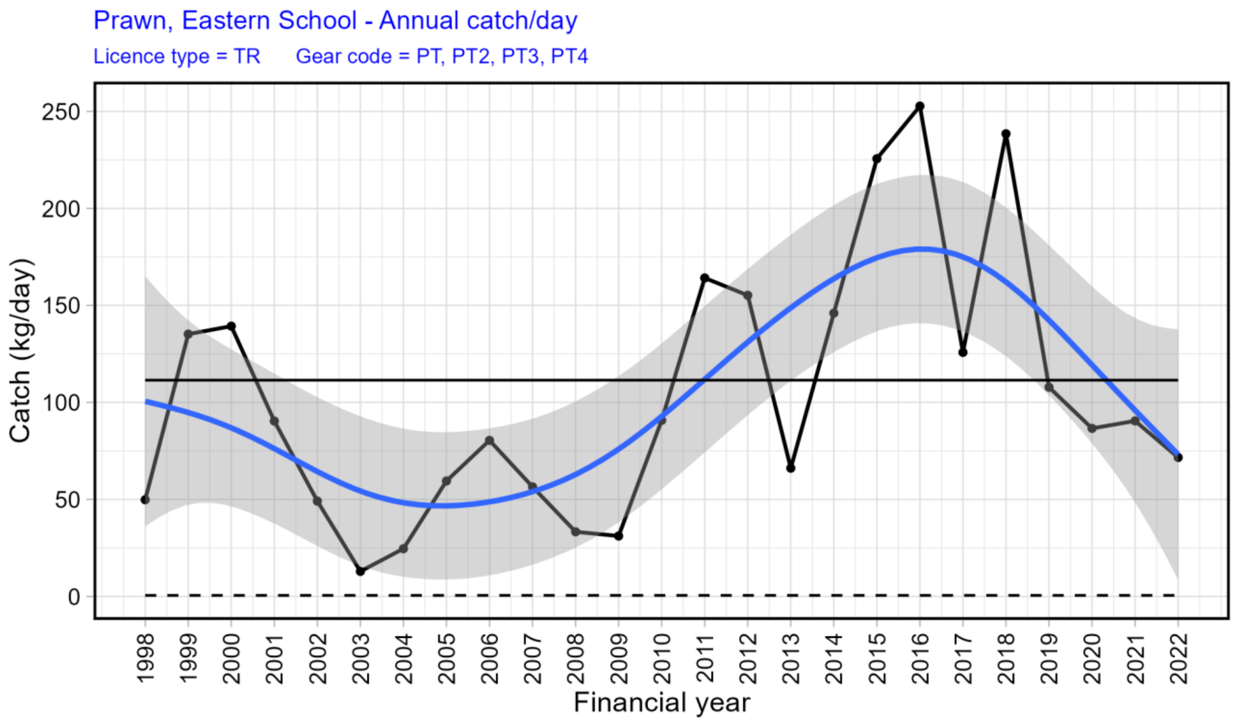


Figure 142 Mean daily catches of Eastern School Prawn by the Victorian inshore trawl fishery during 1998 to 2022. Horizontal black dashed line is the mean nominal CPUE during the reference period (first record since 1996 to 2022) and the dashed black line is the minimum CPUE within the reference period. 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.

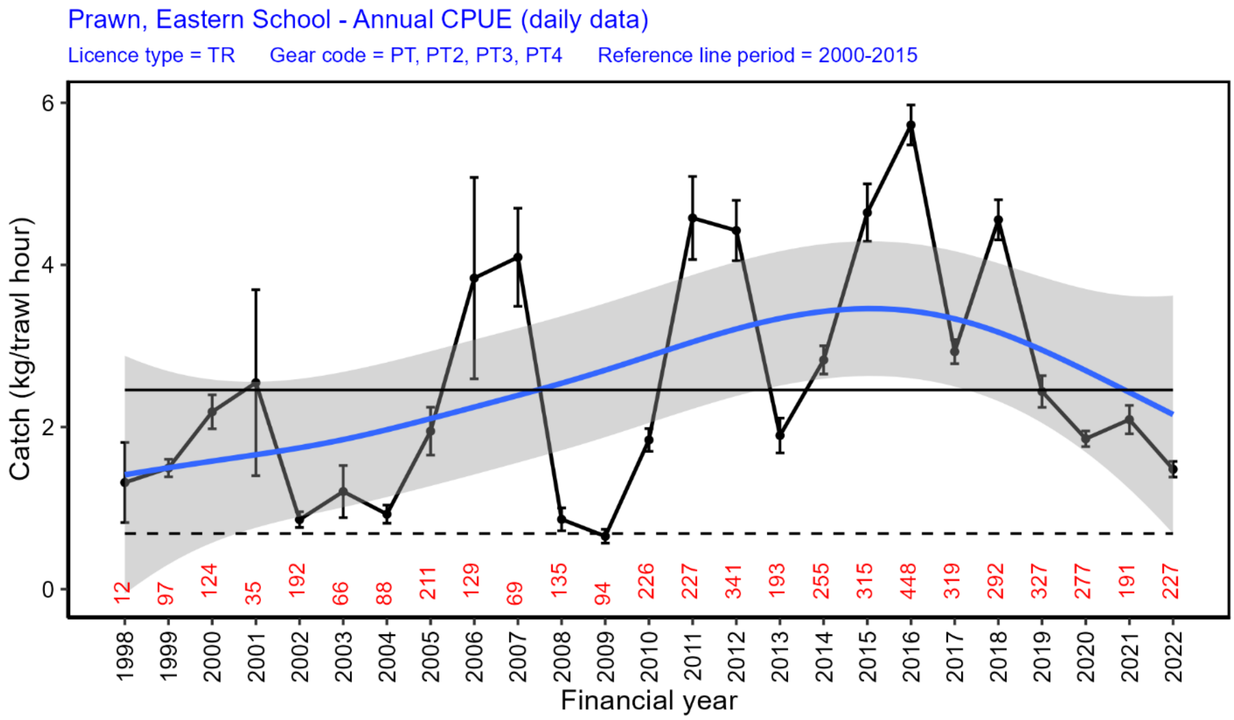


Figure 143 Catch-per-unit-effort (CPUE) (nominal) for Eastern School Prawn by the Victorian inshore trawl fishery during 1998 to 2022. Horizontal black dashed line is the mean nominal CPUE during the reference period (first record since 1996 to 2022) and the dashed black line is the minimum CPUE within 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 observations (fishing events) each year.

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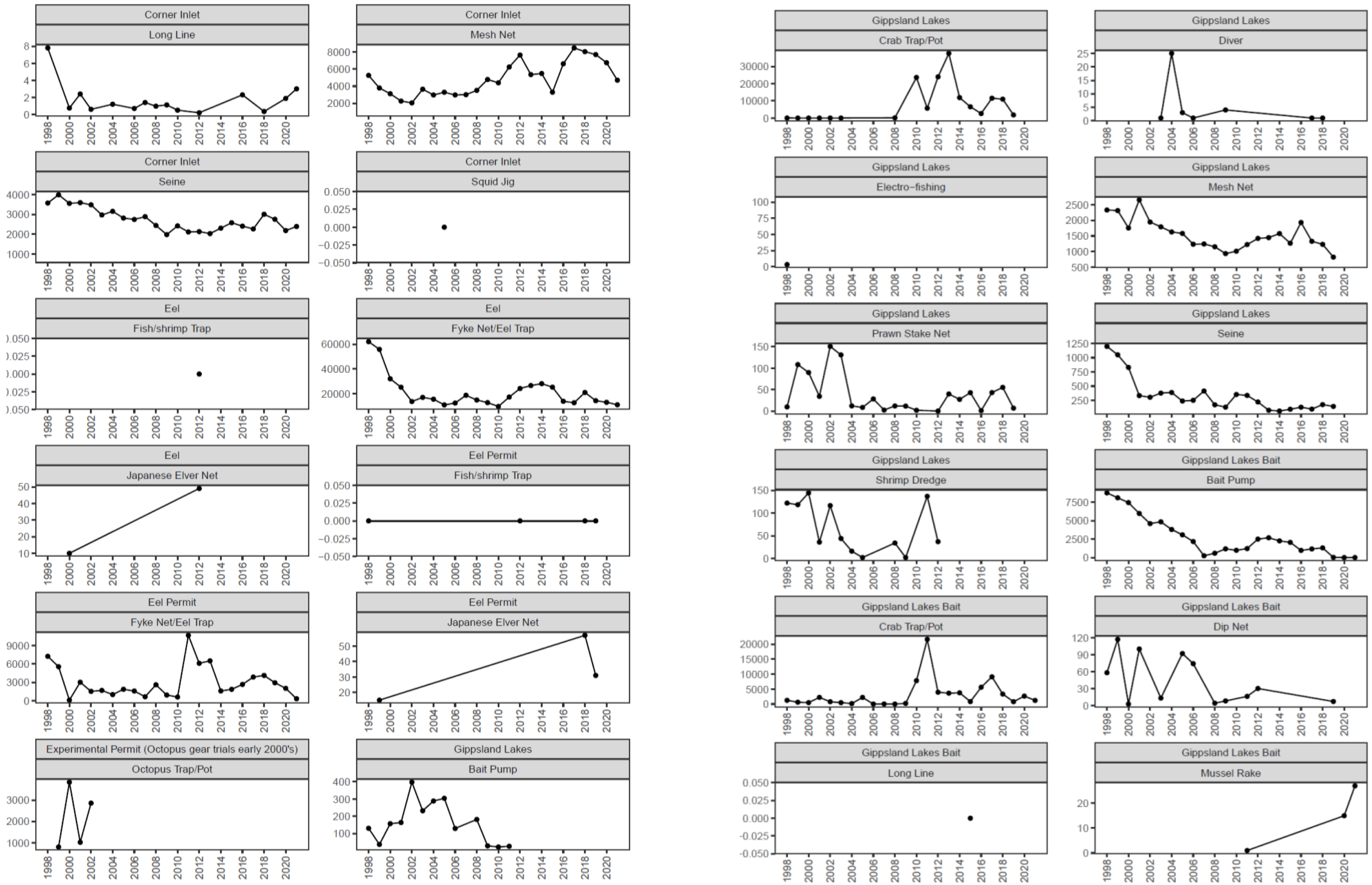
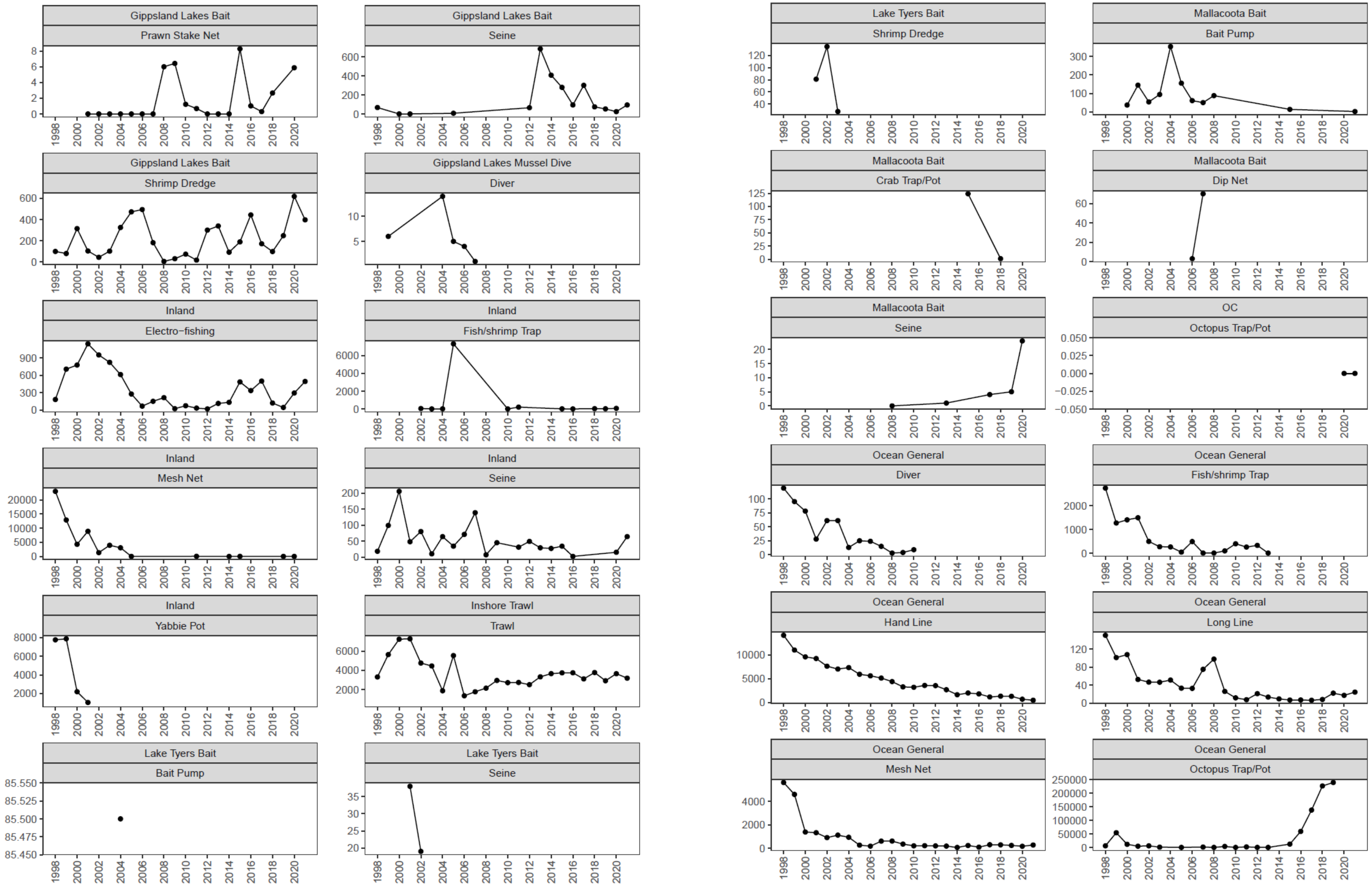
Appendix 1 – Methods

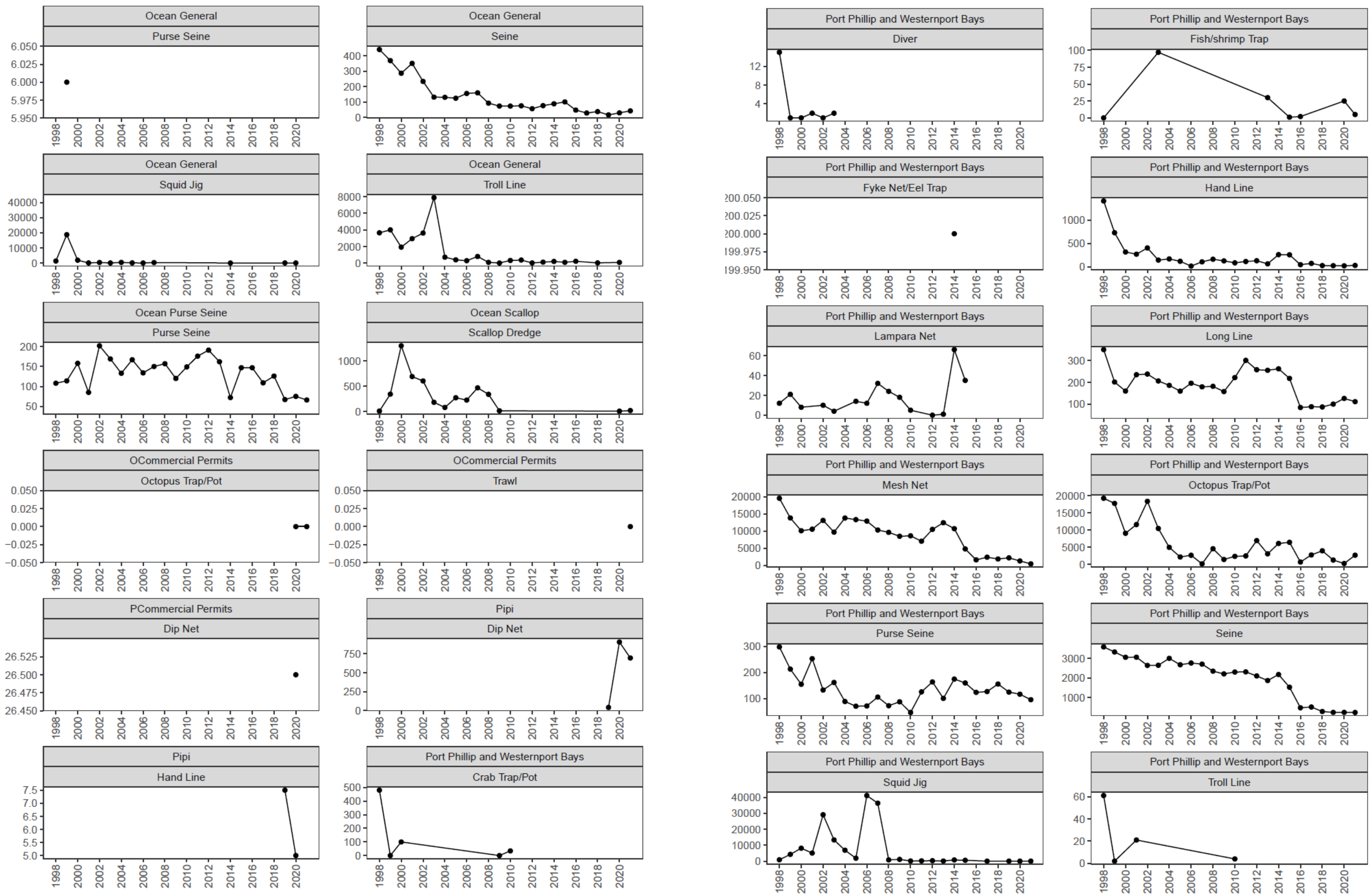
Standardisation and GAMs

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 in 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 fit 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 a 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




Gippsland Lakes Bait
Prawn Stake Net
Gippsland Lakes Bait
Seine
Lake Tyers Bait
Shrimp Dredge
Mallacoota Bait
Bait Pump
Gippsland Lakes Bait
Shrimp Dredge
Gippsland Lakes Mussel Dive
Diver
Mallacoota Bait
Crab Trap/Pot
Mallacoota Bait
Dip Net
Inland
Electro−fishing
Inland
Fish/shrimp Trap
Mallacoota Bait
Seine
OC
Octopus Trap/Pot
Inland
Mesh Net
Inland
Seine
Ocean General
Diver
Ocean General
Fish/shrimp Trap
Inland
Yabbie Pot
Inshore Trawl
Trawl
Ocean General
Hand Line
Ocean General
Long Line
Lake Tyers Bait
Bait Pump
Lake Tyers Bait
Seine
Ocean General
Mesh Net
Ocean General
Octopus Trap/Pot


Ocean General
Purse Seine
Ocean General
Seine
Port Phillip and Westernport Bays
Diver
Port Phillip and Westernport Bays
Fish/shrimp Trap
Ocean General
Squid Jig
Ocean General
Troll Line
Port Phillip and Westernport Bays
Fyke Net/Eel Trap
Port Phillip and Westernport Bays
Hand Line
Ocean Purse Seine
Purse Seine
Ocean Scallop
Scallop Dredge
Port Phillip and Westernport Bays
Lampara Net
Port Phillip and Westernport Bays
Long Line
OCommercial Permits
Octopus Trap/Pot
OCommercial Permits
Trawl
Port Phillip and Westernport Bays
Mesh Net
Port Phillip and Westernport Bays
Octopus Trap/Pot
PCommercial Permits
Dip Net
Pipi
Dip Net
Port Phillip and Westernport Bays
Purse Seine
Port Phillip and Westernport Bays
Seine
Pipi
Hand Line
Port Phillip and Westernport Bays
Crab Trap/Pot
Port Phillip and Westernport Bays
Squid Jig
Port Phillip and Westernport Bays
Troll Line

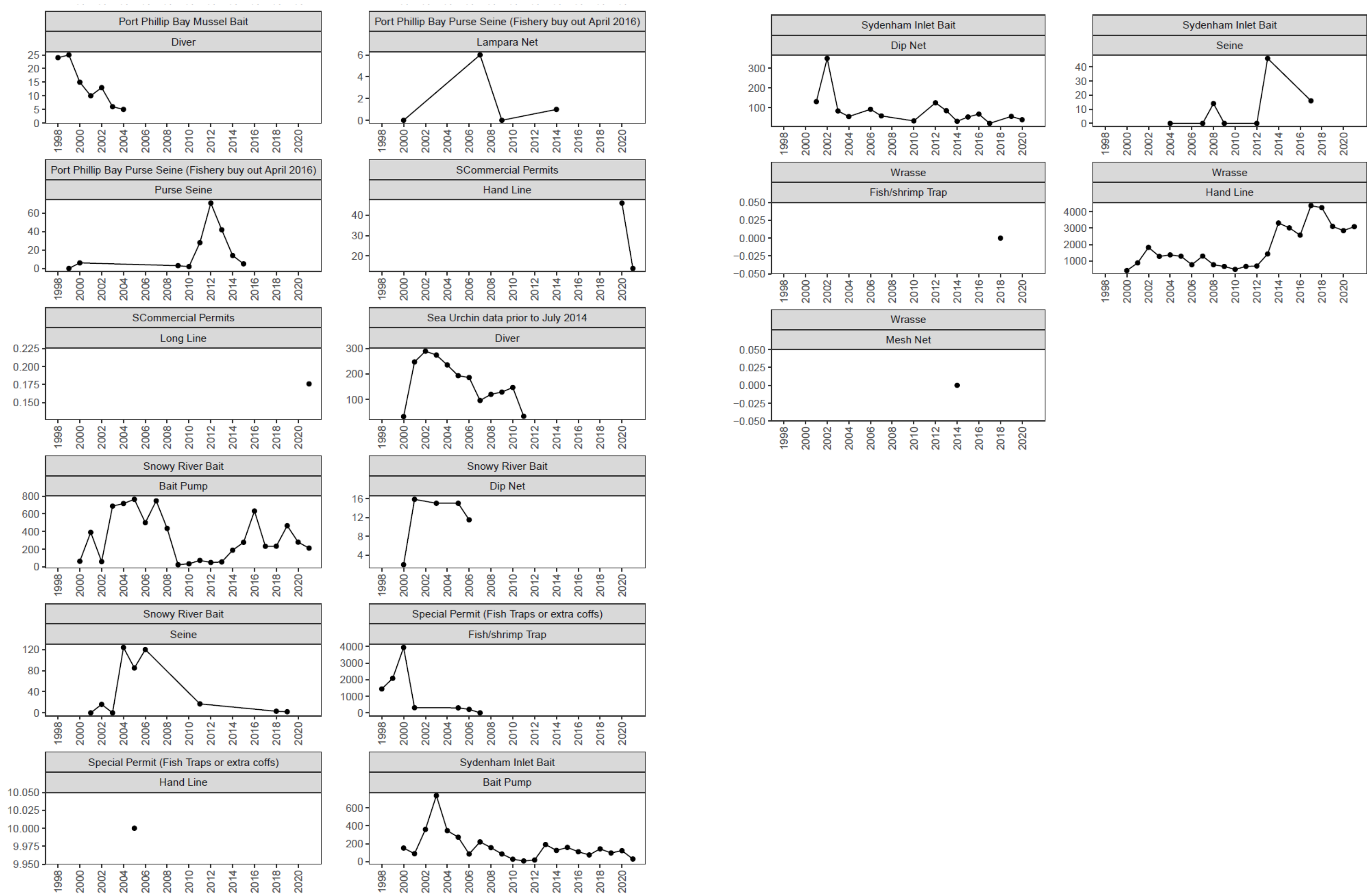


Figure A2.0: Commercial fishing effort by various gears in Victorian waters. Effort units are: hrs for handline and squid jig, '000 hooklifts for long line, km.hrs for mesh net and number of shots for seine and trawl.

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	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	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	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
Wrasse	East/central/west wrasse management zones	Commercial	Fishers with <10 days effort Days of fishing with <5kg catch or <2/>10 hours of effort. 1998 onward only	Model: GLMM. Error distribution: Gamma. Link: Log.	CPUE + 0.01	Financial year	Area + Month + Area:FinancialYear + Month:Year + Fisher:FinancialYear
Commercial Scallop	Port Phillip Bay	Commercial	Catch >10 kg, >30 minutes dive time	Model: GLMM. Error distribution: Gamma. Link: Log.	CPUE	Financial year	Fisher + Area + Month + Fisher:Area
Banded Morwong	Eastern Victoria	Commercial	Catch > 0, Banded morwong licence only, live banded morwong only.	Model: GLMM. Error distribution: Gamma. Link: Log.	CPUE	Financial year	Fisher + Area + Month + Fisher:Area + Fisher:FinancialYear

Gummy Shark	Western Port	Recreational	Target gummy shark, #fisher >0 and <20, fished >0.5 hrs	Model: GLMM Error distribution: Negative binomial. Link: Log. Offset: Log(angler hours).	Retained gummy shark	Financial year	Avidity + Season + Year:Area + Season:Year
Elephant Fish	Western Port	Recreational	Target elephant fish, gummy shark or snapper; March-May, #fisher >0 and <20, fished >0.5 hrs	Model: GLMM Error distribution: Negative binomial. Link: Log. Offset: Log(angler hours).	Retained elephant fish	Financial year	Targeting*** + Month + Area

*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 many 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/).

***Due to low elephant fish abundance in Western Port in recent years, anglers infrequently target them. Thus, it is necessary to include targeting of other species (gummy shark and snapper) for which fishing gears with high elephant fish catchability are used in order to maintain the time series. To account for differential targeting, “TargetSpecies” is included in the model as a factor (i.e. elephant fish, gummy shark, snapper).

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